PROJECT REPORT

Supporting Electrification Policy in the GTHA: Facilitating Stakeholder Coordination through the Integrated Design Process

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Executive Summary

This report documents three builder-utility workshops aimed at fostering collaboration to advance residential electrification in the Greater Toronto and Hamilton Area (GTHA). The traditional separation between the building industry and electric utilities has become a significant structural barrier as the GTHA advances toward electrification in new residential construction. Building code decisions and site planning have historically occurred independently of utility distribution grid planning, a disconnect that can lead to electrical infrastructure mismatch between anticipated and actual loads. This mismatch can lead to increased infrastructure costs or strained grid capacity, depending on whether the distribution systems are over- or undersized relative to actual loads. This is a significant source of risk and uncertainty for new electrified housing and for utility planners. To address this, Volta Research undertook a series of Integrated Design Process (IDP)-inspired builder-utility workshops to foster collaboration among builders, utility engineers, and energy advisors. By developing a methodology to convert standard annual energy models produced by energy advisors for building code or program compliance into hourly temperature-versus-load forecasts, the project demonstrated that the building industry can focus on building solutions that reduce temperature-related peak loads, and that, through collaboration and data sharing, utility designers can better "right-size" grid infrastructure with information from builders. This can reduce costs for both homebuyers and ratepayers while removing barriers to residential electrification.

The three workshops featured the following Ontario-based utility-builder case studies: the Upper Joshua Creek development in Oakville (Mattamy Homes and Oakville Hydro, advised by Building Knowledge Canada), which features a mix of geothermally heated and cooled detached residences, two-storey townhomes, and rear-lane townhomes; the Harvest Run development in St. Thomas (Doug Tarry Homes and Entegrus, advised by Building Knowledge Canada), featuring two-storey semi-detached homes; and the Watercolour Westport development in Eastern Ontario (Land Ark Homes and Rideau St. Lawrence Distribution, advised by Homesol), which comprises single-detached bungalows. Stakeholders from the government, the building industry, and utilities attended the workshops. Key findings from the project's three case studies validated that properly simulated annual energy models for code or program compliance can be converted to hourly building energy models to effectively predict transformer-level electrical loads for groups of houses. Most significantly, the actual anonymized data showed that high-performance, all-electric homes constructed to CHBA Net Zero requirements, or similar, which reflected the type of buildings examined during the workshops, tend to have peak electrical loads during heating of around 5 kW or less. Most of the time, heating loads were less than half of that, even during cold load pickup events. These loads are similar to summer air conditioning loads from a code-built house and may pose less of a winter peak issue than previously suggested. Additionally, the max hourly load data for any given house in a group over any given hour showed that peak draw remained under 100A, suggesting that traditional 200A service requirements are often unnecessary and oversized. These homes' high-performance envelopes substantially mitigate the temperature-related grid impacts of electrification through higher levels of insulation, better windows, improved airtightness, and efficient mechanical systems. The analysis demonstrates that existing distribution assets can support higher electrified housing density, given the type and energy efficiency of the housing

are taken into consideration, more effectively than conventional utility planning assumptions have previously suggested.

The key recommendations from the workshops for builders, utilities, and policymakers are the following:

- Modernize regulatory frameworks and engineering practices to recognize building performance and energy efficiency measures as a fixed capacity grid asset.
- Utilities are encouraged to update planning assumptions to reflect the lower peak demands observed in these case studies, potentially increasing service density on existing assets.
- Policymakers should align building codes with electrical and grid standards, shifting them from annual energy conservation measures to factor in grid-friendly construction practices and demand management.
- Implement a collaborative framework for sharing hourly load data between builders, energy advisors, and utility planners during the design phase to ensure that efficient, affordable, and reliable infrastructure designs support the electrification transition.
- Builders and utilities should engage as early as possible to ensure that there is time for design decisions from both stakeholders to align towards electrification and cost goals.
- A central anonymized database of hourly loads for electrified, high-performance homes that includes information on the characteristics of the house, or an energy modelling file, should be created and maintained to enable policymakers and utilities to be better informed when forecasting future loads and designing new programs meant to mitigate residential electrical demand.

Table of Contents

Executive Summary **2**
Table of Contents **4**
Introduction **5**
Background **7**
Building Codes in Canada 7
Energy Efficiency in Codes and Labels 8
Building Energy and Demand 8
Building Energy Modelling 9
Case Studies from the Builder-Utility Workshops **12**
Background 12
Data Collection Process 12
Building Energy and Demand Simulation Methodology 13
Modelling Setup 16
Results Presentation 16
Sites and Stakeholders Overview 17
1. Mattamy Homes and Oakville Hydro **17**
Case Study Houses 17
Hourly Results 19
2. Doug Tarry Homes and Entegrus **26**
Case Study Houses 26
Hourly Results 27
3. Land Ark Homes & Rideau St. Lawrence Distribution **36**
Case Study Houses 36
Hourly Results 37
Lessons Learned **40**
Technical Analysis and Modelling 40
Policy and Regulatory Barriers 41
Collaborative Stakeholder Engagement 41
Conclusion & Recommendations **41**
Policy and Program Implications 41
Scalability and Replicability Potential 42
Barriers to Market Transformation 42
Recommendations for Utilities and Policy Makers 43
Next Steps 43

Introduction

Traditionally, the residential building industry and the electric utility sector have operated in isolated silos. Building code decisions and neighbourhood design often occur independently of utility grid planning, a disconnect that frequently results in a misalignment between modern home performance and electrical infrastructure. Utilities typically face the challenge of adapting to growing energy demands without specific data on high-performance home behaviour. In contrast, builders face uncertainty regarding the infrastructure requirements for the advanced homes they intend to build. This lack of coordination can result in strained grid capacity or significantly oversized, costly electrical infrastructure that does not reflect actual consumption. As the GTHA moves toward widespread electrification of home heating and transportation, this gap poses a risk to housing affordability and long-term grid reliability. Without a unified approach to energy modelling and load forecasting, the transition to electric-dominant systems such as heat pumps and electric vehicle (EV) charging may be hindered by outdated design standards and inefficient grid capital investment.

The primary purpose of this project was to facilitate direct coordination between the low-rise residential building sector and electrical utilities to address the practical challenges of residential electrification. It sought to replace traditional prescriptive design approaches with data-driven evidence to accurately forecast how modern electrified loads behave on the distribution grid. The project was inspired by the integrated design process, a collaborative approach that brings together multidisciplinary stakeholders early in the design process. Three workshops were held with builders, utility engineers, and energy advisors to analyze successful neighbourhood-level collaborations at the earliest stages of planning, solve technical challenges, and optimize system performance. This collaborative effort was designed to reduce infrastructure uncertainty, optimize grid servicing requirements for greenfield developments, and identify scalable technical solutions for high-performance residential communities. A key technical focus was to bridge the gap between building energy modelling for code compliance and load forecasting for utility infrastructure planning. While standard annual energy modelling tools meet building codes, they are insufficient to capture the dynamic hourly peaks associated with widespread electrification. The project sought to demonstrate how these standard energy models can be converted into hourly demand-forecasting tools, providing utilities with the certainty needed to “right-size” infrastructure and minimize costs for both developers and ratepayers.

Project activities were organized around four specific objectives: stakeholder engagement, technical data validation, infrastructure optimization, and policy support.

Stakeholder Engagement

Three multisectoral workshops were convened with GTHA builders, utility engineers, and energy advisors to evaluate critical pain points in electrification, including the impacts of EV charging and heat pump adoption on local distribution grids.

Technical Data Validation

The project team designed and validated a process to convert standard annual building energy models into hourly demand-forecasting tools, providing a more accurate representation of peak loads for modern utility planning.

Infrastructure Optimization

Real-world case studies demonstrated how high-performance building envelopes and mechanical systems can reduce peak electrical loads, enabling the “right-sizing” of utility assets. These efforts provided the technical evidence necessary to advocate for modernized design standards and support data-driven decision-making.

Policy Support

Findings were collaboratively disseminated to support policy, regulatory, and code updates to accommodate better low-load, high-performance homes, distributed energy resources, and smart energy management solutions.

The purpose of this report is to provide residential, low-rise construction stakeholders with context on the new load types they will encounter as the industry shifts to low-rise electrified housing developments, as defined by the National Building Code (NBC) as homes with 3 storeys or less and under 600 square metres. This report also serves as a reference to understand load curves for high-performance all-electric homes. The report is intended to provide stakeholders and decision-makers with information and guidance to facilitate collaboration on the servicing of new all-electric or mostly electric residential developments, ultimately resulting in efficient and affordable infrastructure designs.

The National Building Code of Canada, specifically Division B, Section 9.36, now offers prescriptive and performance-based pathways to meet tiered energy targets. This model is adopted or adapted by provinces, such as Ontario’s SB-12 and BC's Energy Step Code. The prescriptive path requires a building to meet predefined efficiency measures. This approach uses checklists of specific building components, such as insulation levels, window performance ratings, and minimum efficiency standards for heating and cooling systems. In contrast, the performance path offers design flexibility by allowing builders to trade off performance in one area for another, provided the overall energy target is met through modelling. For example, a builder might invest in a higher-efficiency heat pump to offset different insulation values in the building envelope. Voluntary third-party labels and systems, including the EnerGuide Rating System (ERS), ENERGY STAR® for New Homes, and the CHBA Net Zero Home, further encourage builders to go beyond minimum requirements by utilizing advanced envelopes and mechanical systems.

This shift toward high-performance building standards directly impacts how developments consume power. Transitioning to all-electric systems introduces complex load types for which limited historical data are available to guide grid impact assessments. Historically, Canadian utilities managed predictable residential load patterns because homes primarily used natural gas or other fossil fuels for winter heating, and summertime air conditioner usage was a known, predictable load. However, the implementation of these new building codes with energy efficiency requirements is prompting homes to transition to electricity for heating, either replacing or supplementing fossil fuels, and is driving the adoption of electric heat pumps. This shift, along with the growing transition to electric vehicles, aligns with Ontario’s electrification trends and supports Canada’s commitment to achieving net-zero emissions by 2050. This transition will introduce new loads from unique housing configurations, leaving utilities with little historical data to assess the impact on the local distribution system. Consequently, as residential developments move toward all-electric systems, utilities face the challenge of managing intensified peak events while avoiding oversized infrastructure and unnecessary capital costs.

To address this challenge, this report, through documenting each workshop experience, aims to:

1. Describe the planning and policy scenarios for increased energy demand in Part 9 buildings and electric vehicles, and recommend solutions to manage their impact on the electrical grid; and
2. Share insights, analysis and recommendations from the outcomes of three builder-utility workshops to implement into future code adoption, development, and review processes.

To provide stakeholders with a basis for understanding and demonstrate how to forecast new loads, three case studies of all-electric residential developments will be shared to examine mitigation measures to reduce peak loads and outline next steps for builders and utilities proposing all-electric home developments, both technically and through communication with the stakeholders involved. The report is intended to provide stakeholders and decision-makers with information and guidance to facilitate collaboration on the servicing of new all-electric or mostly electric residential developments, resulting in efficient and affordable infrastructure designs.

Developing a clearer understanding of these residential demand profiles supports infrastructure planning and grid reliability. This data can help utilities design efficient systems and potentially reduce the need for more expensive system upgrades. For developers, this information is essential for right-sizing infrastructure and avoiding the unnecessary capital costs often associated with oversized electrical systems.

The Lessons Learned section provides an overview of issues identified during the technical analysis and energy modelling, and of policy and regulatory barriers identified during the project, and reiterates the case for collaborative stakeholder engagement. Finally, the Conclusion and Recommendations will cover policy and program implications, replicability, barriers to market transformation, recommendations for utilities and policymakers, and next steps.

Background

Building Codes in Canada

Building codes in Canada, particularly the national model code, significantly influence residential construction and energy consumption. Provinces adopt or adapt this national code, which is trending toward net-zero annual energy-ready levels, leading to more electrically heated homes and a reliance on high-efficiency systems like heat pumps. While this reduces annual energy consumption, it can increase hourly electricity demand, directly impacting distribution utilities. Future code versions are expected to extend these requirements to existing buildings. Enforcement occurs at the municipal level, ensuring new homes meet the required energy standards.

The National Building Code of Canada is a five-year cycle model code that sets minimum technical requirements for building design and construction, with a focus on safety, health, and energy efficiency. Most provinces and territories adopt the NBC, while others, like Ontario, use their own NBC-based codes. Adoption sets the minimum performance level for that jurisdiction.

Energy Efficiency in Codes and Labels

The National Energy Code for Buildings (NECB) was designed to complement building codes by setting minimum energy efficiency requirements that can be adopted, in whole or in part, into provincial or territorial legislation and codes (National Research Council Canada). It can also be used as a guideline for energy efficient construction. NBC Division B, Section 9.36, is similar in scope to the NECB as it addresses environmental objectives for housing and small buildings, though it excludes lighting and electrical power systems. To align these standards, the NECB is referenced within Section 9.36 as an acceptable solution. For energy efficiency requirements related to the alteration of existing buildings (AEB) that fall outside the scope of Section 9.36, NBC Part 10 directs users to NECB Part 13.

Prescriptive and Performance Code Compliance

Buildings generally demonstrate code compliance through either a prescriptive or a performance path. The prescriptive path requires a building to meet specific, predefined measures for every relevant code section. These “pick lists” prescribe specific components, such as insulation levels, window performance, air leakage limits, and efficiency ratings for heating, cooling, and hot water systems. No energy modelling or calculations are required for this path; instead, builders submit prescriptive checklists provided by the building department office. In contrast, the performance path offers the most design flexibility, allowing builders to trade off performance in one area for another (such as a heat pump instead of a gas furnace, or lower insulation values in the building envelope) to reduce the cost to build, provided the overall energy target is shown to be met via modelling.

The application of energy codes depends on the building's size and type. Large buildings, covered under Part 3 of the NBC, are defined as having more than 3 storeys or 600 square metres of building area. This category typically applies to larger commercial, industrial, and high-rise residential buildings. The NECB sets energy efficiency requirements for these buildings and uses a performance path approach for code compliance. NBC Part 9 covers housing and small buildings, typically those with 3 storeys or less and a building area of 600 square metres or less. Part 9 building types typically include houses, small residential buildings, and businesses or mercantile buildings. Part 9 buildings are increasingly adopting a performance-based approach using building energy modelling software to meet higher energy efficiency targets in place of the traditional prescriptive “pick list” method. Energy efficiency requirements for housing and small buildings are specifically covered in section 9.36 of the NBC or in Ontario’s SB-12. The requirements in these code sections are directly affecting the transition to electrified buildings and the new loads observed by distribution utilities.

Building Energy and Demand

The heat a home gains or loses changes with outdoor weather conditions. This process is influenced by the building envelope, which acts as the "coat" that the house wears. The envelope includes the insulation values for the walls, roof, basement, and windows, as well as the house's air leakage. A more insulated and airtight house requires less energy to maintain a comfortable interior temperature for occupants. While this energy consumption is often measured in annual Gigajoules (GJ), the systems that maintain indoor air quality and temperature must operate on much shorter timescales.

Mechanical systems, including heating, ventilation, and air conditioning, help maintain stable temperatures and breathable air for occupants while also providing hot water for daily use. Because these systems must meet a building's energy needs hour by hour, they are evaluated based on "design days". These represent the predicted worst-case outdoor temperatures for a specific location. This hourly heat loss or gain is expressed in thermal kilowatts (kW) and is predicted using standardized software calculations to help determine the appropriate size of a home's mechanical system.

The efficiency of different mechanical systems influences the energy they consume to heat and cool a house relative to its predicted annual needs and its hourly worst-case. Traditionally, utilities estimated household demand loads by focusing primarily on air conditioning and occupant behaviour. In an electricity system context, thermal heat loss and gain in kW translate into electricity system demand through mechanical design and efficiency curves, bridging demand response and conservation program mandates. While conservation programs aim to reduce total annual kilowatt-hours (kWh), it is important to understand that measures affecting demand and consumption do not always move in the same direction. For example, a heat pump will help a builder vastly reduce the overall annual energy consumption of a home versus a gas furnace and air conditioner, but if not designed with demand in mind, it could result in higher demand due to items such as oversized auxiliary resistance heaters. In practice, these design decisions are made with the help of energy consultants and building energy modelling software.

