BDA Open-Source Model

The Case for The Building Decarbonization Alliance Open-Source Model

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About the Building Decarbonization Alliance:

An initiative of the Transition Accelerator, the **Building Decarbonization Alliance (BDA)** is a non-partisan cross-sectoral coalition that works to inspire and inform industry and government leadership, accelerate market transformation, and get the building sector on track to meet Canada's emission reduction goals. The BDA convenes conversations, conducts original analysis, and identifies structural barriers to building decarbonization—we then work with our partners to overcome them. Our vision is to create a future where electrified buildings are part of an affordable and resilient energy systems that contributes to a **prosperous, sustainable and decarbonized Canada**. One of the BDA's primary market transformation strategies is to enhance the analytical capacity of the building sector.

About The Transition Accelerator

The Transition Accelerator is a pan-Canadian organization that exists to support Canada's transition to a net-zero future while solving societal challenges. Using our four-step methodology, The Accelerator works with innovative groups to create visions of a socially and economically desirable net-zero future. We then work to build out credible, capable and compelling transition pathways to make these visions a reality. The Accelerator's role is that of an enabler, facilitator, and force multiplier that forms coalitions to take steps down these pathways and get change moving on the ground.

Get Involved!

The BDA believes the increased analytical capacity provided by this model will help the industry move toward a vision of "a future where electrified buildings are part of an affordable and resilient energy system that contributes to a prosperous, sustainable, and decarbonized Canada" and our mission "to serve as a cross-sectoral coalition working to accelerate the electrification of buildings in Canada."

A Call to Modellers, Researchers, Academics, Consultants, and Data Managers:

The BDA is now releasing the Minimum Viable Product (MVP) of the model and analyzing preliminary policy scenarios. If you have experience related to the Canadian building industry, we welcome the opportunity to collaborate to inform and review our assumptions, datasets and modelling results. In early 2024, we will be establishing an advisory committee to oversee the development of the model, along with working groups to iterate and advance its development. Our goal is not to displace or repeat work done elsewhere in Canada. We wish to aggregate and build on existing expertise to accelerate the transition of Canada's building industry.

A Call to the Canadian Building Industry:

The BDA will be conducting a stakeholder engagement series across Canada, and we want to hear from the industry about our modeled results. The feedback from these sessions will help prioritize the next features for consideration by the advisory council and will feed into our working groups. Stakeholders whom we believe should take an interest include but are not limited to:

- Utilities
- Policy makers
- Governments
- Construction companies and developers
- Manufacturers and distributors
- Contractors and advisory services firms

If you are interested in being involved in an advisory council or working groups, please reach out to info@buildingdecarbonization.ca.

Join Us!

If you support BDA's mission and wish to be included in future research, newsletters and events, please visit www.buildingdecarbonization.ca to learn how to become a Partner, or reach out to us at info@buildingdecarbonization.ca to find out how you can help accelerate building electrification.

Executive Summary

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There is currently a gap in publicly available analytical capacity to evaluate the impacts of building decarbonization measures in Canada. Models that are publicly available and open source tend to be so-called “top-down” models which occupy a broad econometric scope. By practical necessity, these models lack the granularity required to fully incorporate Canada’s varied building stock, the range of available technological measures, and provincial or regional differences into their outputs.

Conversely, many “bottom-up” models exist at useful granularities, but these tend to be proprietary, closed-source models and therefore are not available for direct review—or direct use—by stakeholders. These models also tend to be built for specific regions and are rarely capable of creating a national roll-up of results.

The Government of Canada’s own top-down economic emission models have been reviewed by the Office of the Auditor General (OAG) Environment Commissioner and found to be lacking with respect to how assumptions and interactive effects are managed, and with transparency of inputs and results.[1] The Commissioner called for increased collaboration and a Forum integrating the Energy Modeling Hub (EMH) into its framework.

Canada’s Net-Zero Advisory Body has identified that Canada’s modelling community is fragmented, and opaque, and that there is a lack of coordination in the modeling community and government. It called for the establishment of a modeling and data centre of excellence to improve modeling methods, data and transparency.[2]

“Canada’s Net-Zero Advisory Body has identified that Canada’s modelling community is fragmented, and opaque, and that there is a lack of coordination in the modeling community and government.

To begin to address some of these issues for the building sector, the Building Decarbonization Alliance (BDA), a non-partisan building industry coalition, has designed and built a model that allows policy makers to evaluate how various building decarbonization measures impact different areas of Canada under a range of input assumptions. The Building Decarbonization Alliance Open-Source Model (BDA-

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[1] Reports of the Commissioner of the Environment and Sustainable Development to the Parliament of Canada Canadian Net-Zero Emissions Accountability Act— 2030 Emissions Reduction Plan, Report 6.

