Step 5 Next-Generation Home: "Fit for the Future"

Wilden's Net-Zero Energy Home

Kelowna, BC

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THE CHALLENGE

With a push towards more efficient homes in BC and questions surrounding the most effective way to achieve higher tiers of the BC Energy Step Code, Wilden took on the challenge of designing and constructing a Step 5, net-zero energy home in the BC Interior. By showcasing innovative approaches to efficient home design and construction, they hoped to educate and inspire developers, builders, and customers across BC to build more energy-efficient homes. Wilden wanted to demonstrate products and technologies that are cost-effective, especially when they're considered on a life-cycle basis.

PRO TIP

Treat energy efficiency like a "recipe" that balances mechanical systems, airtightness, and thermal envelope performance. Investments in one of those aspects can offset compromises in another.

HOME PROFILE

Location	Kelowna (Climate Zone 5)
Construction	2022
Size	3,437 ft^2
Bedrooms	5
Bathrooms	3.5
BC Energy Step Code Level	
Targeted	Step 5
Achieved	Step 5 / Canadian Home Builders' Association Net-Zero Home

THE SOLUTION

Wilden partnered with AuthenTech Homes, a local builder, to build a net-zero energy home that was "fit for the future". They embraced the Integrated Design Process (IDP) that emphasizes early and ongoing collaboration amongst all relevant stakeholders to streamline the design process, develop innovative approaches, and reduce costs. The home includes fundamental changes to design and construction practices to help build a highly insulated and airtight envelope. It also incorporates a hybrid dual-fuel HVAC system, comprised of an air-source heat pump and a condensing natural gas boiler with multi-zonal control, to maximize system efficiency and occupant comfort. A rooftop solar array coupled with battery storage further reduces electricity bills while improving resilience. This home will be part of the Wilden Living Lab, helping to test the ongoing performance of innovative processes and equipment in a livable home.

DEVELOPER BACKGROUND

Wilden is a residential developer based in Kelowna, responsible for the largest master-planned real-estate development in the city. Wilden has taken a leadership role in sustainability and embraces the highest level of energy efficient building practices. Most recently, they have advanced these goals by developing the Wilden Living Lab, a partnership between Wilden, local post-secondary institutions, and FortisBC to test the real-world performance of a series of homes built to increasing energy performance standards. The Wilden Living Lab collects data on the ongoing performance of a variety of building components to help inform the optimal design of future energy efficient homes.

BUILDER BACKGROUND

AuthenTech Homes is a Kelowna-based builder that has been building quality award-winning homes since 1991. They focus on customization and are responsible for some of the most notable projects in the Okanagan. They are one of Wilden's signature builders of its master-planned community and have been a Wilden Select Builder since 2002.

THE INTEGRATED DESIGN PROCESS (IDP)

OVERVIEW

As home design and construction becomes increasingly complex, interdependent, and reliant on building science best practices, efficient performance requires communication and buy-in from all parties as early as possible. The integrated design process is a collaborative design approach that brings all relevant stakeholders together during the design process and keeps them engaged throughout the entire construction process. The integrated design process for this home included a variety of parties:

- Developer (Wilden)
- Builder (AuthenTech)
- IDP Facilitator/Energy Advisor (Total Home Solutions)
- Architect
- Utility (FortisBC)
- Skilled Trades
  - Mechanical Contractor
  - Electrical Contractor
  - Plumbing Contractor
- Solar Contractor

The IDP Facilitator plays a key role in the integrated design process by leading pre-construction energy modeling and providing critical feedback on balancing cost-effectiveness, lifetime energy performance, reliability, and occupant comfort.

BENEFITS

The improved planning and communication that are enabled by this collaborative approach yield several clear benefits:

1. **Cost reductions** since the process helps avoid delays and last-minute design changes. The focus on pre-construction energy modeling and optimized design can also help reduce costs by prioritizing the most cost-effective energy efficiency solutions and right-sizing mechanical systems.