Building Energy Modelling

Building energy modelling is a computer-based simulation used to estimate and predict a building's energy consumption and thermal loads. It utilizes a collection of inputs based on the building's design (including geometry, envelope composition, mechanical systems, energy sources, and local climate) under standard operating conditions (SOC). By using standardized software, designers create a "digital twin" of a proposed home to compare its annual performance with that of a reference building, such as one built to a minimum prescriptive list or a voluntary labelling program.

In Canada, energy modelling is a foundational tool for the energy component of building code compliance, especially for projects seeking higher energy efficiency targets and pursuing a performance-based compliance path. This process verifies that a proposed design meets or exceeds minimum standards by comparing the "upgrade case" to a reference building, typically one that meets the minimum prescriptive requirements of the NBC or NECB. Because building codes are legally enforced at the municipal level, these requirements set the energy loads for new construction. Beyond mandatory codes, voluntary programs and municipal green development standards encourage builders to exceed these minimums. These pathways are essential for linking lower energy demand, a key utility requirement, to homebuilders' need to demonstrate low annual energy consumption during the code compliance, permitting, and labelling process.

While energy modelling provides more detailed data, not all builders use it. Many still rely on prescriptive compliance for permit applications because building codes allow this approach without formal modelling, making compliance simple. Although these lists offer a standard framework for home performance, they do not provide the same level of detail as a full energy model. Despite these barriers, there is an opportunity for builders and utilities to collaborate on data flow. By starting discussions early, stakeholders can evaluate the impacts on the building before the electrical infrastructure is finalized — either by engaging the utility in the energy modelling process or by providing data from existing buildings of the same configuration that demonstrate demand profiles. A hybrid approach that combines utility hourly data with hourly energy modelling can bridge the gap between building designs and utility forecasting and provide utilities and builders with a language template for communicating energy and demand. Proactive data sharing and collaboration help ensure that efficient electrical systems support the transition to electrified residential communities. The case studies in this guide demonstrate how the process has worked for three builder-utility pairings in Ontario.

Labels and Compliance

Building energy labels in Canada, such as EnerGuide for New Houses (EGNH), ENERGY STAR® for New Homes, and the CHBA Net Zero Home, evaluate a home's energy performance in accordance with their respective rule sets. These voluntary, third-party labels provide homebuyers with estimated annual energy consumption data and allow for comparisons of homes across the country. They also provide program designers with pathways to verify participants' energy efficiency actions rather than to analyze utility consumption data. Some of these labels, including EGNH and CHBA Net Zero, require building energy modelling to demonstrate compliance against a reference case. Others, like ENERGY STAR®, offer a prescriptive list of options to reach their efficiency targets. These labels require building designs to go beyond minimum building code requirements, often calling for higher insulation values for the building envelope, more efficient heating and cooling equipment, and optional items such as on-site renewable energy and EV charging.

The CSA F280-12 standard further supports this alignment from an HVAC direction by determining the required capacity of residential heating and cooling appliances based on a home's worst-case instantaneous heat loss and gain. To properly size heat pumps for both new construction and retrofit applications, CSA F280-12, Determining the Required Capacity of Residential Space Heating and Cooling Appliances ("F280 calculations"), provides recommended calculation methods. These calculations provide a more precise representation of peak thermal loads than annual energy models alone. Typically performed by building science professionals or Registered Energy Advisors (REAs), F280 calculations ensure that mechanical systems, especially heat pumps, are sized correctly for a home's thermal needs. In Canada, software used to calculate ratings under the F280 standard is validated by the HVAC Designers of Canada. This prevents the inefficiency of oversized units and the comfort issues caused by undersized systems. Much of the data for these calculations can be pulled directly from HOT2000 files generated during standard energy evaluations, allowing stakeholders to ensure that equipment is right-sized and that the resulting electrical demand is accurately accounted for in utility planning.

Whether through labels like CHBA Net Zero Ready (NZR), provincial codes such as BC's STEP Energy Code or Ontario's SB-12, or HVAC standards like F280, these compliance pathways are critical for utilities, as they provide a verifiable framework for reducing total building energy loads and, likely, demand loads. However, a significant gap exists because standard energy models focus on annual consumption rather than the peak hourly demand required for grid planning. While these models contain detailed home characteristics useful to utilities, they are often finalized too late in the builder's development workflow to influence utility infrastructure design. Integrating this data earlier in the design and development process would allow utilities to use these models to "right-size" the grid more effectively.

Qualitative Impacts of High-Performance Homes

High-performance homes offer significant non-energy benefits beyond reduced energy use, including occupant comfort, health, and climate change resilience. High-performance building envelopes, achieved through added insulation and improved airtightness, provide greater thermal comfort by maintaining consistent temperatures throughout the home and reducing drafts, cold spots, and condensation. A tight building envelope also improves sound isolation and increases durability by improving moisture management, which in turn reduces the risk of mould or rot. From a health perspective, high-performance homes include mechanical ventilation to ensure a constant supply of fresh air, which removes moisture and indoor pollutants, improving indoor air quality.

Homes built above code to standards such as CHBA NZR also deliver climate change resilience, an important safety feature. These low-energy homes experience slower thermal gains and losses, allowing them to maintain habitable temperatures for up to 36 hours during power outages caused by extreme weather, a significant advantage over standard code-built homes that may quickly fall below freezing in winter or overheat in summer.

However, the adoption of high-performance homes is accompanied by specific challenges. The initial construction cost can increase incrementally by approximately 10% to 15%, depending on the builder's experience with this type of construction. There is also a learning curve for occupants. For the homeowner, these high-performance measures translate to benefits such as lower, more predictable overall monthly utility bills and access to specialized green mortgage products with lower interest rates. Homeowners must be educated to operate sophisticated systems correctly, though. For example, avoiding deep thermostat setbacks that can reduce the efficiency of systems like geothermal heating, or expecting higher electricity bills because they no longer have a gas heating bill. Builders face systemic barriers, specifically a financial disparity in infrastructure costs. While competing gas lines are often subsidized, builders must pay up front for electrical infrastructure. This often results in financial penalties for choosing not to connect to gas networks, with limited means to recoup those costs.

Case Studies from the Builder-Utility Workshops

Background

Traditionally, the residential building industry and the electric utility sector have operated in silos. Building code decisions and site planning often occur independently of utility grid planning, creating a disconnect that frequently leads to design tension between modern home energy performance and electrical infrastructure. Utilities typically face the challenge of adapting to growing energy demands without specific data on high-performance home behaviour, while builders face uncertainty regarding the infrastructure requirements for the advanced homes they intend to build. This lack of coordination can result in strained grid capacity or oversized infrastructure, neither of which reflects actual consumption and both of which lead to additional costs and an “us and them” relationship between builders and utilities. As Canada moves toward widespread electrification of home heating and transportation through codes, incentives, and programs, this gap poses a risk to housing affordability and long-term grid reliability. Without a coordinated approach to site planning that involves all stakeholders and utilizes data and energy modelling for per-site demand forecasting, the transition to electric-dominant systems such as heat pumps and EV charging may be hindered by prescriptive or outdated design standards that cannot respond to a rapidly changing load landscape.

Purpose

The primary purpose of these case studies was to document successful instances of direct, early coordination between the low-rise residential building sector and electrical utilities to address the practical challenges of residential electrification, as was highlighted in three builder-utility workshops. These cases replaced traditional approaches with data-driven evidence to accurately forecast how modern electrified loads behave on the distribution grid and react with flexible engineering designs. This collaborative, data-driven effort reduced infrastructure uncertainty, optimized grid servicing requirements for greenfield developments, and identified scalable technical solutions for high-performance residential communities that serve as a model for other builder-utility relationships. A key technical focus was to bridge the gaps between building energy modelling for code compliance, building-specific data analysis, and load forecasting for utility infrastructure planning. While standard annual energy modelling tools are effective for building code compliance, they are often insufficient to capture the dynamic hourly peaks associated with widespread electrification. These case studies demonstrated how standard energy models can be converted into hourly demand-forecasting tools, and how anonymized data from similar buildings can be identified and collected by builders and utilities, and that, when taken together or separately, can provide utilities with the certainty needed to right-size infrastructure and minimize costs for both developers and ratepayers.

Data Collection Process

The builder-developer for each site initiated data collection. Qualitative insights were captured through a series of emails, virtual meetings, and in-person workshops, then summarized for inclusion in the following case studies. The quantitative data included metrics for assessing both the collected meter data and the energy modelling data. Home characteristics were gathered from the energy modelling files provided by the builder's REA. Some of these characteristics included F280 design heat loss and heat gain calculations, as well as peak- and energy-saving measures added to homes, such as air source heat pumps (ASHP), ground source heat pumps (GSHP), envelope upgrades, and water heater load-shift devices. Further information about the houses was obtained from the builders' websites to ensure a complete profile for each site.

Utility data collection was an ad hoc process in which Volta Research and the builder worked with each utility to determine the minimum number of addresses required to aggregate and anonymize the data, thereby eliminating the need for homeowner consent. The Electricity Distributors Association (EDA) also assisted with this process by sharing each utility's data aggregation risk thresholds and tolerances with other utilities, enabling data sharing. An Excel sheet format was provided to each utility to be completed with the available anonymized hourly data for each group of homes. Data was requested for each group per the following:

- Average kWh for each hour for all houses in the group
- Max kWh for each hour for any house in the group
- Min kWh for each hour for any house in the group

The raw data includes building configuration details in HOT2000 and text formats, supplemented by information from builder sales documents. Quantitative data also includes the anonymous, grouped hourly housing loads provided by the utilities. Energy modelling files were provided by the Energy Advisor firms used by the builders. Building energy models were associated with the groups of addresses.

Combining utility data for each house type with the collected building characteristics allows utilities to apply lessons from existing homes to future developments. Because builders often replicate the same housing products across multiple sites, this integrated data enables utilities to better inform infrastructure requirements for new projects of the same type.

Data for counterfactual analyses were collected from utilities for other housing with known features, using anonymized meter data. It was collected from builders in the form of models they would have called their base model before full electrification, and from the Independent Electricity Systems Operator's small service demand by forward sortation areas (FSA), and for residential service types.

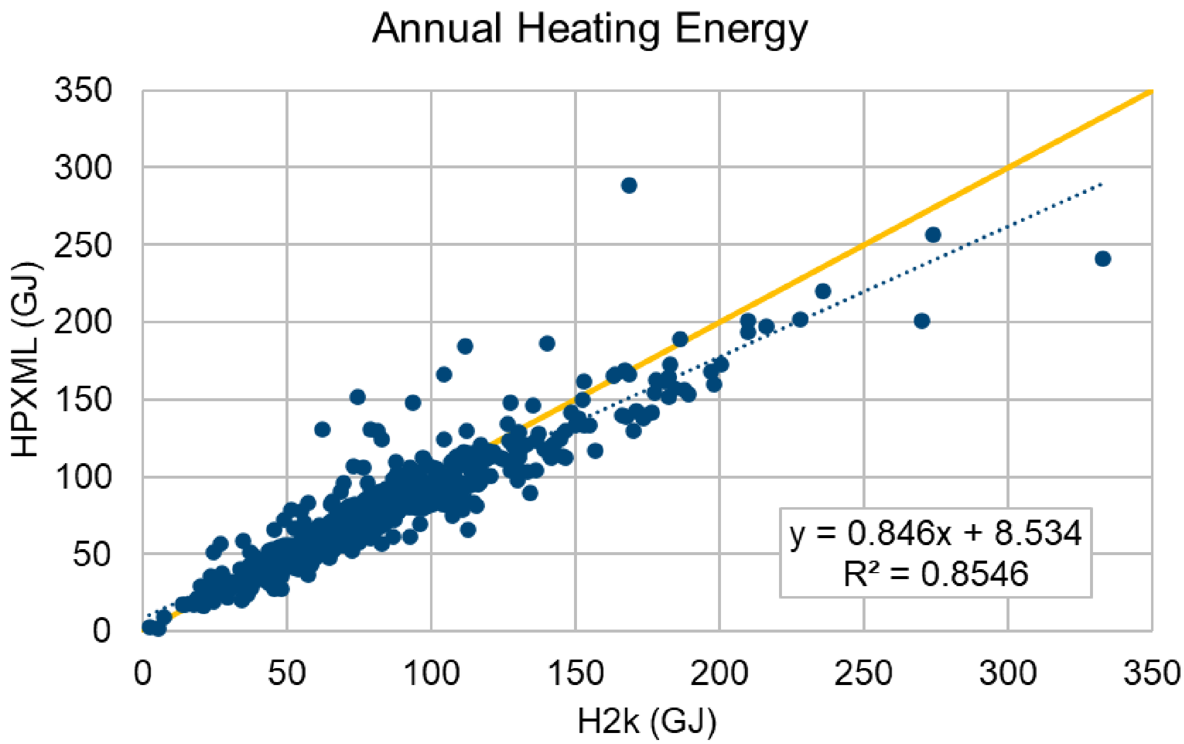
Building Energy and Demand Simulation Methodology

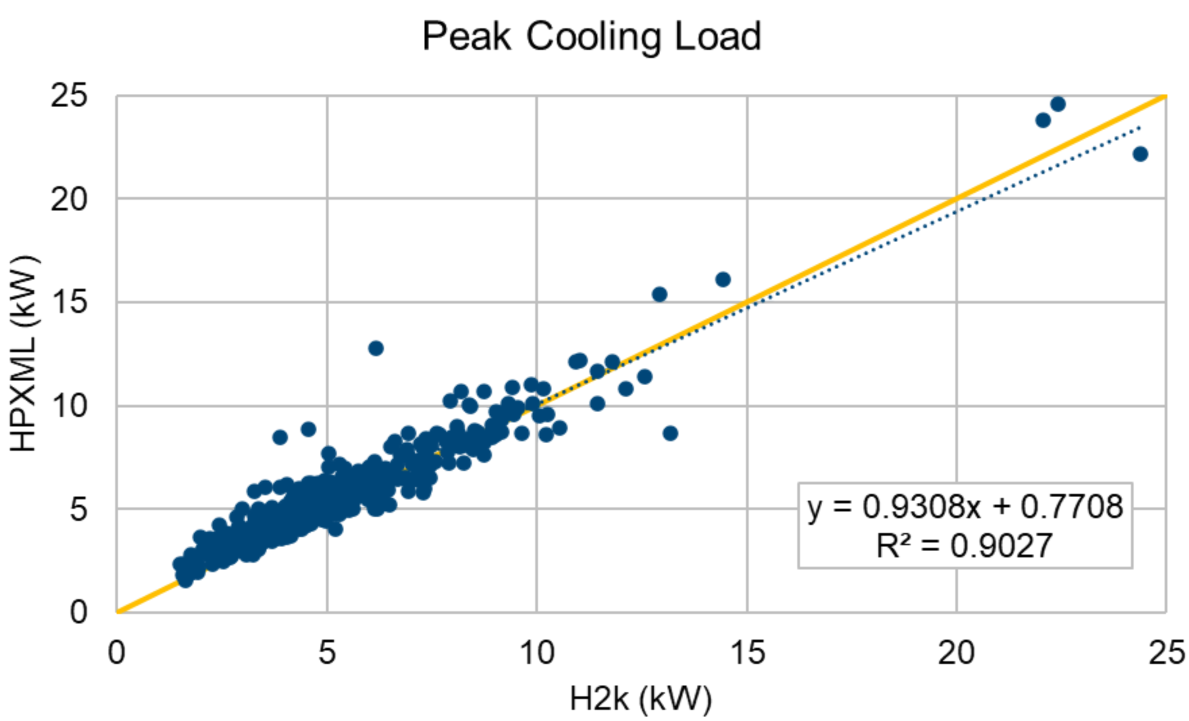
As housing electrification becomes increasingly common due to more stringent energy efficiency requirements, it is important to accurately understand the impact of households' electrical demand on the grid. The collection of known building characteristics and anonymous usage data is effective for known cases, but does not address how to assess demand for novel home configurations while managing risk. Building energy modelling addresses this need and was a significant component of these case studies.