[2] Compete and Succeed in a Net Zero Future First Annual Report to the Minister of Environment and Climate Change, January 2023

OSM) is focused on decarbonizing Canada's new and existing residential, commercial, and institutional buildings. The results will initially be calculated on both national and provincial levels. This model is a joint initiative hosted in partnership with the Energy Modelling Hub and the University of Victoria.

The BDA-OSM incorporates multiple residential, commercial, and institutional building archetypes specific to each climate zone. With an initial focus on space heating and cooling and water heating, the user can customize policy scenarios and compare the impacts on equipment count, energy consumption, peak load, emission reductions, and cost. These outputs can be calculated based on aggregated energy end-uses in each building archetype and region across Canada.

The BDA-OSM is designed to be flexible, transparent, powerful, collaborative, agile and accessible.

The BDA-OSM is designed to be open-source—all data, assumptions, and calculations will be made public. The iterative development process will invite stakeholders to challenge inputs and assumptions and contribute to the model's evolution, with the goal of creating and managing a model that acknowledges and reduces modelling biases, and that reflects reality to the best degree possible.

"The BDA-OSM is designed to be flexible, transparent, powerful, collaborative, agile and accessible.

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The BDA has completed the process of developing the first iteration of the model and preliminary scenario analysis. This "Minimum Viable Product" (MVP) is a proof of concept constituting a stand-alone model using input and output files in a .csv format. The model will be hosted within the Energy Modelling Hub GitLab database by early 2024. The BDA will then work to develop data visualization tools and conduct a stakeholder engagement series to continue model development in an iterative, open-source process.

This initiative is designed to produce an evergreen model, which will be both modular and iterative, and will evolve based on user feedback and engagement. The long-term view is that this model will become part of a broader National tool-set to overcome some of the identified shortcomings in analytical capacity and transparency with current emission modelling. The BDA encourages stakeholders to collaborate in the initiative with a view to improving datasets, modules, calculations, and assumptions.

Introduction

With buildings accounting for 18% of Canada's total national greenhouse gas emissions (Government of Canada, 2023), we need to pursue the most credible, compelling, and capable pathways to decarbonize the sector. The BDA's paper "The Case for Building Electrification in Canada" outlined why we believe electrification is the leading "no regrets" pathway to building decarbonization in Canada[3].

> *The BDA contends that current publicly available analytical capacity in the country is insufficient to answer the type of research questions we are faced with in our efforts to decarbonize buildings.*

We recognize, however, that electrification of building heating cannot be realized as an off-the-shelf, one-size-fits-all policy response. Instead, it is a pathway on which many aspects require tailored considerations and appropriate nuance to implement in the real world. The heat-pump technologies that will enable electrification vary greatly, the building sector itself is very diverse, and the characteristics of the electrical grids from which the buildings draw power introduce complexities that are beyond the reach of simple analysis and cannot be fully captured in tidy sound bites.

Mathematical models allow us to develop scenarios which can tackle these complexities to inform policy, but models can have embedded biases, and their outputs are only as useful as their input assumptions and algorithms are robust. It is therefore critically important to have well-considered tools with which to inform building policies in each region of Canada.

The BDA contends that current publicly available analytical capacity in the country is insufficient to answer the type of research questions we are faced with in our efforts to decarbonize buildings. We believe that a project to develop, launch and systematically improve an open-source building decarbonization model is timely and necessary to allow policy makers to better understand the implications of building-decarbonization measures in every region of the country. We further contend that an open-source process is critical to ensuring that all stakeholders in building decarbonization can engage with evidence and transparency. This paper presents the rationale and the vision for such a model.

Considerations for Analysis of Building Decarbonization Strategies and Measures

There are many considerations that rapidly introduce complexity into analysis of how best to decarbonize buildings in Canada at scale. One significant consideration is that heat pumps, the primary decarbonization technology, are not in fact a monolithic technology: they come in all shapes and sizes, and employ different technical solutions for a range of applications. The implementation impact from residential air-source ducted systems and/or mini-splits is vastly different to that of commercial water-to-air systems, which also differ from community-scale water-to-water ground source heat pumps. Yet far too often, the detailed analysis of specific technologies is lacking, and the results of the analysis of one type of heat pump are taken to characterize all heat pumps with statements such as "heat pumps won't work for such-and-such an application".

[3] Poirier and Cameron (2023).