Currently, the most common method of data collection and energy modelling for houses in Canada is through the HOT2000 (H2k) simulation engine and supporting EnerGuide Rating System program. While the use of H2k and ERS has resulted in the collection of vast amounts of data useful for a variety of purposes (e.g. NBC development), the H2k engine is not capable of providing hourly or sub-hourly energy consumption estimates. These estimates are required to accurately analyze the impact of electrification on the grid, making H2k of limited use to utilities for demand determination and infrastructure design.

A portable data format, Home Performance XML (HPXML), was developed by the National Renewable Energy Laboratory (NREL) to collect, store, and transfer housing data. Additionally, NREL has developed a workflow for this data format that enables HPXML files to be opened and run in OpenStudio (OS). This software platform performs whole-building energy simulation using the EnergyPlus (E+) engine. This project leveraged NREL's work on the HPXML-OS workflow and an open-source process to translate .h2k files into HPXML files, enabling them to be run in E+ using the HPXML-OS workflow. E+ supports more detailed inputs and provides hourly and sub-hourly energy consumption estimates, enabling analysis of the impact of electrification on the grid. Details on the process are available at https://github.com/canmet-energy/h2k_hpxml. The translator was also assessed in accordance with ASHRAE 140 and, in its current “under-development” state, passes all 2024 RESNET HERS acceptance criteria except for one heating delta test case, indicating sufficient performance against software assessment standards.

Two methods were used to convert HOT2000’s monthly binned and annual energy simulation formats into hourly energy consumption data. The first method (“H2k-Hourly”) was derived from a methodology developed by NRCan’s Office of Energy Efficiency (OEE) and CanmetENERGY-Ottawa (Brideau, 2020), and data were generated by implementing the algorithm in Volta SNAP. The second method (“HPXML”) uses the above-mentioned E+ simulations derived from HOT2000 files using the H2k-HPXML conversion library. Both methods were used in this project for comparison purposes. They are expected to produce minor differences in results, as shown below, because they rely on different underlying simulation engines and are not always both shown in the results unless necessary.





The gathered anonymous utility data had to be aligned with climate conditions to enable comparison of real-world utility data with simulated energy consumption, a central goal of these case studies. In this instance, historical weather data from Environment and Climate Change Canada was obtained for the case study locations and aligned with the hourly utility data. To isolate and investigate the temperature dependence of loads more closely, the methodology uses a binned temperature range to organize the data in a more manageable format. The case studies used the demand load distributions in each temperature bin to evaluate the ability of simulated hourly electricity consumption to predict the real-world electricity consumption of groups of homes within a builder's community.

Modelling Setup

The methodology outlined above was leveraged for each case study and applied as follows:

1. For each unique home model in a builder's community (or area of study), the HOT2000 energy models were obtained from the builder and their energy consultant. These models were simulated "as-is" through both the H2k-Hourly and HPXML workflows. They were not altered from their original state to best reflect the models used for actual performance path code compliance. In addition, no smart HVAC or other controls were applied to the models, as such controls are not available for annual code compliance modelling.
2. The builders and utilities were then engaged to provide aggregated utility data for all homes in a builder's community that matched a given builder's model type. For example, if 10 homes of a single type (represented by a single HOT2000 model) were built in a community, the utility would provide the total hourly electrical consumption for all 10 homes, aggregated, without exposing any individual addresses or information that could identify the homeowners. This data could then be divided by the number of homes in the group to determine the average hourly electrical consumption for that type of home.
3. Simulated hourly electricity consumption was compared to actual hourly consumption across different home models to validate simulation outputs. This process assessed the potential of simulations to predict electrical behaviour in future developments accurately.
4. The electrified housing models were compared to counterfactuals for each given case study. Generally, this process involved comparing each of the highest-performance cases to "business as usual," which may have been the building code or another base case. Ideally, all counterfactuals are based on data, but simulations were performed as needed to juxtapose the electrified case with the data. Data from the IESO in Ontario, including FSAs for each case study location, were also used to illustrate the broader load profiles of the regions where the case studies are located.

Results Presentation

Results for the case study are presented in both tabular and graphical formats. Actual results represent an average of fewer than 20 addresses per group across all cases, with winter defined as temperatures below 10°C and summer as temperatures above 10°C. Since the modelled data uses CWEC files (which consist of historical data points representing an average year) and the measured data represents actual recorded energy readings at a specific temperature and hour, the time-domain data points from the simulation and the meter data could not be compared directly. Instead, both meter and simulated data were converted to the temperature domain by binning recorded and simulated energy readings into 5-degree-Celsius-wide bins, as outlined in the modelling methodology section. The temperature domain presents data for simulated results and actual measurements. The temperature domain is ineffective for handling non-temperature-dependent or large step-change loads, such as cooking, drying, and EV charging, which require the time domain. The time domain helps visualize trends over the entire year, and time-of-day graphs are necessary to understand intra-day characteristics.

Sites and Stakeholders Overview

To provide the real-world context needed to test energy modelling and infrastructure assumptions, the project centred on three case studies:

1. The Upper Joshua Creek development in Oakville features a collaboration between Mattamy Homes and Oakville Hydro. Mattamy Homes is the largest privately owned homebuilder in North America, with a presence in both Canada and the United States. The company manages all stages of development, including land acquisition, community design, and construction. This project was supported by Oakville Hydro, a utility that has provided electricity to the Town of Oakville for over a century and currently serves more than 78,000 residential and commercial customers. Building Knowledge Canada provided energy advising for this project.
2. The Net Zero Ready Harvest Run development in the St. Thomas community was developed by Doug Tarry Homes, who collaborated with Entegrus, the local distribution company, to right-size the infrastructure. Doug Tarry Homes has been building in the St. Thomas region since 1954, focusing on energy-efficient residential construction and community-centred development. The local utility, Entegrus, maintains electricity distribution systems for over 63,000 customers across 17 communities in Southwestern Ontario and manages services ranging from powerline maintenance to renewable energy investments. Building Knowledge Canada provided energy advising for this project.
3. The Watercolour Westport development in Eastern Ontario brought together Land Ark Homes and Rideau St. Lawrence Distribution. Land Ark Homes is an Ottawa-based builder with over 30 years of experience in the residential sector, focusing on the design and construction of durable, high-performance homes. They coordinated with Rideau St. Lawrence Distribution, a municipally owned utility that delivers power to approximately 6,000 customers across several villages in Eastern Ontario and the Town of Prescott. Homesol provided energy advising for this project.

1. Mattamy Homes and Oakville Hydro

Case Study Houses

The Upper Joshua Creek development in Oakville, Ontario, served as the first case study and workshop. Mattamy Homes used this project to showcase how geothermal technology can reduce a community's direct operational carbon and the reliance on natural gas infrastructure.

Oakville Hydro collaborated on the study to evaluate its "Electrification Readiness Strategy" in response to a forecasted increase in peak load demand of 48% to 106% by 2050. This partnership was driven by the Town of Oakville's projected population doubling by 2051 and a broader industry transition toward phasing out natural gas in favour of fully electrified residential systems. The project aimed to reconcile these future requirements with existing grid capacity, positioning the site as a strategic model for sustainable urban growth and utility modernization.

The study focused on Upper Joshua Creek’s Phase 5, a high-density neighbourhood in Oakville featuring 66 all-electric homes. This phase includes a diverse mix of housing types: 8 detached residences, 31 two-storey townhomes, and 27 rear-lane townhomes. Every home in this phase was built to either Energy Star for New Homes (ESNH) or Net Zero Ready performance standards, ensuring high levels of energy efficiency and comfort. The community relies on a district-scale geothermal system for both heating and cooling, which utilizes individual boreholes drilled to depths of 300 to 700 feet to maintain efficient thermal exchange. To ensure these homes operate effectively within the local grid capacity, some units were equipped with a Hoot Smart Device. This smart technology was specifically implemented to shift the energy consumption of electric heat pump water heaters away from peak system periods, helping stabilize the electricity grid while providing cost-saving opportunities for residents. This approach allows the neighbourhood to achieve superior energy performance while providing a scalable model for sustainable urban residential growth.

House Characteristics

Data from five different house models representing groups of all-electric, geothermally conditioned homes were collected. The models are labelled according to the modelling nomenclature from Building Knowledge Canada, which provided the HOT2000 models for this analysis, with permission from Mattamy Homes. No data was available on how many homes had opted for the hot water tank control or had activated the system.

The nomenclature translates as follows for the individual lot type discussed in this case study:

- B38L - Detached 38': ~2500-3000 sq. ft., 4 bed, 2 bath

This home is also unique in that Phase 4 was built with essentially the same envelope but used an ASHP and furnace for hybrid heating, allowing the collected utility data for each model to be compared across phases and fuel types, providing a counterfactual data example. Energy models were not provided for the Phase 4 hybrid-system-conditioned homes. A counterfactual analysis was also conducted for the smart hot water system.

Aggregated Data

The utility provided hourly kWh data from the following aggregation groups. Data were given as the maximum for any house in the hour, the average across all houses in the hour, and the minimum for any house in the hour. Averages that were zero were discarded.

Data were collected from September 1, 2024, to August 29, 2025, for Phase 5 for each model, and for Phase 4, aggregated across all homes from the start date until March 1, 2025. Phase 5 had between 8+ homes per group, and Phase 4 aggregated around 100 homes. From March 1, 2025, to August 29, 2025, Phase 4 data was also split into building-model aggregation groups.

Detailed aggregation group sizes for the homes in the case study are listed below.

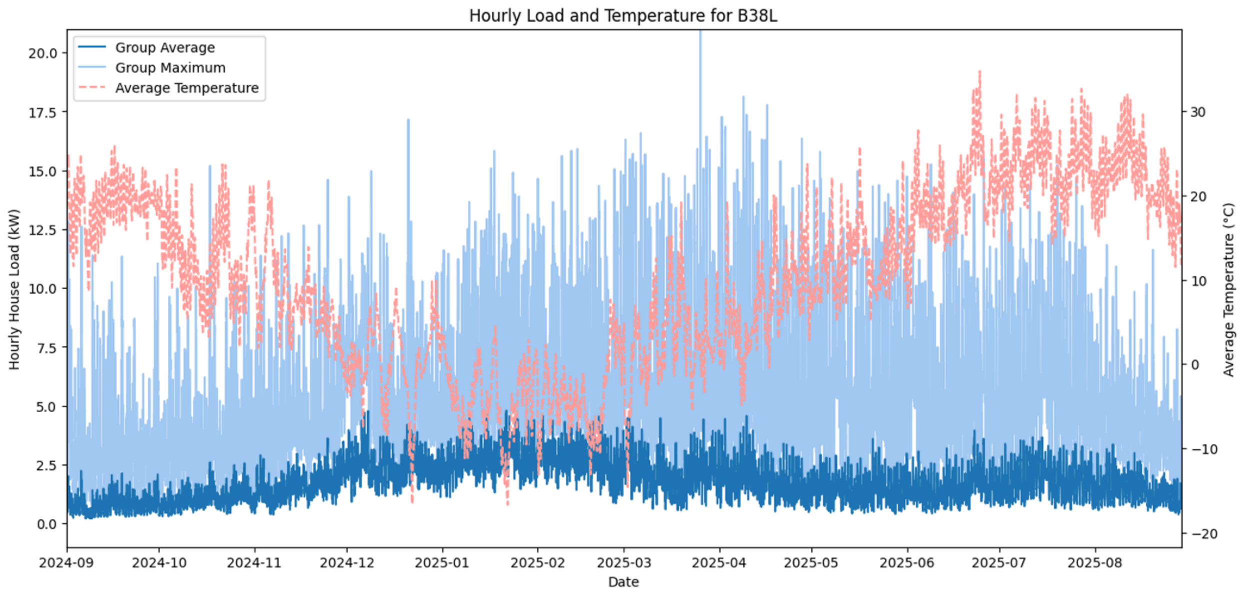
- B38L - Detached 38': 8 homes

Hourly Results

ELECTRICAL DEMAND	**B38L Geo**	**B38L Hybrid**
GROUP		
Winter Peak Load (H2k)	3.96 kW	N/A
Winter Peak Load (HPXML)	4.30 kW	N/A
Winter Peak Load (Actual)	4.79 kW	2.79 kW
Summer Peak Load (H2k)	3.80 kW	N/A
Summer Peak Load (HPXML)	3.49 kW	N/A
Summer Peak Load (Actual)	3.95 kW	4.15 kW
INDIVIDUAL		
Winter Max House Load (Actual)	21.11 kW	15.41 kW
Summer Max House Load (Actual)	16.34 kW	17.94 kW

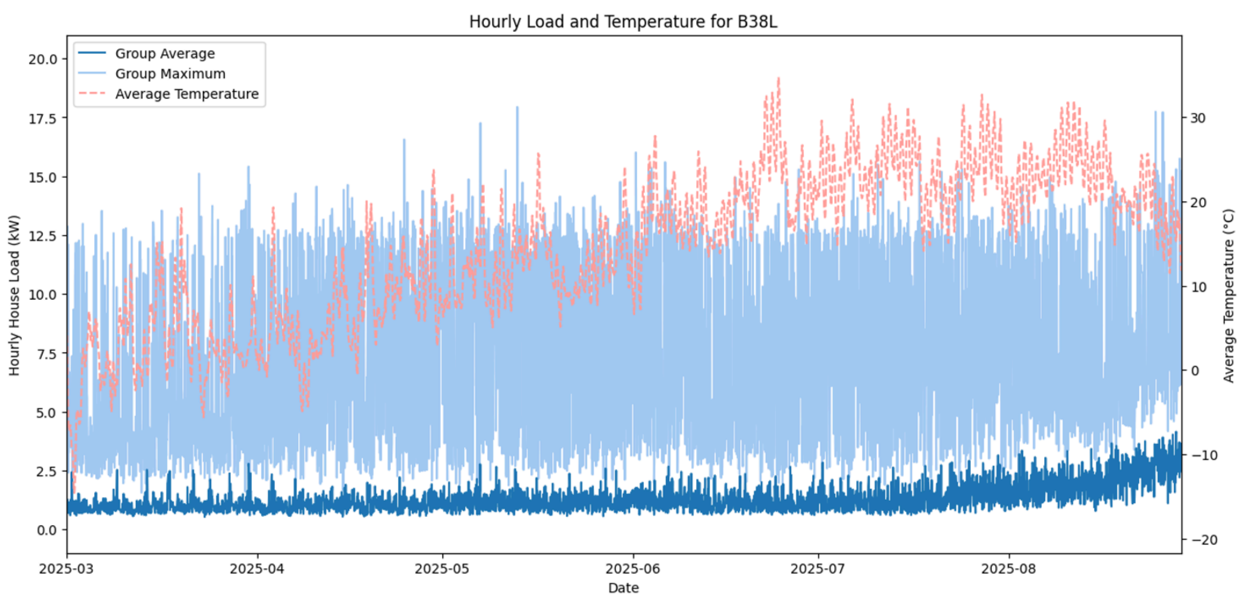
The above table shows the summary demand results for the all-electric geothermal B38L type and the counterfactual hybrid B38L type. Total annual peak loading was very similar between the two types. For the individual worst-case home, maximum hourly usage was similar and below the 24 kW level of a 100 A electrical panel and well below the 48 kW level of the 200 A panels these homes were equipped with.

Time Domain (B38L Geo)



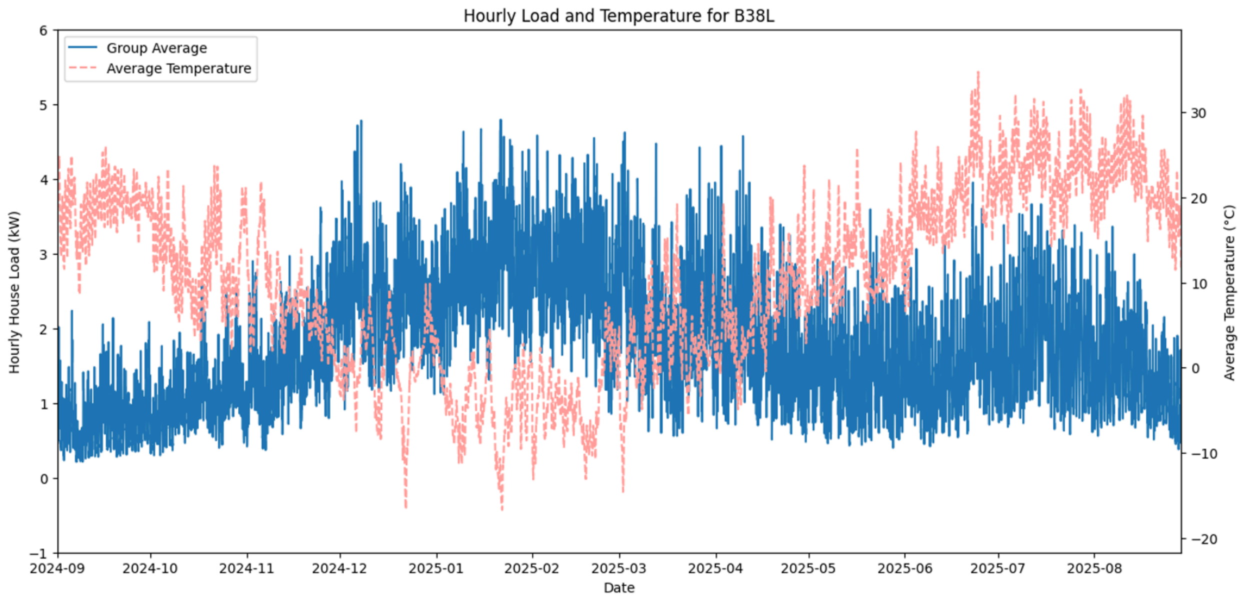
This results graph shows the time-domain behaviour over the year for the all-electric B38L under both the average and worst hourly loading cases. The average temperature is also shown.

Time Domain (B38L Hybrid)



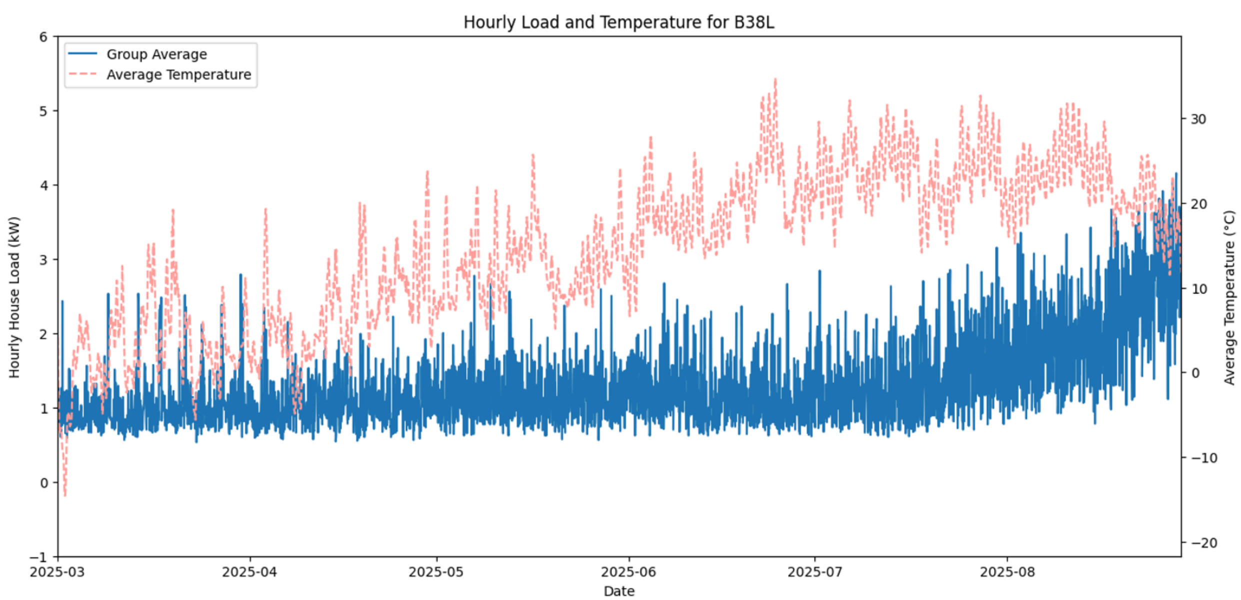
This results graph shows the time-domain behaviour over the year for the hybrid B38L under both the average and worst hourly loading cases. The average temperature is also shown.

Time Domain (B38L Geo)



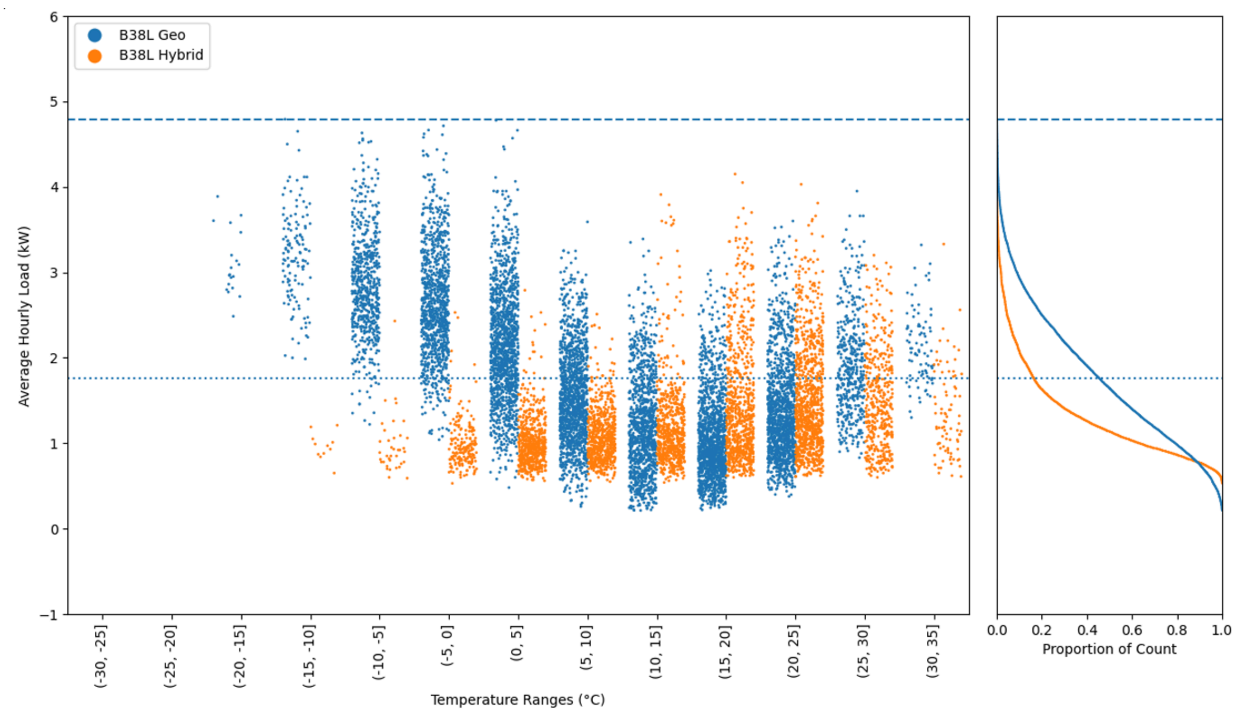
This results graph shows the time-domain behaviour over the year for the all-electric B38L under the average hourly loading case. The average temperature is also shown.

Time Domain (B38L Hybrid)



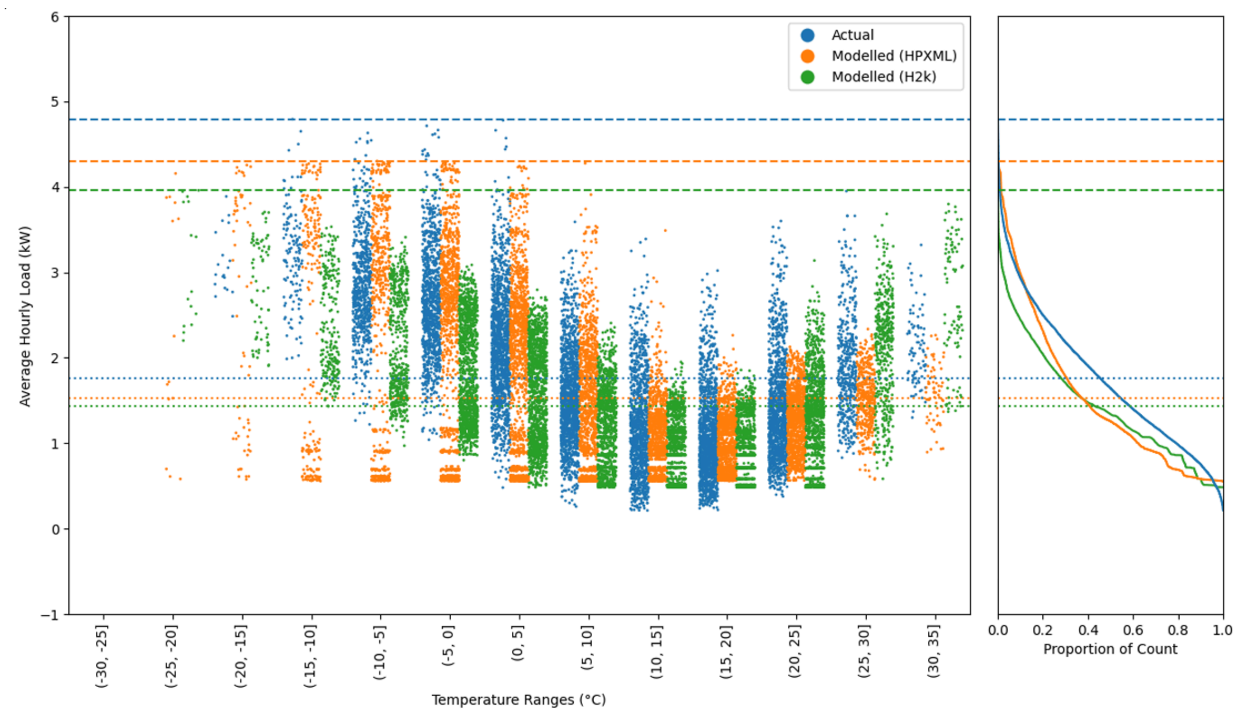
This results graph shows the time-domain behaviour over the year for the hybrid B38L under the average hourly loading case. The average temperature is also shown; note that the x-axis labels differ from those in the all-electric graph.

Temperature Domain (B38L Geo/Hybrid)



This graph demonstrates the temperature-domain behaviour of the all-electric and counterfactual hybrid-heating B38L model. Summer cooling loads are very similar for both home types, while the winter all-electric load is higher in the all-electric case. Summer and winter all-electric cases are similar for peak loading, which is typical behaviour for geothermal heat and cooling, which uses relatively stable ground temperatures.

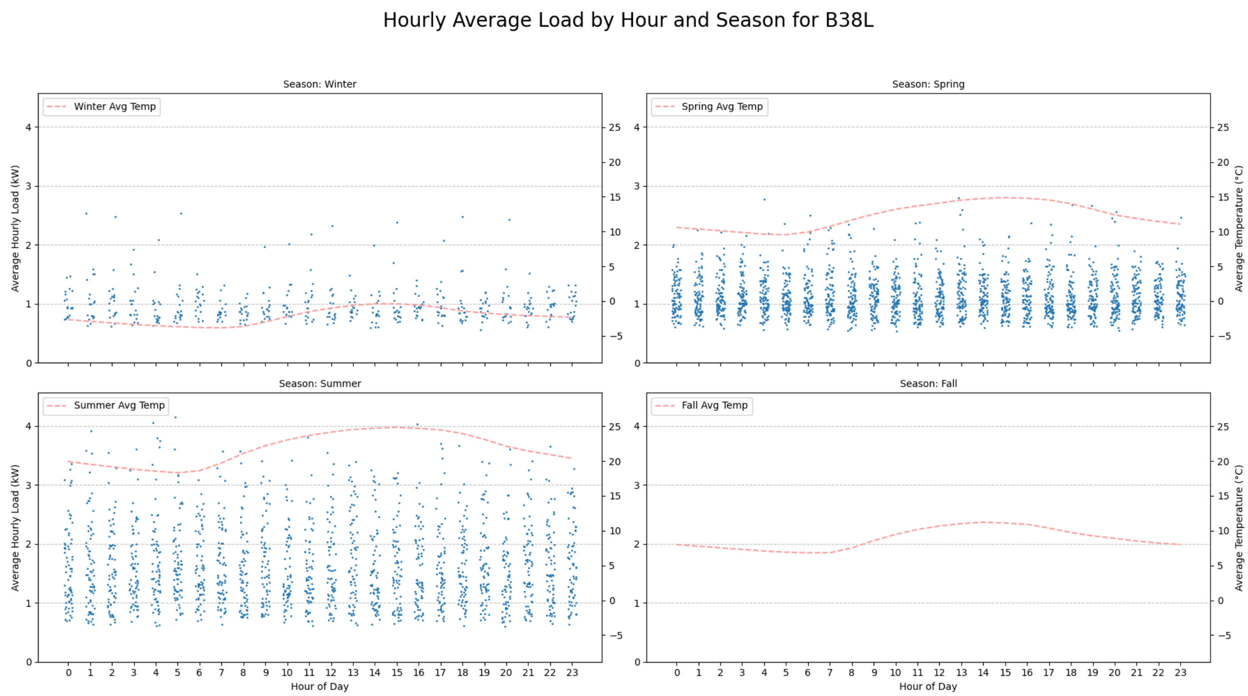
Temperature Domain (B38L Geo)



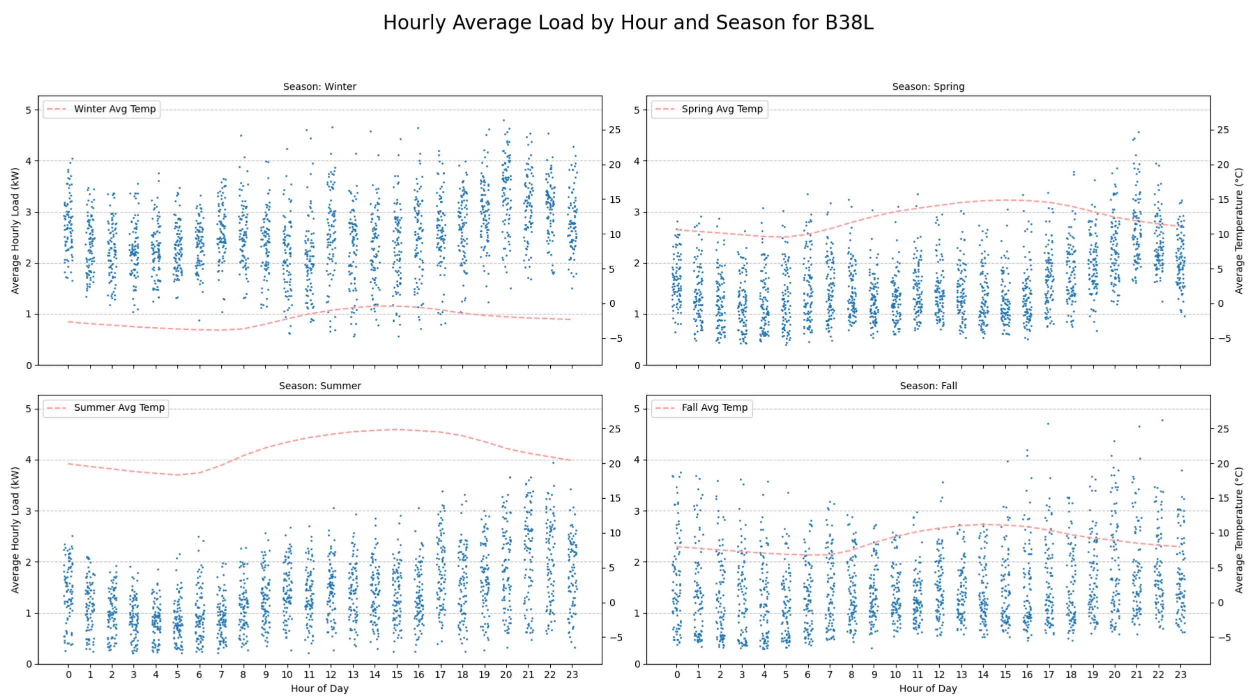
The graph above shows model accuracy compared with the actual data. The alignment between both models and the actual data is strong for the n=8 samples used in this analysis. This demonstrates that a building energy model deployed as-is through an hourly energy modelling engine shows good promise for predicting transformer-level loads.