Another consideration is that residential, commercial, and institutional buildings have fundamentally different requirements and barriers to electrification. Notwithstanding that they are governed by different code requirements and are generally served by different segments of the construction industry, residential and commercial buildings for the most part employ fundamentally different equipment, and their equipment uses and load profiles vary greatly between them and among all the different commercial building types. A home uses electricity very differently than a commercial office does, which uses electricity differently than a hotel, or a car wash, or a hospital. Unfortunately, there is a lack of analysis surrounding heat pump applications across all building types. This results in a common discourse on electrification that lacks distinction and nuance of analysis from one building type to another.


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Further, the benefits and challenges of electrifying new construction of a building are very different than those of existing buildings for many obvious reasons. Appropriate planning, design and implementation of new construction technologies and techniques can leverage integrated design elements that simply cannot be retrofitted into existing buildings. Not only are the system impacts associated with all new electric buildings and neighborhoods likely to be significantly lower than retrofitted existing buildings, the electricity system planning cycles for new connections in such circumstances are also generally more easily managed by electricity distribution system planners. All of this is intuitive, and yet there is a lack of analysis on what the impacts of fully electrified new construction would look like in various areas of the country.

What's more, effectively planning for the thermal needs of an entire neighborhood or community can lead to vastly different electrical energy requirements compared to planning for a collection of single homes in that same community. Much of our industries' analysis to date fails to capture these efficiencies.

Importantly, electricity grids are not homogenous across the country, and they are often most constrained at individual feeders and substations in the distribution system, rather than at the system level. Analysis that considers only total gross peak demand requirements does not capture the peak coincidence factors that are specific to each grid, despite the vast influence of those factors on the economics of electrifying building heating in any given utility service territory.

Finally, models seek to represent the real world, but they must by necessity create a simplified version of our reality. In the book Escape from Model Land, Erica Thompson shares her view that models inherently reflect the biases of their creators [4]. These biases at best serve to confirm analytical hypothesis of their developers, and at worst can significantly underestimate important consequences such as impacts to marginalized communities. To reduce this bias, a collaborative, open-sourced, and ongoing development process that invites stakeholders to challenge methods, inputs and assumptions is critical.

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While we know that we must electrify at scale to decarbonize the building sector, given the above considerations, many questions remain about the benefits and costs of doing so in all regions of Canada while avoiding potential pitfalls along the way:

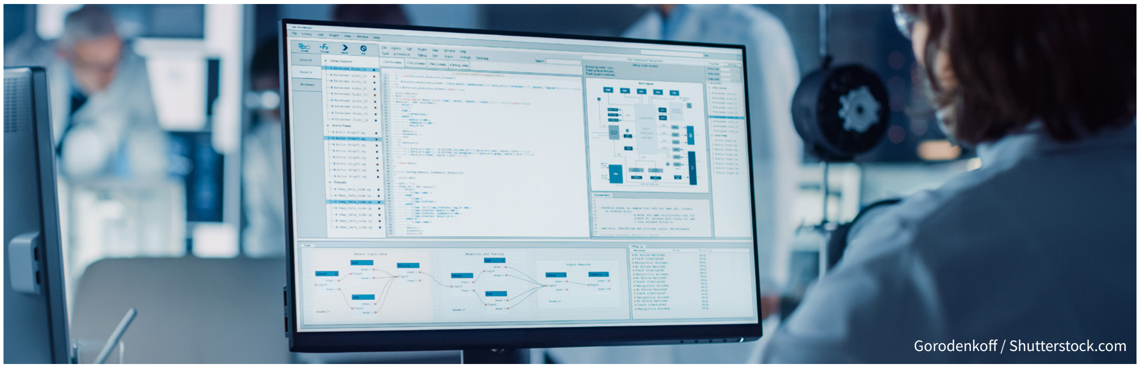
- What policies specific to new construction and existing buildings for the commercial and residential sectors can be implemented today to pave the way to net zero going forward?
- What is our best estimate of peak load impacts of electrifying building heat on Canada's various electricity grids? How does that coincide with their unique system peaks?
- What other technologies should we prioritize for investment to accelerate the transition while also mitigating grid impacts?
- How should electrification strategies differ from province to province?
- In a labour-constrained environment, where is the greatest return on human resource investments between grid expansion, building retrofits, and new construction labour?
- What might the impact of new business models be which allow energy efficiency retrofits at scale?
- How can decarbonization alleviate energy poverty and improve affordability?

These are but a few of the vital research questions where the inputs and modelling require granularity for the type of buildings, the specific technologies being applied, and the assumptions about the electricity grids where they reside. It is very important that these characteristics are incorporated into modelling activities to create a realistic view of decarbonization pathways. These nuances are necessary to understand the baseline conditions and become even more important when developing scenarios of how regional policies will play out between now and 2050.