Time Domain (24-hour day)

The following graph shows the 24-hour-per-hour behaviour of the hybrid B38L model for seasons with available data. Summer clearly has the highest demand loading, and the days follow a standard occupant trend.

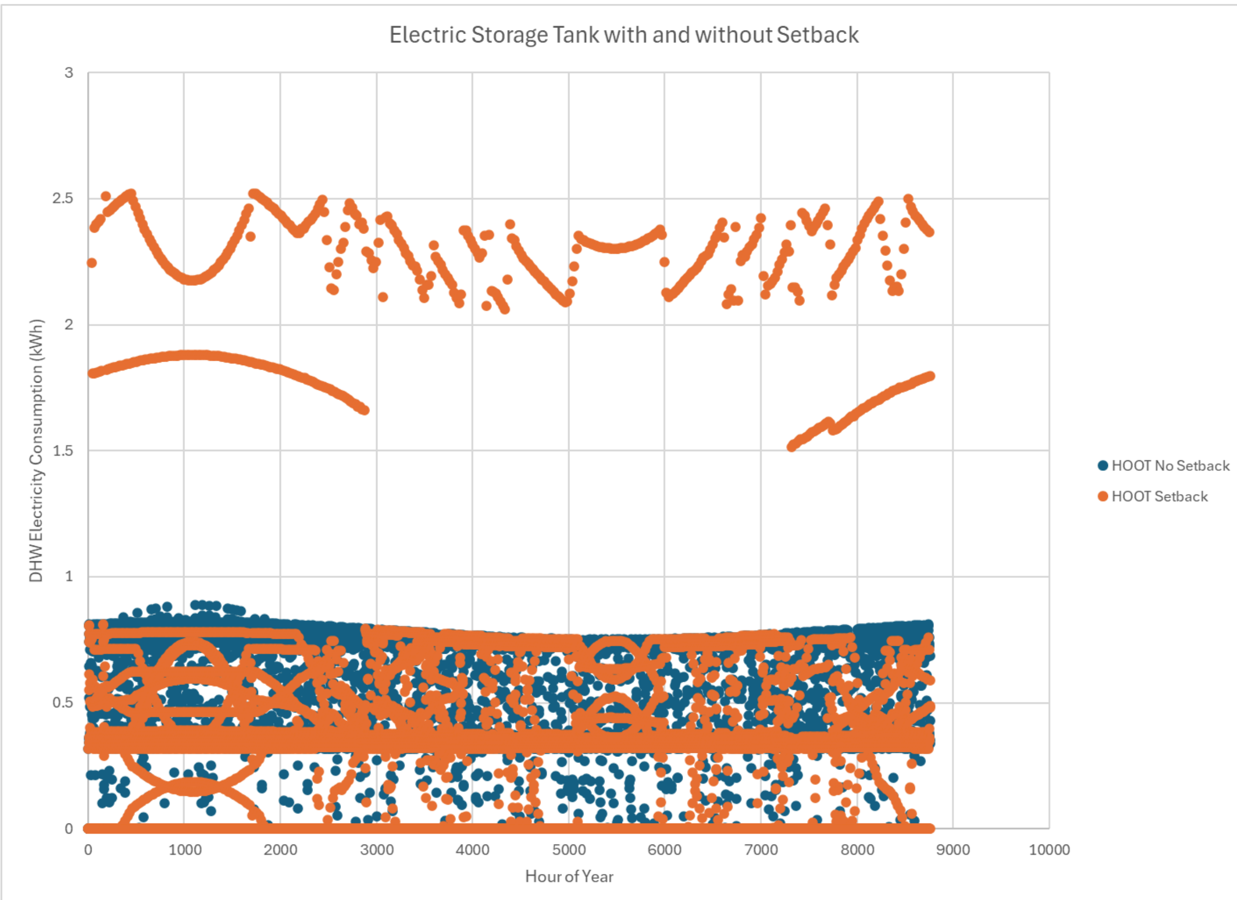


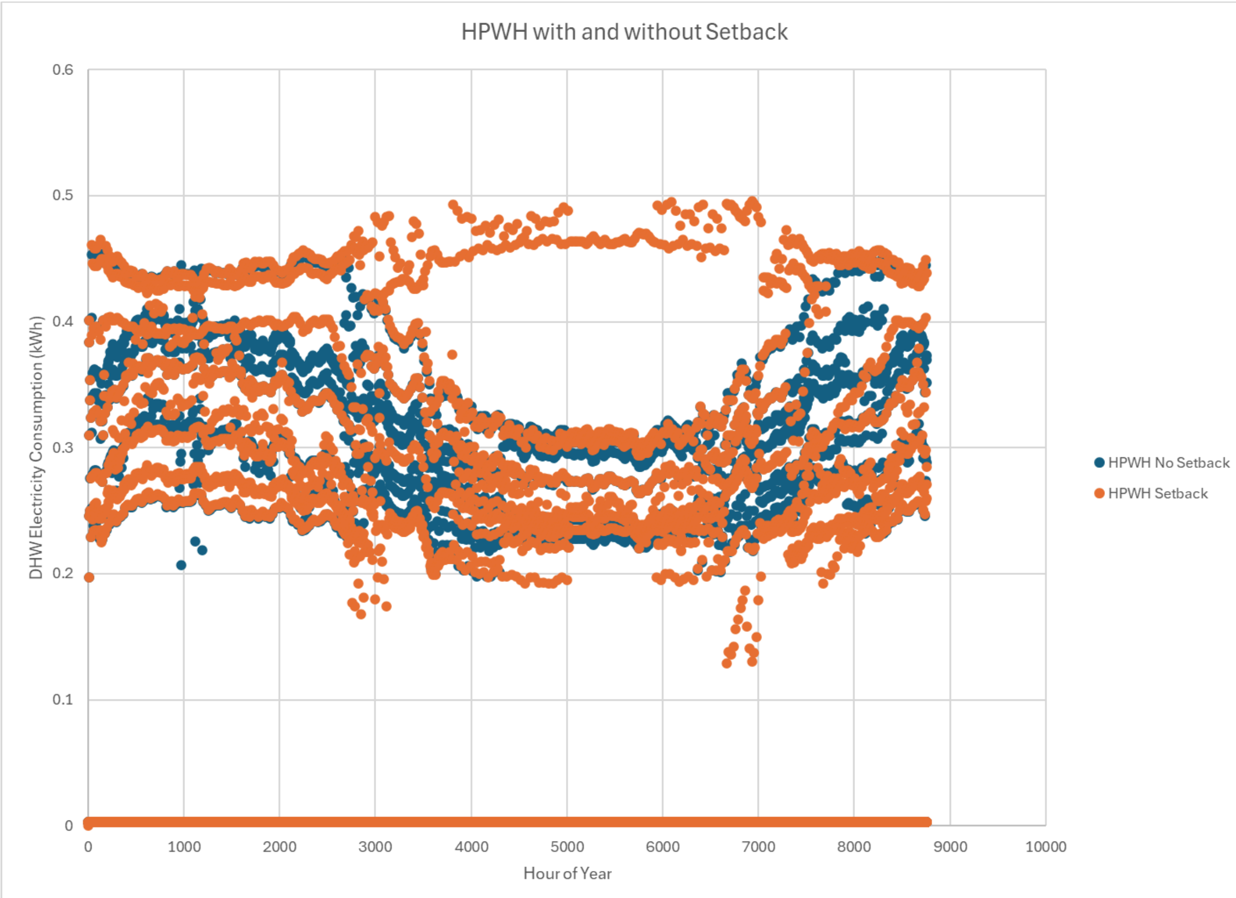
The following graphs show the 24-hour behaviour of the B38L all-electric model, which shows the highest demand in winter, with a clear trend of peak demand before midnight.



Hot Water Control Analysis

The following graphs show the simulated behaviour of the HOOT hot water control system using an electric tank with TOU setback control, as well as the same control on a heat pump water heater tank. From the hourly data, it is clear that setback activity for both tank types results in higher hourly demand than when no setback is applied. This makes sense, as the control strategy deployed on the HOOT system prioritizes homeowner cost over peak-demand reduction for the utility in its current implementation. No meter data were available for the HOOT system at known addresses, so no analysis of actual data could be performed.





2. Doug Tarry Homes and Entegrus

Case Study Houses

The Harvest Run development in St. Thomas, Ontario, serves as a primary example of advancing Net Zero Energy (NZE) and resilient design at a production scale within a mid-sized urban utility territory. A central focus of this site is the "LifeARK" concept, which integrates building science with climate resiliency. This approach goes beyond standard construction by prioritizing sustainable survivability, ensuring that homes remain functional and safe during extended power outages. As the local utility, Entegrus collaborated with the builder to examine how these low-load buildings perform relative to traditional utility design standards during a period of rapid regional growth.

This development features high-performance residences built to NZR performance levels as standard. These homes use advanced building envelopes, featuring rigid exterior insulation and airtight barriers, to enhance thermal resilience. To evaluate grid impacts across different levels of electrification, the study analyzed two distinct unit types.

House Characteristics

The Elmwood is a 1,520 sq. ft. 2-storey semi-detached plan built to Energy Star and Net Zero Ready. The Elmwood A model utilizes a hybrid system consisting of an air source heat pump and a high-efficiency gas furnace and features an airtightness level of 1.3 air changes per hour. The Elmwood B model is a fully electrified system featuring an air-source heat pump with electric furnace backup and a heat pump water heater, achieving an airtightness level of 0.7 air changes per hour. A representative HOT2000 file was provided by Building Knowledge Canada for analysis, with permission from Doug Tarry Homes.

Floor plans are available here: https://www.dougtarryhomes.com/show-home-plan/?model=8803 and here: https://www.dougtarryhomes.com/wp-content/uploads/2022/06/Elmwood-Brochure-Jan-2026.pdf.

Aggregated Data

The utility provided hourly kWh data from the following aggregation groups. Data were provided as the maximum for any house in the hour, the average across all houses in the hour, and the minimum for any house in the hour. Averages that were zero were discarded.

- Elmwood A: 14 homes
- Elmwood B: 14 homes

Data was collected from August 1, 2024, to August 1, 2025.

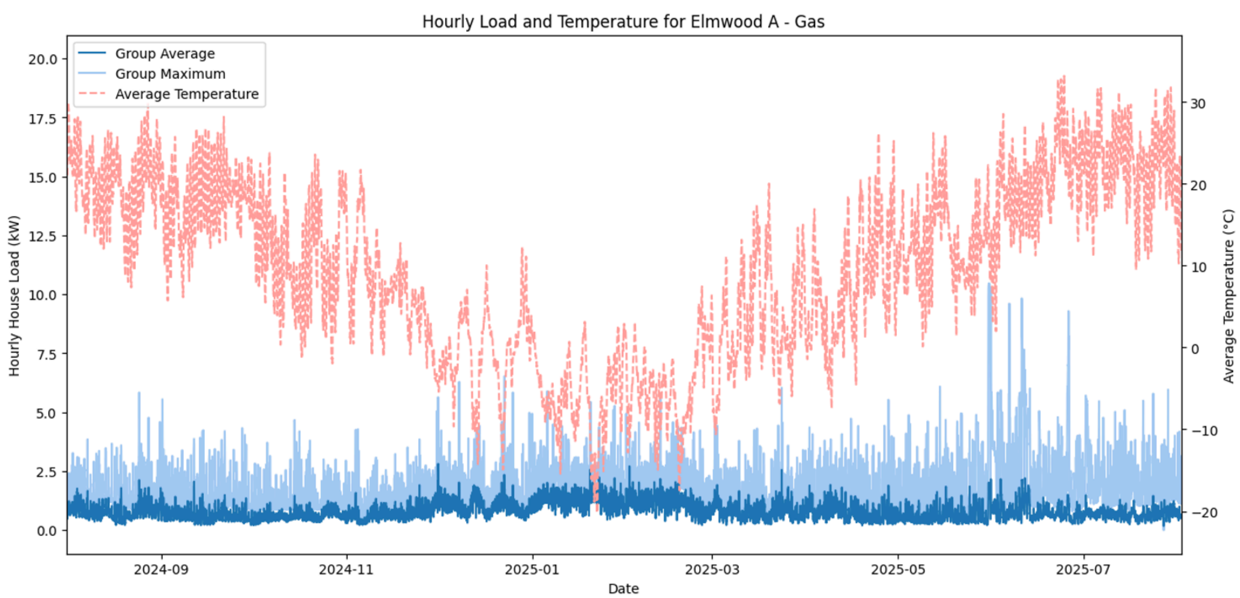
Hourly Results

ELECTRICAL DEMAND	Elmwood B (Electric)	Elmwood A (Hybrid)
GROUP		
Winter Peak Load (H2k)	5.75 kW	2.24 kW
Winter Peak Load (HPXML)	7.17 kW	2.68 kW
Winter Peak Load (Actual)	4.75 kW	2.81 kW
Summer Peak Load (H2k)	2.25 kW	2.29 kW
Summer Peak Load (HPXML)	2.04 kW	1.96 kW
Summer Peak Load (Actual)	2.65 kW	2.21 kW

INDIVIDUAL		
Winter Max House Load (Actual)	23.52 kW	10.20 kW
Summer Max House Load (Actual)	16.00 kW	10.47 kW

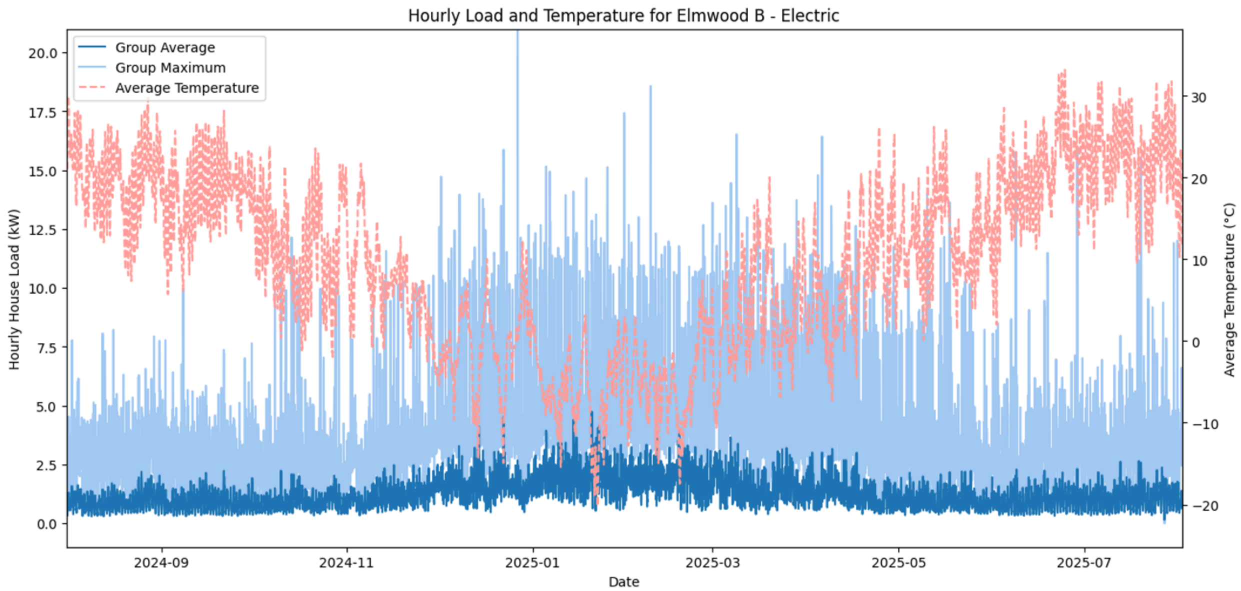
The above table shows the summary demand results for the all-electric Elmwood B type and the counterfactual hybrid Elmwood A type. Winter peaking was significantly higher for the all-electric type than for the hybrid heating type. For the individual worst-case home, maximum hourly usage was higher for the all-electric type, but both types were below the 24 kW level of a 100 A electrical panel, and well below the 48 kW level of the 200 A panels these homes were equipped with.