[4] Thompson, E. (2019)

Existing Modelling in Canada

Aren't there already many energy and decarbonization models in Canada? The Energy Modelling Hub database alone hosts 59 models related to buildings and efficiency in the Canadian context [5]. Do we really need another model? **The BDA believes that we do.**



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While other Canadian models exist, those that are public and open source tend to be so-called "top-down" models, which occupy a broad econometric scope. By practical necessity, these models lack the granularity required to examine specific issues relevant to the varied building stock, the range of technological measures available, and the diverse needs of different regions. Many "bottom-up" models exist at useful granularities, but these tend to be proprietary, closed-source models and therefore are not available for direct review—or direct use—by stakeholders. These models also tend to be built for specific regions and are therefore rarely capable of creating national roll-ups.

The Government of Canada's own top-down economic emission models have been reviewed by the Office of the Auditor General (OAG) Environment Commissioner and found to be lacking with respect to how assumptions and interactive effects are managed, and with transparency of inputs and results [6]. The Commissioner called for increased collaboration and a Forum integrating the Energy Modeling Hub (EMH) into its framework.

Canada's Net-Zero Advisory Body has identified that Canada's modelling community is fragmented, and opaque, and that there is a lack of coordination in the modeling community and government. It called for the establishment of a modeling and data centre of excellence to improve modeling methods, data and transparency [7].

Existing Top-Down National Energy Models

Models such as Pembina's Energy Policy Simulator, IET's Pathways Explorer, and Navius' Canada Energy Dashboard provide a high-level overview of energy use across a variety of sectors, including buildings, transport, industry, agriculture, electricity generation, and hydrogen. They are very useful for providing a high-level overview of Canada's estimated GHG emissions under various input

[5] https://emi-ime.ca/modelling-inventory/search

[6] Reports of the Commissioner of the Environment and Sustainable Development to the Parliament of Canada Canadian Net-Zero Emissions Accountability Act— 2030 Emissions Reduction Plan, Report 6.

[7] Compete and Succeed in a Net Zero Future First Annual Report to the Minister of Environment and Climate Change January 2023

scenarios. That said, to analyze across all sectors and energy uses while maintaining usability, many simplifying assumptions must understandably be made. For example, while Natural Resources Canada's CANMET labs have identified over 6,000 residential building archetypes across Canada via HOT2000 modelling, most economy-wide models only incorporate a few building archetypes on which to perform their calculations and therefore struggle to assess the specific impacts of building decarbonization measures for the complex building inventory and mix that exists on a regional or provincial scale.

Decarbonization of the energy sector is a complex puzzle which requires decarbonizing energy production while continuing to serve the wide array of energy end-uses. The Energy Modelling Hub's SILVER [8] and COPPER [9] models explore the impacts of a time varying renewable energy and generation mix on the grid. However, these models are not focused on specific sub-sectors or energy end-uses.

"Decarbonization of the energy sector is a complex puzzle which requires decarbonizing both energy production while continuing to serve the wide array of energy end-uses.

Existing Bottom-Up Models

Various universities and municipalities have developed "bottom-up" models to evaluate the impacts of decarbonization on specific cities. Such models include Concordia's Urban Simulation Platform, currently focused on Montreal, and Canadian Energy End-use Mapping (CEE Map), focused on Kelowna [10]. These models can provide very interesting insights for a specific jurisdiction, but do not roll-up or scale to provincial or national levels and are therefore less useful for assessing policy options at those scales. These models would also be difficult to replicate nationally owing to the cost and usability implications of a national model with such high granularity.

There are more detailed privately held models used to evaluate building energy efficiency and decarbonization, such as the Posterity Group Navigator [11] and Dunsky Consulting HEAT [12], and these play a very important role in the building and utility eco-system. However, these models are closed source, and understandably not made available publicly given their proprietary development and intellectual property investment. As a result, it is often not possible to fully explore their modelled results, their underlying data, and most importantly their full range of input inclusion/exclusion assumptions and calculation algorithms.

The entities who hire private modelling firms and consultants to undertake this modelling (such as utilities undertaking achievable potential studies to estimate the impact of energy efficiency measures and programs) do of course gain greater visibility into these characteristics, but this level of visibility is not generally shared publicly. Some data, assumptions, algorithms, and results can be made public where required, such as in regulatory proceedings. However, these results are often only presented as static scenario outputs that can be visualized differently using data slicing tools; the public (including utility and building stakeholders) are generally not able to re-run the models with different assumptions or to explore different scenarios.

Finally, there are a wide range of building-level models focused on detailed energy analysis of

[8] https://cme-emh.ca/inventory-model/silver/

[9] https://cme-emh.ca/inventory-model/copper/

[10] https://www.concordia.ca/research/chairs/smart-cities/projects/canadian-energy-end-use-mapping-project.html

[11] https://www.poweredbyposterity.com/

[12] https://www.dunsky.com/model/heat/

individual buildings and building designs. Volta SNAP is a platform designed to perform energy assessment of new and retrofit residential housing[13]. The University of Victoria created the Building and Energy Simulation, Optimization and Surrogate modelling platform[14]. These models are very useful to determine the effects of various energy upgrades at the building level and can inform development of building archetypes for less granular modelling.

A Vision for an Open-Source End-Use Decarbonization Model

Canada's path to net zero is akin to a complex puzzle, and this complexity demands appropriate modelling and analytical capacity to allow policy makers to focus on the policy pieces that will correctly fit together into the broader decarbonization picture. Based on the current landscape of modelling platforms, including those currently listed in the Energy Modelling Hub database, the BDA has identified a meaningful gap in analytical capacity for building decarbonization modelling (Figure 1). As a result, there are many questions that remain difficult to fully assess, such as:

- The peak load impacts of installing various types of heat pumps on various building archetypes (by vintage, size etc.) situated in various climate zones, which will simultaneously host various other measures such as energy efficiency, electric vehicle charging and load flexibility technologies.
- The emissions associated with installation of different types of heat pumps on a range of electricity grids having variable emission factors throughout the day, with unique system constraints, and capturing the expected rate of decarbonization of provincial grids.
- The potential impacts (GHG and energy demand) of national policies such as equipment, building performance and fuel regulations at municipal, provincial, and national levels.
- The required numbers of the various types of heat-pump units and the composition of the workforce to decarbonize heating and cooling on national, provincial, and regional levels.

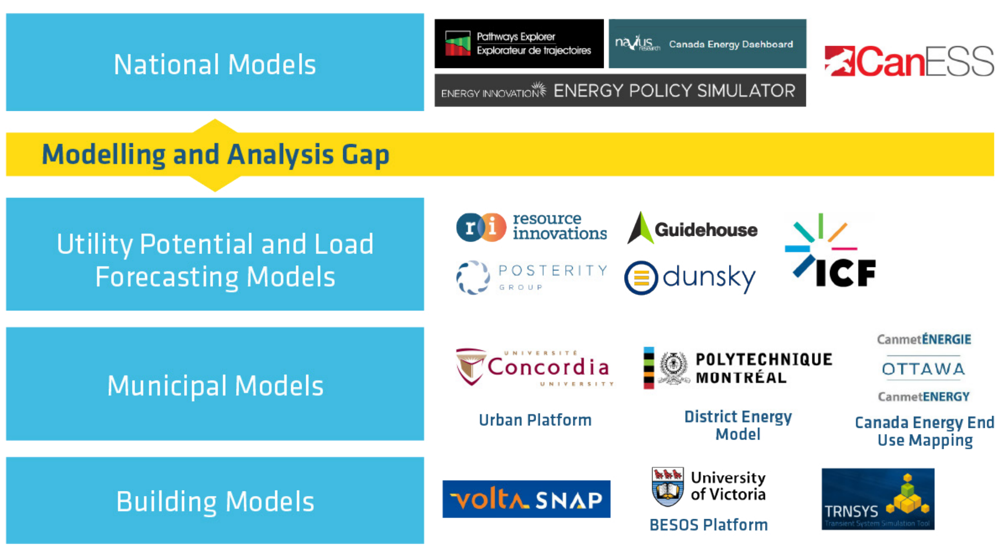

Figure 1: Canadian Modelling Gap Illustration

[13] https://uploads-ssl.webflow.com/61d71606618c945ff38a5c6e/6465132de99a434b92750e0b_Volta_SNAP-St.-Hilaire-and-Brookson.pdf

[14] https://besos.uvic.ca/

The BDA seeks to identify the pathways that lead to the most economical, effective, and socially just solutions to reducing building emissions in each region across Canada. Our vision is that actors in the building industry can freely access and use a powerful tool to undertake national and regional building policy impact analyses, and to enable them to create and advocate for effective policies. Our vision includes the continuation of current models, whether public or private, and intends to supplement them and leverage the expertise of their users to fill the analytical capacity gaps shown in Figure 1. In the long term, we believe access to this new national model can increase value and enhance services of public and private organizations alike. To this end, we have established the following development principles for the Model:

Flexible: Users will be able to customize input scenarios on an input dashboard. They will also be able to download all files, datasets, and assumptions, modify inputs, and run them through the model to develop their own custom analyses.

Transparent: Users will have ready access to the model's data, source code, and documentation of underlying assumptions. Rather than a "black box" solution, the open-source approach should invite discussion and collaboration about input data, calculations, and assumptions to improve them in a systematic and controlled way over time.