Time Domain (Elmwood A, Hybrid)



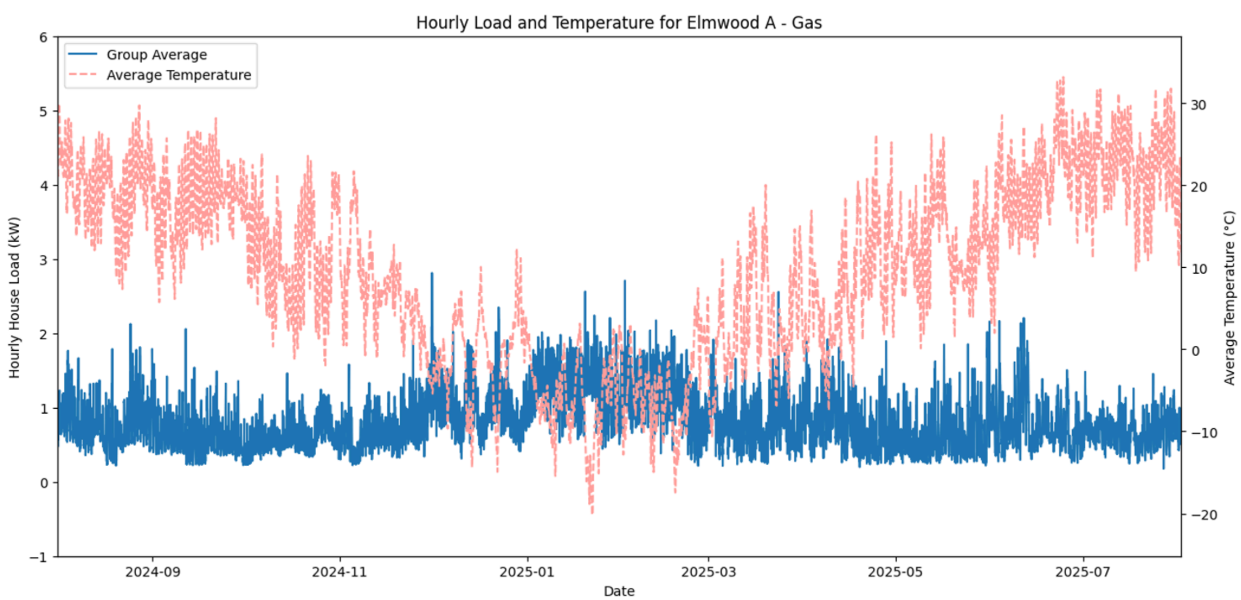
This results graph shows the time-domain behaviour over the year for the hybrid heating Elmwood A counterfactual case for both the average and worst hourly loading cases. The average temperature is also shown.

Time Domain (Elmwood B, All-Elec)



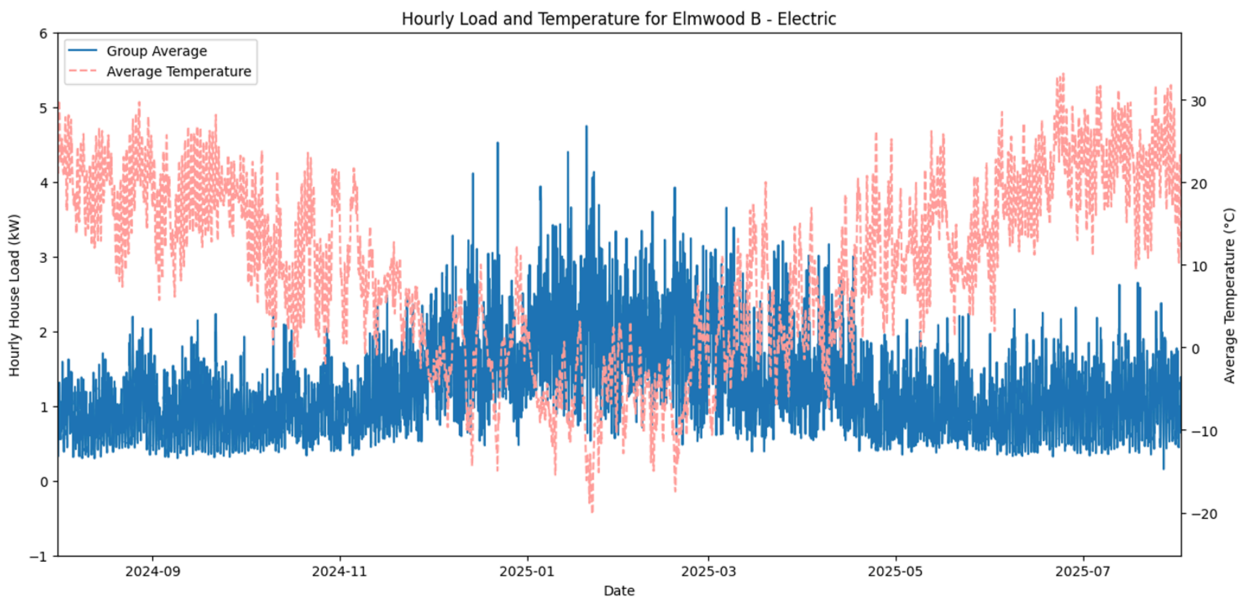
This results graph shows the time-domain behaviour over the year for the all-electric Elmwood B type for both the average and worst-case hourly loading cases. The average temperature is also shown. It is clear that the highest worst-case peak hours for any given home occur very rarely, though there is a definite trend for the all-electric home type to have higher worst-case average loads in winter than the hybrid type.

Time Domain (Elmwood A, Hybrid)



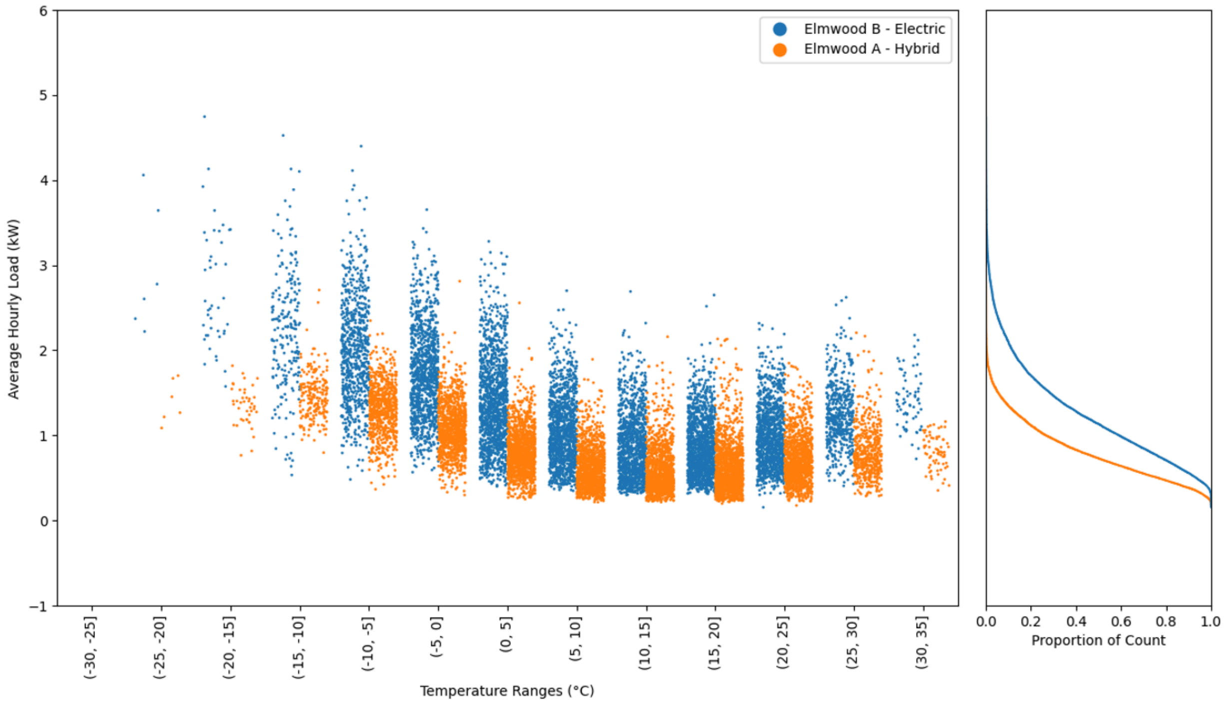
This results graph shows the time-domain behaviour over the year for the hybrid heating Elmwood A counterfactual case for the average hourly loading case. The average temperature is also shown.

Time Domain (Elmwood B, All-Elec)



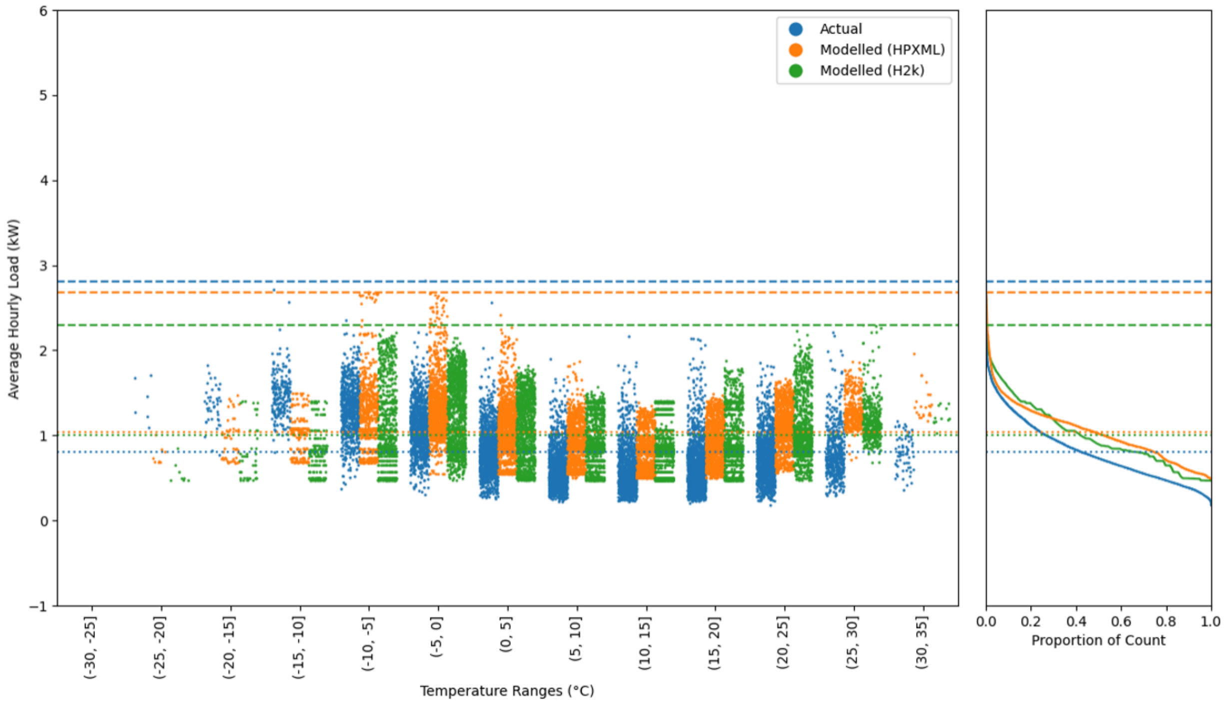
This results graph shows the time-domain behaviour over the year for the all-electric Elmwood B type under the average hourly loading case. The average temperature is also shown. Demand clearly tracks with temperature for this case.

Temperature Domain (Elmwood Elec/Hybrid)



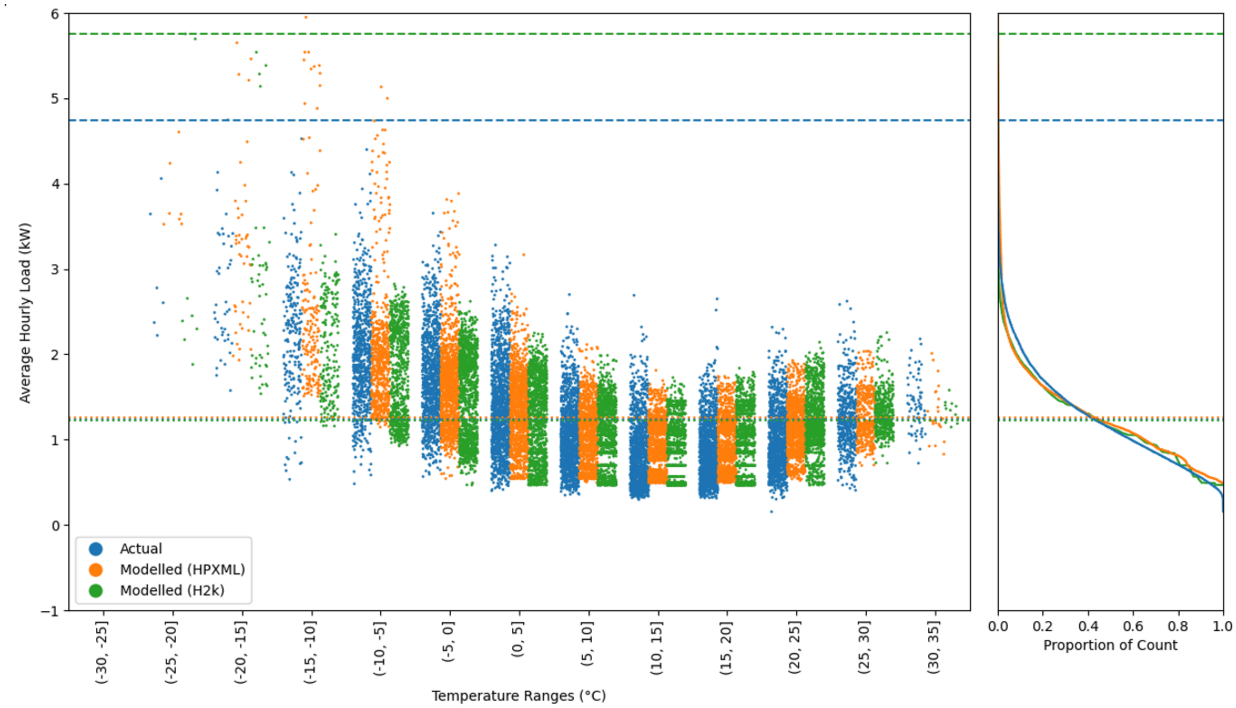
This graph demonstrates the temperature-domain behaviour of the all-electric Elmwood B model versus the counterfactual hybrid-heating Elmwood A model. Summer cooling loads are very similar for both home types, with the winter all-electric load higher in the all-electric case. From the temperature domain analysis, the control point for switching from electric to gas heating in the hybrid model is clearly evident in the bins around zero degrees.

Temperature Domain (Elmwood A, Hybrid)



The graph above shows model accuracy compared with the actual data for the Elmwood A type. The alignment between both models and the actual data is strong for the n=14 samples used in this analysis. This demonstrates that a building energy model deployed as-is through an hourly energy modelling engine shows good promise for predicting transformer-level loads.