Fast and Powerful: The model is being built on an efficient Python platform and will be hosted on super-computers in partnership with the Energy Modelling Hub. This will allow users to explore various scenarios and effect multiple modelling runs quickly and efficiently.

Collaborative: The BDA aims to reduce modelling bias by enabling an ongoing, collaborative, open-source development process that invites stakeholders to challenge inputs and assumptions. The goal is to create a model that acknowledges and reduces modelling biases, and that reflects as many realities as possible.

Agile: The model will evolve with time as new data, information, and analytical capacity becomes available. To this end, the model will allow other modellers, programmers and researchers to build out future modules or analytical capacity within the model oversight structure and working groups.

Free and Accessible: Knowledge is power, and the model should remain a tool that is free of charge to empower anyone to investigate policy implications, and to verify or challenge the findings of other studies—including our own.

The BDA-OSM

The Building Decarbonization Alliance Open Source Model (BDA-OSM) is being designed to allow policy makers to evaluate how various building decarbonization measures impact different areas of Canada under a range of input assumptions. Its scope encompasses all of Canada's residential, multi-residential and commercial buildings. The results will initially be calculated on both national and provincial levels, with further granularity developing over time.

The BDA-OSM incorporates hundreds of residential and commercial building archetypes, including archetypes specific to each climate zone. With an initial focus on space heating and cooling and water heating, the user can customize policy scenarios and compare the impacts on equipment count, energy consumption, peak load, emission reductions, and cost. These outputs are calculated based on aggregated energy end-uses in each building archetype and region across Canada.

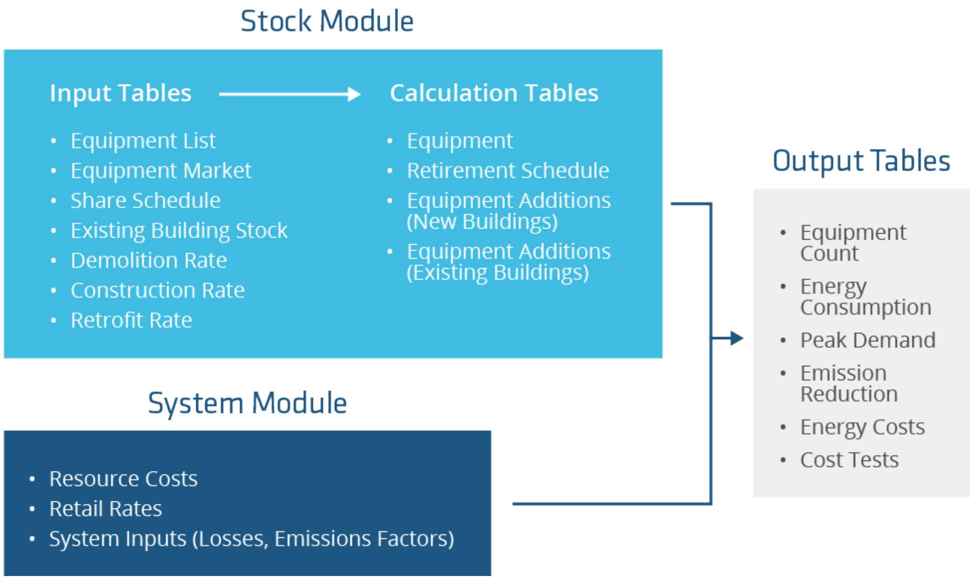

Figure 2: Model Flow Diagram

The model engine is built using two core modules: the stock module and the system module, with a model flow diagram as outlined in Figure 2. The stock module consists of building stock parameters and equipment stock parameters. Building stock includes existing building stock, demolition rates, construction rates and retrofit rates, which are calculated based on factors such as population growth in each province between now and 2050. Equipment stock characterizes a variety of equipment that can be installed in buildings for space heating, space cooling and water heating, including a range of heat pumps including air-source heat pumps with electric backup, fuel backup, cold climate heat pumps, and ground source heat pumps. From these parameters, the module calculates the equipment retirement rates and addition rates for new and existing buildings.

The system module takes into consideration parameters such as energy retail rates, emission factors, transmission and distribution losses, all calculated per region per year. The model then generates outputs including total resource cost, maintenance cost, greenhouse gas emissions, and equipment count, along with hourly 8760 building load plots, which can then be used for system planning and grid analysis purposes.

Potential Users

The purpose of the BDA-OSM is to evaluate impacts and effectiveness of various policies; therefore, the target users are government officials, policymakers and advisors, extending to all levels of government, including municipal, provincial, and national policymakers. However, many other building and utility industry stakeholders could also benefit from this tool, including utilities, academic institutions, regulators, think tanks, journalists, consulting firms, equipment and service providers. The model will be publicly accessible to anyone online following migration to the Energy Modelling Hub servers at the University of Victoria in early 2024.

The Open-Source Approach

The BDA-OSM is an open-source tool, and as such, all data, assumptions, and calculations will be public, and users will be able to customize input scenarios and examine results once it moves beyond the MVP development stage. As an open-source project, the BDA-OSM is built using datasets from publicly available sources, and users will be able to download the Excel files and datasets used for calculations. These data sources include Natural Resources Canada Survey of Commercial and Institutional Energy Use, CANMET BTAP files, EnerGuide HOT2000 files, and National Renewable Energy Laboratory ResStock and ComStock files.

The University of Victoria will host the National Building Decarbonization Model at the Energy Modelling Hub, a joint initiative of the school's Institute for Integrated Energy Systems and the University of Calgary's School of Public Policy that is helping guide the transformation of Canada's energy systems. As the BDA-OSM evolves, we encourage stakeholders to help us improve datasets, modules, calculations and assumptions. The BDA's vision for this model and process is to act as an aggregator of information and expertise from across Canada.

Model Development Timeline and Roadmap

The model development is being executed in phases. The current plan is to develop a proof-of-concept Minimum Viable Product (MVP) as a starting point to engage with and collect feedback from stakeholders. The model will then evolve based on industry need within a systematic and controlled open-source development environment with secretariat services being provided by the BDA.

Figure 3: Model Development Timeline

Phase 1: Minimum Viable Product (MVP) – The first phase of the project is to develop an MVP to evaluate the impacts of a limited set of building decarbonization scenarios. When examining building loads across Canada, the vast majority of energy is consumed for space heating, water heating, and space cooling. This totals to 83% of GHG emissions in residential buildings and 71% of GHG emissions in commercial buildings (Natural Resources Canada, 2023).

In Canada, only 25% of space and water heating is electrified (Natural Resources Canada, 2021). This provides significant potential for electrification to decarbonize buildings. Therefore, the MVP will be focused on analyzing the impacts of policies on the end uses of space heating, space cooling and water heating in residential and commercial buildings.

The current level of electrification of space heating, water heating, and space cooling differs greatly on a provincial basis. The residential heating system stock variation across Canada can be viewed in Figure 4 below, which highlights the need for impact evaluations to be measured at the regional level.

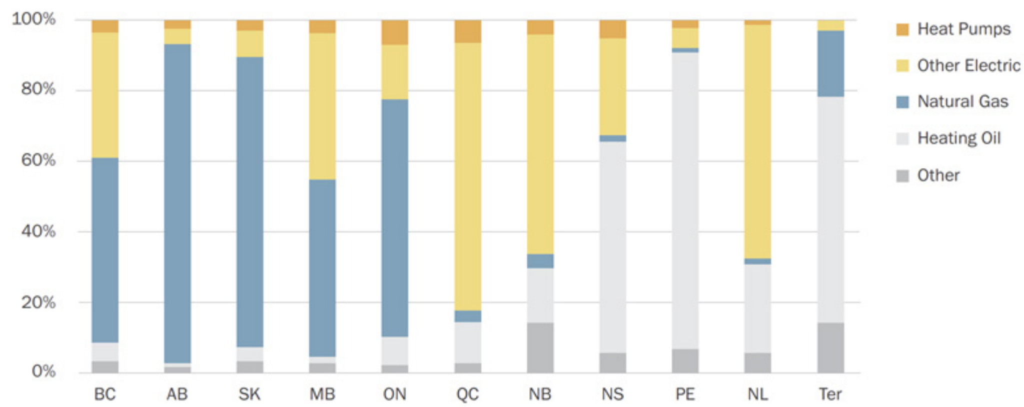

Figure 4: Residential heating system stock varies across Canada [15]

The MVP uses up to 100 of the most prominent residential building archetypes across Canada, and takes into account envelope and efficiency measures, fuel rates, local weather and equipment load curves. The output of each of the preliminary scenarios includes impacts relative to a business-as-usual (BAU) reference scenario based on current policies, and the results include impacts on equipment count, energy consumption, peak demand, emissions reduction, and cost. While the full model will give users complete control to develop and run their own scenarios, the MVP is a stand-alone model using input and output files in .csv format, with outputs available for users to download and assess.

Phase 2: Visualization – In early 2024 and in partnership with the Energy Modelling Hub and the University of Victoria, the BDA will migrate the model to a hosted model website. This website will provide a user interface and data visualization tools where model outputs will be able to be visualized and compared on national and provincial levels.

Phase 3: Stakeholder Engagement – The BDA will conduct stakeholder engagement activities across Canada in 2024 to collect feedback on analysis and results created with the Model MVP. The aim is to collect input and provide a degree of ground-truthing of the preliminary scenario results in each region. We are also interested in learning which features are relevant and useful, and what assumptions should be modified for local context.