Temperature Domain (Elmwood B, All-elec)

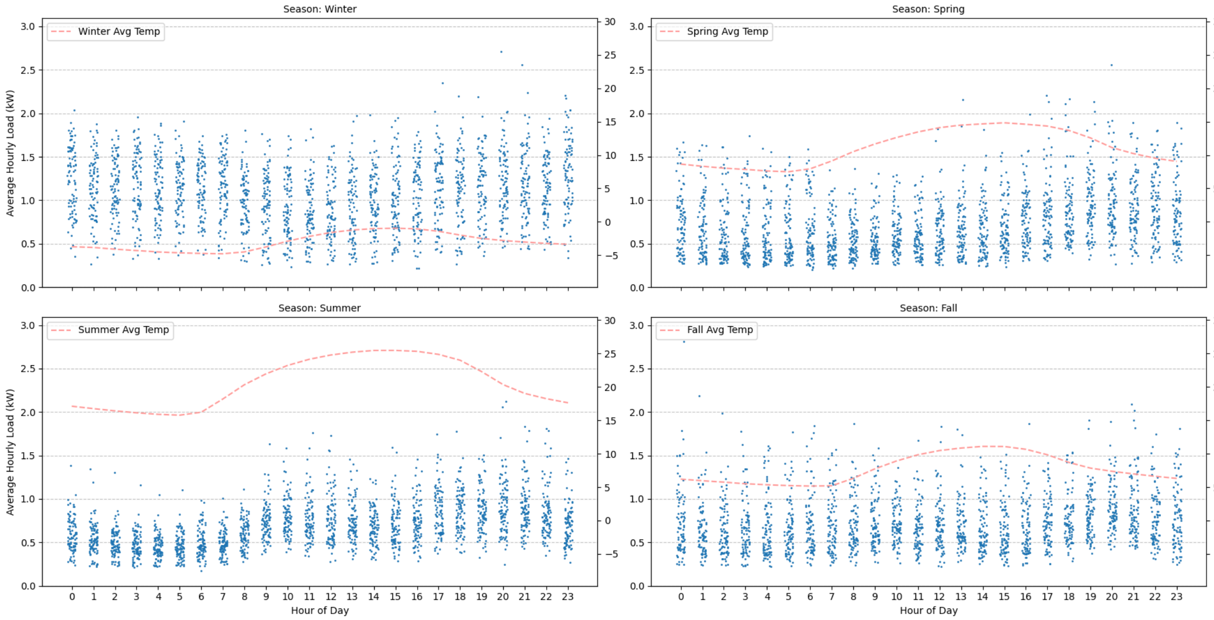


The graph above shows model accuracy compared with the actual data for the Elmwood B type. The alignment between both models and the actual data is strong for the n=14 samples used in this analysis. This demonstrates that a building energy model deployed as-is through an hourly energy modelling engine shows good promise for predicting transformer-level loads.

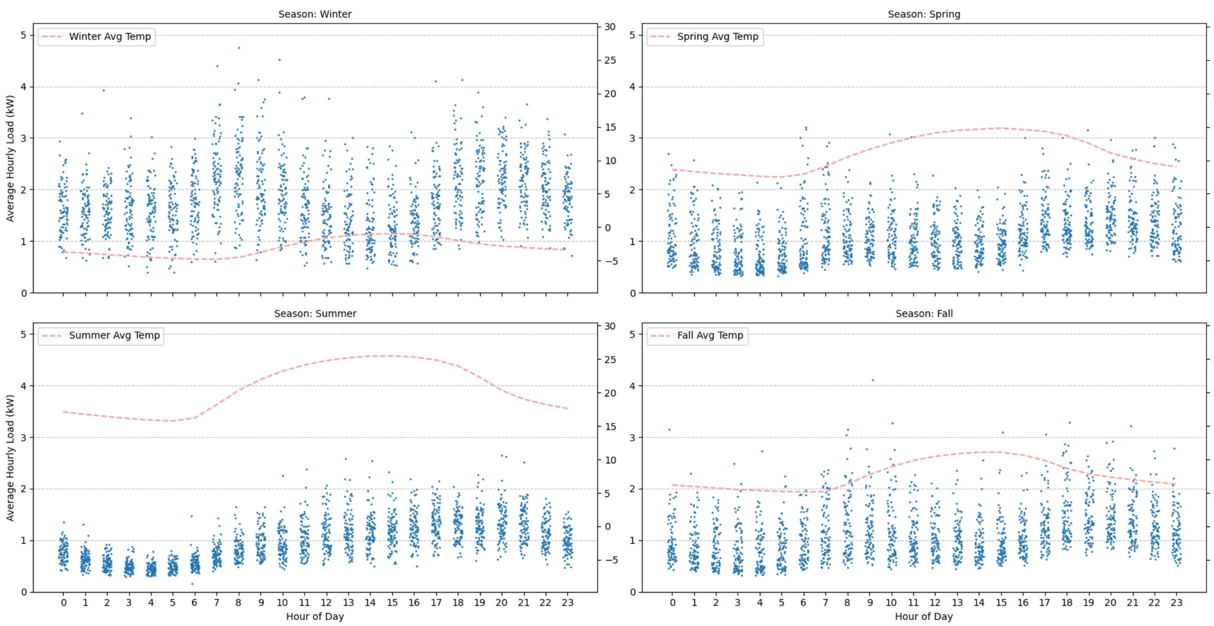
Time Domain (24-hour day)

The following graph shows the 24-hour behaviour of the Elmwood types for seasons with available data. Both Elmwood A and B models follow a clear daily loading trend, as expected, with the highest loading being on the all-electric Elmwood B during morning and evening hours.

Hourly Average Load by Hour and Season for Elmwood A - Gas

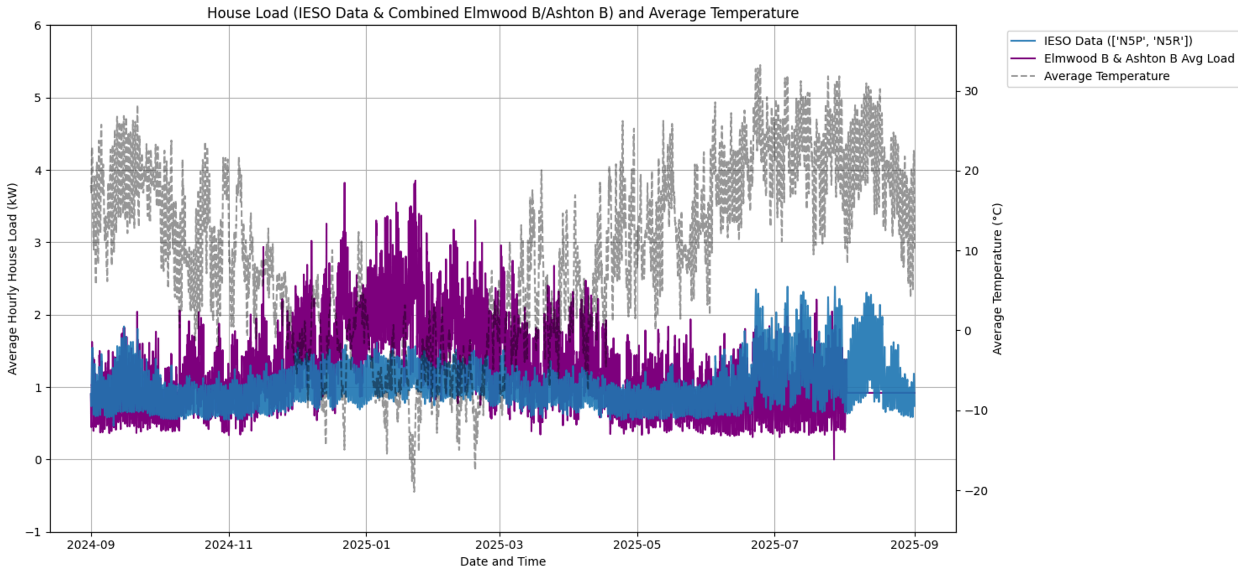


Hourly Average Load by Hour and Season for Elmwood B - Electric

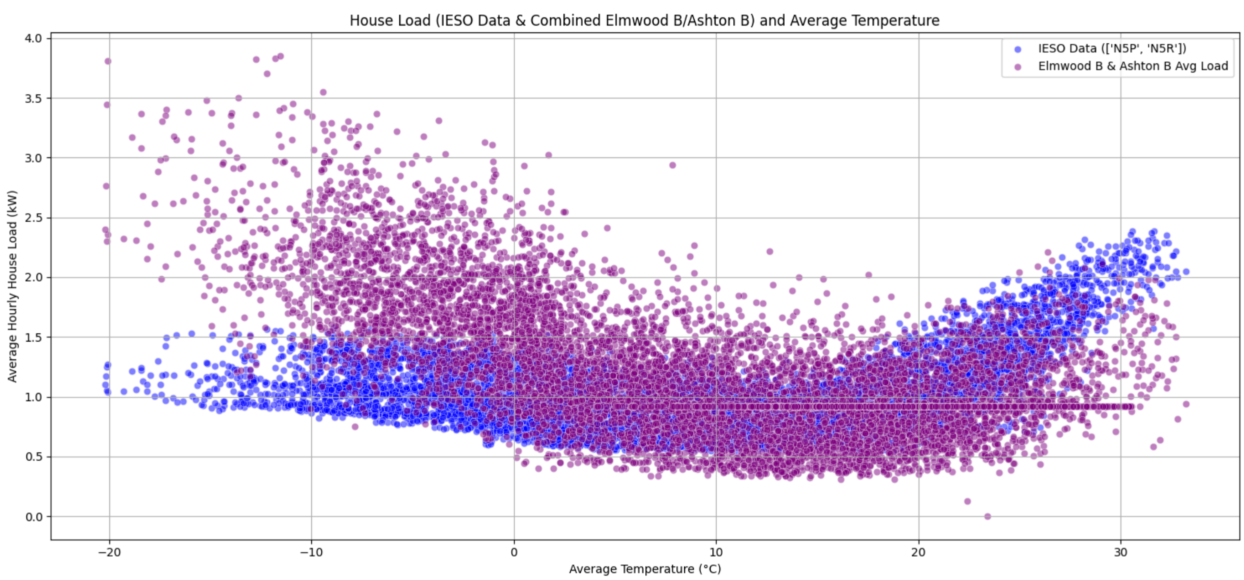


IESO Data Counterfactual Case

Residential-type meter data (n=20966) for two FSAs in St. Thomas, Ontario (N5P and N5R), where the Harvest Run development was built, were obtained and compared to *__all__* of the all-electric data available from the Harvest Run dataset from Entegrus, n=22 in this case. Notwithstanding the orders-of-magnitude difference in sample size, which can affect data smoothness, the comparison shows that all-electric homes have higher winter demand and lower summer demand than other houses in these FSAs.



This can be observed more clearly in the temperature-domain graph below, where the typical “hockey stick” curve is evident for the IESO data, and the more “bean”-like distribution is evident for the all-electric houses. It can also be seen that, in winter, the number of points in the all-electric cases that exceed the IESO summer data is small, and the all-electric homes in this neighbourhood would likely have very little impact on the annual peak load.



3. Land Ark Homes & Rideau St. Lawrence Distribution

Case Study Houses

The Watercolour Westport development by Land Ark Homes in Westport, Ontario, is a community designed around the principles of walkability, sustainability, and connection to nature. It features residences built to NZR standards to ensure they remain relevant as building codes evolve and avoid the long-term risks associated with “obsolete” construction. This project demonstrated how proactive engagement between a developer and a local utility could streamline the servicing process and overcome traditional resistance to innovation. By collaborating with Rideau St. Lawrence Distribution, the local electric utility, the project established a dependable foundation for infrastructure forecasting based on hybrid modelling, providing the technical certainty needed to optimize local grid assets in all-electric neighbourhoods.

The Watercolour Westport development features high-performance residences in Eastern Ontario inspired by heritage cottage architecture. This community consists of all-electric homes designed to exceed standard energy requirements through high-performance envelope construction.

House Characteristics

This case study used the Sydenham model as the house model, a 50' Bungalow, 1,457 sq. ft., single detached with two bedrooms and two baths and a CHBA Net Zero Ready label. These homes achieve a verified airtightness level of 0.6 air changes per hour, which is essential for reducing the peak demand typically associated with air infiltration in cold climates. This high level of airtightness allows for the use of smaller, high-efficiency mechanical systems, specifically a cold-climate air-source heat pump for primary heating and cooling, with an electric furnace as a backup.

The sales brochure for the house is available at this link: https://waw2.wipsites.ca/wp-content/uploads/SYDENHAM-Bungalow-Floor-Plan-Update-May-6.pdf. The Sydenham model was selected because there were enough occupied properties to anonymize the data. Almost 30% of the neighbourhood has adopted solar, but generation data was not available for this analysis due to the lack of a simple method to coordinate information sharing among the builder, homeowners, and the utility.

Aggregated Data

The data requested and received were 1-hour kWh data from the utility from January 1, 2025, to November 23, 2025. Data were aggregated from 13 properties that the builder indicated were consistently occupied over that period (no owners leaving for the winter, etc.). Data were given as the maximum for any house in the hour, the average across all houses in the hour, and the minimum for any house in the hour. Averages that were zero were discarded.

The data has proven unique compared to other data sets in that it includes a 3- to 9-hour power outage in the community, with outdoor temperatures around the freezing mark. This allowed the investigation of cold load pickup behaviour in later tasks of this project. The data request took longer than the other utilities because Rideau St. Lawrence Distribution was not accustomed to a request like this. The EDA facilitated the communication.

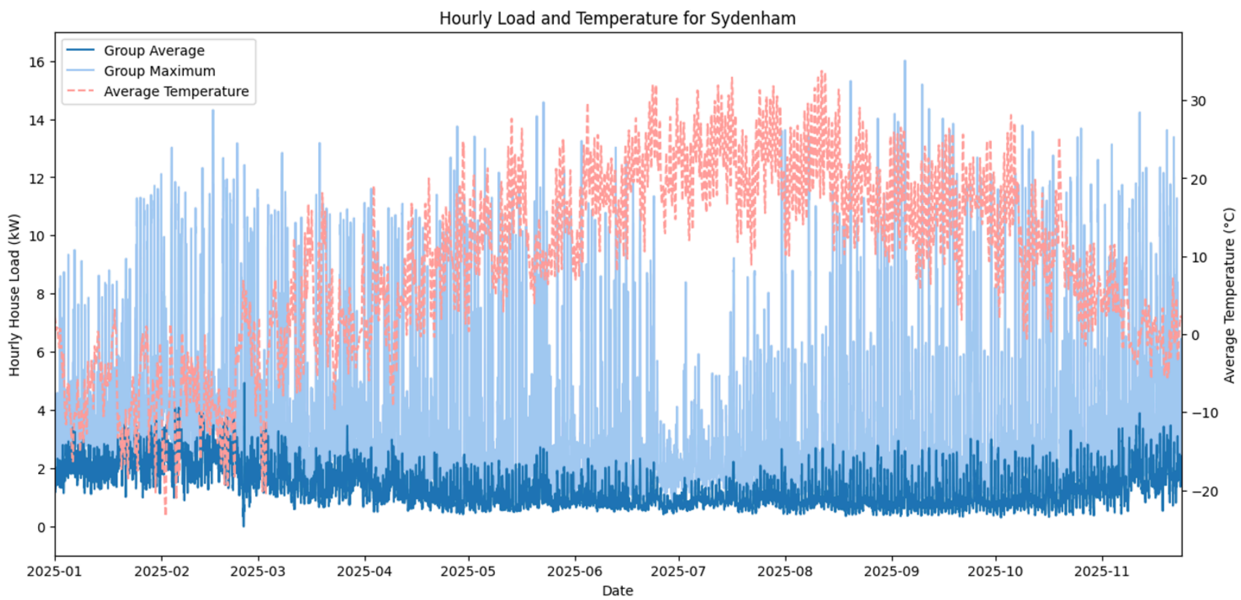
Hourly Results

ELECTRICAL DEMAND	Sydenham
GROUP	
Winter Peak Load (H2k)	6.61 kW
Winter Peak Load (HPXML)	6.02 kW
Winter Peak Load (Actual)	4.93 kW
Summer Peak Load (H2k)	3.71 kW
Summer Peak Load (HPXML)	2.11 kW
Summer Peak Load (Actual)	3.01 kW
INDIVIDUAL	
Winter Max House Load (Actual)	14.58 kW
Summer Max House Load (Actual)	16.01 kW

The summary data above show load characteristics very similar to those of the Harvest Run case study. This makes sense because Watercolour Westport followed the guidance in Doug Tarry's book on building Net Zero homes that consider resilience and building science. These results indicate that homes built to the CHBA Net Zero specification, with a similar building envelope and HVAC system set, would likely exhibit similar load characteristics.