This feedback will be used to prioritize features for the next iteration of the model, to be released in late 2024. Future iterations could consider factors such time-of-use rates, number and type of skilled workers required for measures, district heating options, or projected weather pattern changes in climate zones due to climate change.

[15] Poirier and Cameron (2023)

Looking Ahead: Managing, Iterating and Improving the BDA-OSM

This initiative is intended to produce an evergreen model, and it is being designed to be modular and iterative. The BDA-OSM will evolve over time based on user feedback and engagement; our vision is to use the model as a centre of focus to foster collaboration and aggregate information and expertise across Canada, resulting in a tool that is highly relevant, reputable and defensible.

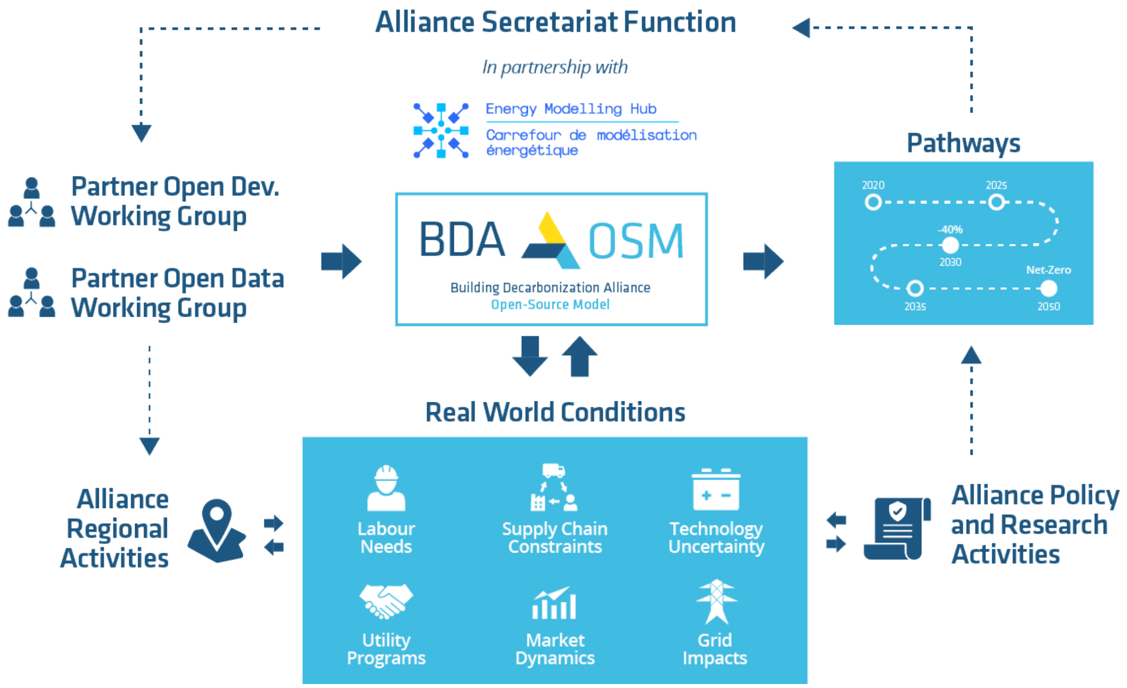

Figure 5: Iterative Open-Source Model

As shown in Figure 5, the development process will be centred on the open-source code and input and output files. In 2024, the BDA intends to launch a process by which:

- The BDA plays a secretariat function to enable, facilitate, and manage subsequent modelling development and engagement activities.
- The Energy Modelling Hub and their partner the University of Victoria host the model on their super-computers and GitLab database and provide the UI and visualization infrastructure.
- The BDA's Partners and the broader model user community collaborate in the context of working groups for analytical methods, code, and data to advance the functionality of the model.
- The BDA convenes stakeholders in regional engagements to inform a "real-world overlay" to validate or challenge model results, inform model enhancements, and further flesh out local decarbonization pathways and challenges.
- The regional engagements help identify further gaps in research and policy development activities that the BDA can advance, and which feed into our broader understanding of decarbonization pathways.

Conclusion

The BDA believes the increased analytical capacity provided by the BDA-OSM will help the industry move toward a vision of "a future where electrified buildings are part of an affordable and resilient energy system that contributes to a prosperous, sustainable, and decarbonized Canada," and will advance our mission "to serve as a cross-sectoral coalition working to accelerate the electrification of buildings in Canada."

We encourage stakeholders to participate in the iterative development cycle and to engage and collaborate with us with a view to improving datasets, modules, calculations, and assumptions.


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