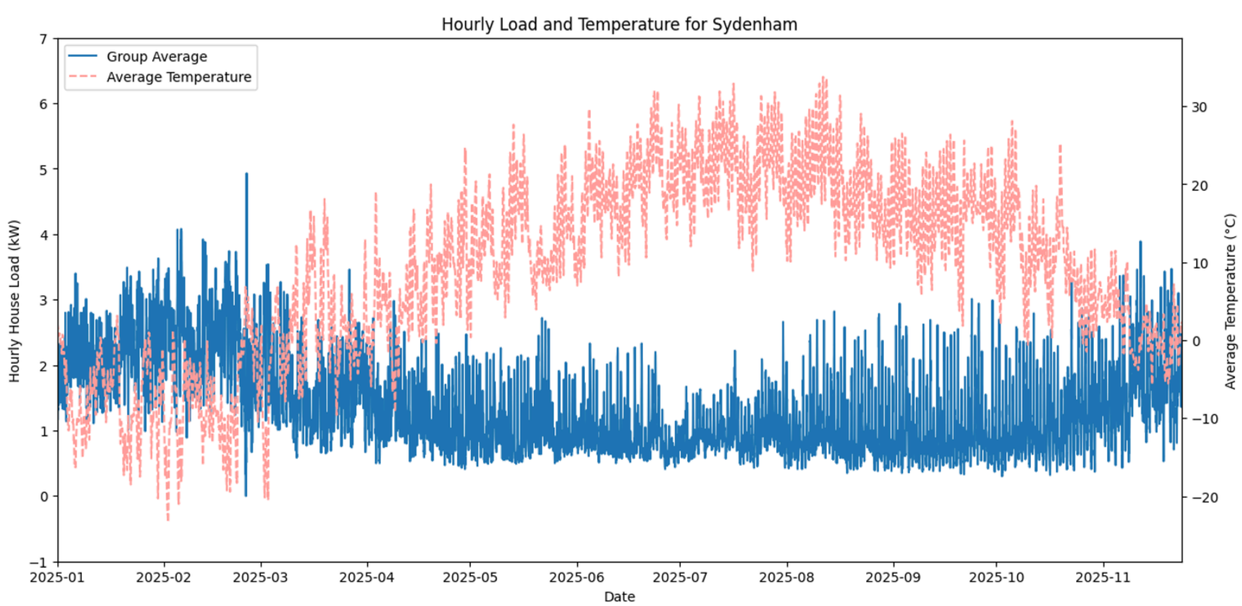
For the individual worst-case home, maximum hourly usage was below the 24 kW level of a 100 A electrical panel, and well below the 48 kW level of the 200 A panels these homes were equipped with.

Time Domain (Sydenham)



This results graph shows the time-domain behaviour over the year for the all-electric Sydenham type under both the average and worst hourly loading cases. The average temperature is also shown. The data show that the highest-peaking homes have similar peaks throughout the year and are likely linked to occupant behaviour rather than temperature.

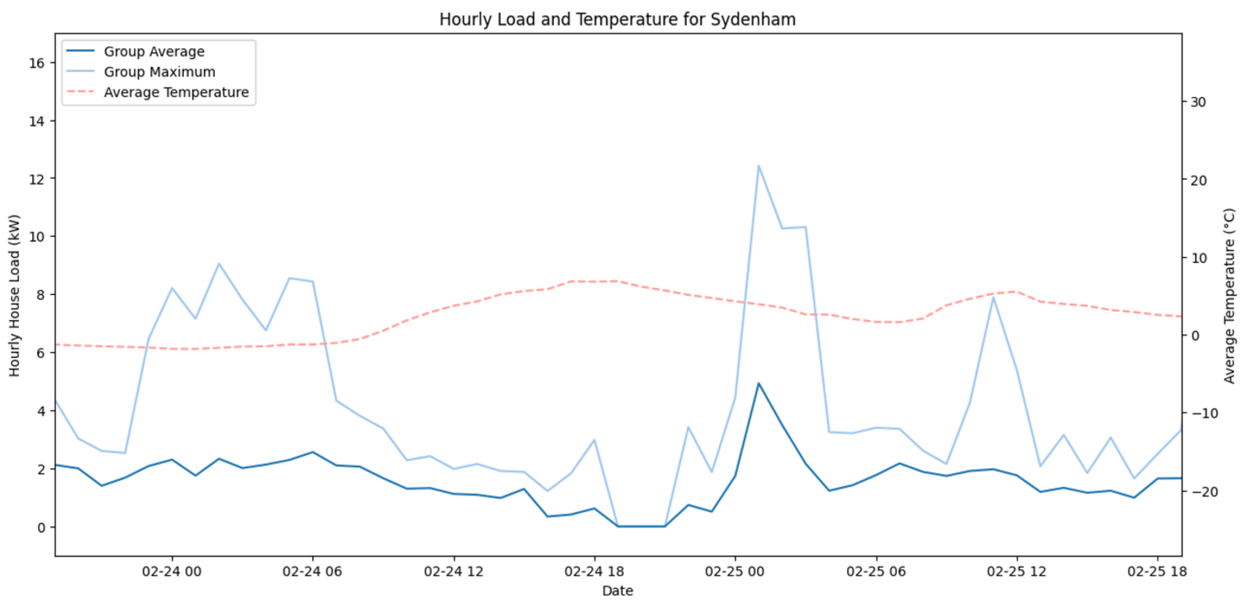
Time Domain (Sydenham)



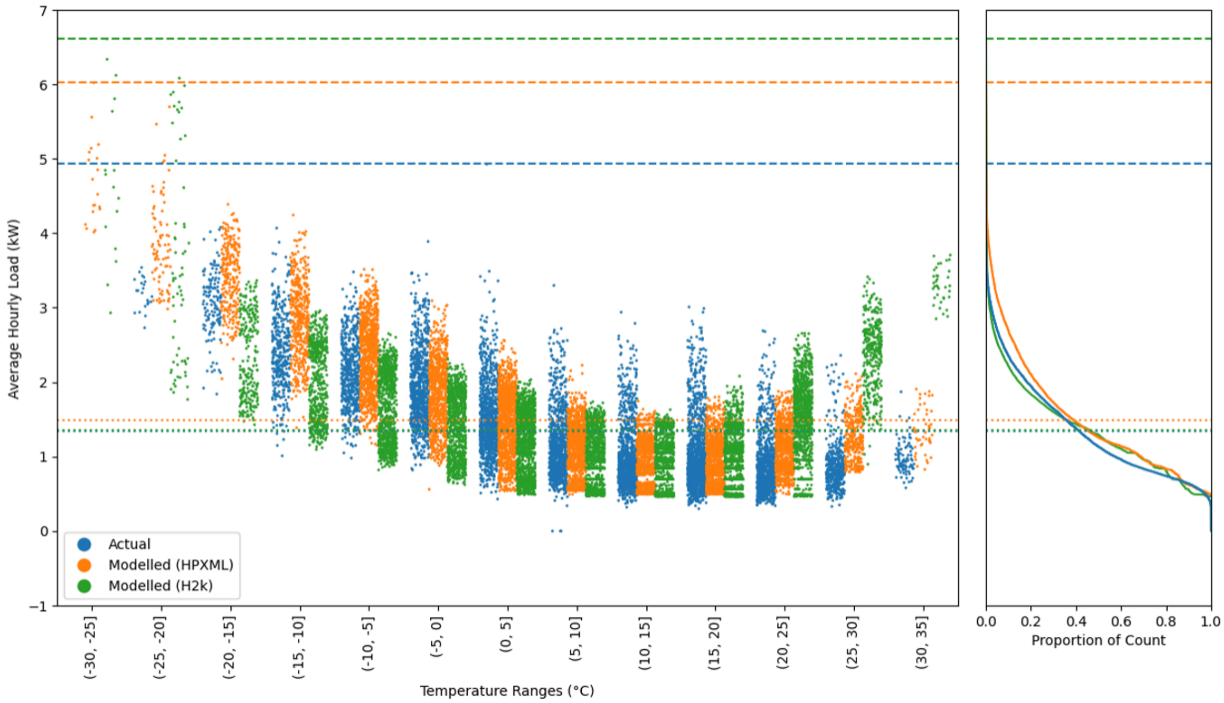
This results graph shows the time-domain behaviour over the year for the all-electric Sydenham type under the average hourly loading case. The average temperature is also shown. Demand clearly tracks with temperature for this case. The spike seen in the year-long time series graph is a cold load pickup event and will be discussed in the next section.

Time Domain (Cold Load Pickup)

In February of 2025, the power went out in this development for at least 3 hours across all homes and up to 9 hours in some. When the power came back on and with the temperature being at the freezing point, these homes demonstrated their “cold load” pickup behaviour. This is clearly seen in the graph below. This data indicates that the group average does not indicate a simultaneous pickup of backup electric resistance heaters, and that the group maximum was not the highest for the year. Therefore, this event did not demonstrate any grid-stressing activities typically associated with all-electric heating cold-load pickup events.



Temperature Domain



The graph above shows model accuracy compared with the actual data for the Sydenham type. The alignment between both models and the actual data is strong for the n=13 samples used in this analysis. This demonstrates that a building energy model deployed as-is through an hourly energy modelling engine shows good promise for predicting transformer-level loads. The loading curve on the right side of the graph also shows very good alignment of proportional load predictions.

Lessons Learned

Technical Analysis and Modelling

The case studies highlighted that, while building code energy models prioritize annual energy over demand, converting HOT2000 data into hourly profiles provides a reliable approximation of aggregate per-building peak power loads. By comparing these models with actual utility meter data, the case studies established and validated a process showing that building model-derived demand profiles could provide the technical detail necessary for utility engineers to evaluate the impact of modern, electrified homes. Utilities might be able to begin evaluating building load forecasting using novel input parameters rather than prescribed engineering rules.

Aside from the modelling validation, the anonymous data results confirm that even all-electric, electrified homes do not exceed 100A during peak events, suggesting that a 125A service is sufficient and that traditional 200A requirements are likely oversized. The data also show that, for homes constructed to CHBA Net Zero Ready envelopes with efficient mechanical systems, actual demand loads at the transformer level may allow for a higher density of homes per asset than conventional servicing assumptions suggest. The data also showed that winter demand loads from these homes do not significantly exceed counterfactual summer peaking loads and are a viable means of controlling new peaking demand for residential loads.

Policy and Regulatory Barriers

The project identified friction points between building performance standards and electrical code requirements. A key lesson is that prescriptive electrical sizing and traditional demand-factor rules often lead to oversized infrastructure, hindering the adoption of cost-effective solutions for all-electric developments. Modernizing these codes to account for data-driven load profiles is a necessary step toward aligning advances in building science with the realities of local distribution engineering activities. Standardizing forecasting by transitioning to hourly load data provides a common technical language for stakeholders, helping ensure that regulatory approvals and infrastructure sizing reflect actual performance and specific electrification needs.

To support this transition, regulatory frameworks should be updated to recognize building performance labels and code compliance data as predictable variables for sizing utility infrastructure. Rather than relying on historical high-load assumptions, these policies should prioritize infrastructure readiness, such as adequate panel space and future-proofing, as a cost-effective alternative to mandating oversized initial services. Providing utilities with access to high-resolution, data-driven forecasting enables a shift away from traditional, one-size-fits-all assumptions.

Collaborative Stakeholder Engagement

The case studies demonstrated that early communication and coordinated planning are important for identifying technical constraints and grid capacity issues during land development and before construction begins. Successful planning relies on the early involvement of REAs and utility engineers to review code and label compliance strategies and identify peak-causing choices before grid infrastructure plans are locked in. This multidisciplinary coordination allows stakeholders to address the intersection of grid servicing, HVAC design, and occupant comfort, which is often overlooked in each industry’s siloed workflows. Furthermore, builders working with utilities and their REAs to validate their building energy models against actual meter data in their neighbourhoods build the technical certainty needed to collaborate more closely with utilities that need to manage risk. To maintain this collaborative efficiency, a formal framework or system would help share hourly load data among REAs, builders, and utility planners throughout the design phase.

Conclusion & Recommendations

Policy and Program Implications

The transition to all-electric homes suggests a necessary shift in how utility programs are designed and evaluated. While historical conservation efforts have focused on reducing annual energy consumption, the case study results demonstrate that the primary value of high-performance electrified homes lies in their ability to reduce peak power demand. Policy and program design should move toward grid-friendly incentives that specifically reward builders for measures that flatten the demand curve. This includes prioritizing high-performance building envelopes, which were shown to mitigate the impact of electrification on the distribution system.

Current building codes and energy performance labels provide a foundation for this transition, but a gap remains between code compliance and utility planning. Program frameworks should be updated to recognize building-level efficiency as a predictable grid asset rather than an unknown variable. By aligning provincial building standards with utility-facing incentives, policymakers can encourage the adoption of technologies that reduce the need for physical grid expansion. This alignment supports a modernized approach to system design, in which high-performance homes are integrated into the grid to help manage capacity.

The OEB, which recommends 200A service in all new homes, may want to take a more measured approach to ensure electrical service is not overbuilt at the expense of affordability. These case studies have shown that even with the adoption of EVs, the progression of building codes and labels towards higher-performance homes mitigates much of the need for services greater than 100A for all but the most demand-heavy homes.

Scalability and Replicability Potential

The data from these case studies show that high-performance electrified homes can maintain stable and predictable demand profiles across different building types when built with net-zero-like envelopes and mechanical systems. By proving that electrified new homes can reliably control their demand curves, these results provide a technical foundation for building similar all-electric communities and using the same pathways for builder-to-utility collaboration. The data-driven approach reduces technical uncertainty, making it easier for utilities to evaluate and service these developments as they become more common in the residential market.

While these case studies were GTHA- and Ontario-focused, the collaborative process of aligning building performance data with utility planning is replicable in other regions. This approach provides a blueprint for municipalities and utilities across Canada to support broader electrification and decarbonization goals. Establishing this collaborative framework as standard practice supports the transition to all-electric communities with a modernized, scalable approach to grid management, while ensuring that homeowners seeking to buy an all-electric home do not shoulder the entire cost burden.

Barriers to Market Transformation

Systemic financial hurdles currently discourage the adoption of all-electric communities, primarily due to utility connection costs. While gas infrastructure often benefits from subsidized installation models, electrical capacity for hybrid or all-electric neighbourhoods frequently requires significant upfront capital from the developer and loses the financial incentive from the gas utility. This imbalance deters builders from opting out of gas networks, as they face higher upfront costs and few established mechanisms for recovering them. Beyond these financial gaps, the market lacks consistent regulatory signals to prioritize peak-demand performance over simple energy efficiency. Addressing these cost imbalances and creating targeted financing tools, such as on-bill financing, enhanced rebate programs, residential developer-focused demand response programs, and non-wires alternatives, are necessary steps to de-risk investments in high-performance electrified housing in Canada.

Recommendations for Utilities and Policy Makers

Utilities should adjust standard demand factors to reflect the lower peak draws observed in high-performance electrified homes when a builder is willing to work with them through energy modelling and past performance data. By updating these planning assumptions, utilities can increase the service density of existing distribution assets. Using validated building data to inform these capacity requirements ensures the grid is optimized as residential electrification scales.

Policymakers should prioritize aligning building codes with electrical distribution standards to create consistency across the residential building sector. Establishing a coordinated pathway between HBAs and electricity distributors will ensure that high-performance building standards and grid management work together to support long-term electrification.

Next Steps

Building on these case study results, the expansion of high-resolution archetype models being made available, which would provide a standardized reference for the utility industry, would help utilities understand the new loads they are facing from the residential building industry. Incorporating higher-resolution data allows for a better understanding of thermal loading and transient events, such as cold load pickup. Refining these models to include simulations for EV loads, variable occupant behaviour, and complex HVAC control sequences is a necessary step to evaluate grid readiness for residential electrification and enable more cost-effective program design. Establishing dedicated internal roles or workflows to process granular meter data for both internal and builder consumption further supports this evolving data landscape.

Moving beyond case studies and into standard practice involves monitoring homeowner demand trends through Advanced Metering Infrastructure (AMI) to evaluate how current design practices perform as electrification accelerates. A move toward formalized builder-utility process flows, including regular collaborative meetings between developers, municipal planners, and utility engineers, is needed. Integrating building energy models into these early-stage workflows would allow utilities to check capacity requirements and identify infrastructure optimization opportunities before assets are deployed. This approach will depend on sustained collaboration to establish technical trust among utilities, builders, and their consultants.

Long-term grid flexibility remains a priority for utilities, given the increased use of demand-side technologies such as EVs, battery storage, V2G, and dynamic load management in homes. Internal education at utilities would help ensure that planning and operations teams are equipped to manage the specific requirements of the electrification process, and broader dissemination of knowledge through utility-led technical reports and webinars would enable the scalability and replication of these results nationally.

Taken together, these steps would help build a collective body of knowledge that builders and utility planners can use to ensure the transition to all-electric communities is supported by smart building choices, data-driven servicing, and a modernized approach to grid management.