2. **Increased energy performance** through consideration of a longer list of opportunities and tailored design choices. Increased communication and collaboration also ensure that there is enough time to educate and gain the buy-in of trades, who are critical to achieving energy efficiency goals.

3. **Design flexibility** achieved by balancing the cost and performance considerations of airtightness, building envelope, and mechanical system selection, while ensuring that the design prioritizes homeowner preferences and occupant comfort.

LESSONS LEARNED

As with any innovative process, there were some challenges with successfully applying IDP to this project. Indeed, Wilden and Authentech quickly learned that the process required significant commitment from every stakeholder and contractor. However, by bringing everyone to the table as early as possible, the design team was able to work with the IDP Facilitator to iteratively model home performance and identify small changes that improved envelope performance.

Identifying these changes early in the process saved both time and money, but the process wasn't flawless. The solar contractor was engaged later and quickly identified that the existing design didn't leave enough roof space for sufficient solar capacity to meet net-zero requirements. This led to changes to the roof design late in the design timeline, impacting costs and project timelines. Despite some minor challenges, the additional time dedicated to advanced planning, contractor training, and debriefing on lessons learned created lasting benefits. All parties interviewed about their experience with IDP plan to apply these techniques more broadly moving forward.

"I've never seen it before, the combination of what we put in this house. I think it's pretty pioneering."

—Scott Tyerman, President, AuthenTech Homes

MECHANICAL SYSTEM INNOVATIONS

In this home, Authentech opted for a dual-fuel HVAC system, with a modulated inverter-style air-source heat pump (ASHP) and a high-efficiency condensing boiler system that also provides hot water. The inverter design allows the ASHP to turn on only to the degree necessary for current HVAC needs, while the natural gas boiler maintains heating efficiency on the coldest days.

To improve HVAC system efficiency and offer an even greater level of modular control, the home also uses an iFlow fan coil system, which acts as a central controller of a multizonal system with four zones. While many modern residential HVAC systems offer zonal control for supply air, the iFlow system offers the ability to zonally control both supply and return air, preventing an inefficient blending of the comfort levels between different areas and improving occupant comfort.

The mechanical system includes a dedicated ventilation loop that is tied into bathroom exhaust and an energy recovery ventilator (ERV) with a MERV 13 filter to help maintain the home's humidity balance and improve the system efficiency. The airtight design and ventilation system layout also improve indoor air quality in an area prone to wildfire smoke. In addition, the home features a drain water heat recovery system to reduce water heating energy consumption.

ACHIEVING EXTREME AIRTIGHTNESS

Extremely high levels of airtightness were essential to meeting Step 5 performance. AuthenTech employed a holistic air barrier system that relied on exterior rigid foam insulation applied on top of a frame with R24 batt walls and careful consideration of how to seal intersections with other building components (roof, foundation, windows, etc.). Exterior insulation offers many air-sealing benefits, as it allows for straight, even planes without worrying about leaks at wall intersections.

Beyond taping gaps between insulation panels and employing rubber gaskets for larger penetrations, the building team used self-healing membranes at every puncture site and self-sealing drywall screws. While these components required more contractor training and buy-in, they eliminated a large number of microleaks that can add up to significant leakage. For most builds, much of a home's airtightness comes down to the training of skilled trades installing these systems. Wilden encouraged and facilitated this training and buy-in by involving the skilled trades early in the integrated design process, which proved to be critical in achieving the final airtightness of 0.57 ACH_{50}.

BUILDING FOR THE FUTURE

ENVIRONMENTAL AND RESILIENCY BENEFITS

Decarbonizing BC's energy system is an immense task. Increased electrification can play an important role in meeting BC's energy targets, but it will also create new pressures on the electricity system that will necessitate large investments in generation and transmission assets. Wilden's net-zero home addresses this challenge by integrating a dual-fuel HVAC system and solar PV generation to further decarbonize the operation of the home. Signing up to the voluntary Renewable Natural Gas (RNG) program also helped reduce overall greenhouse gas (GHG) emissions.

Integrating both natural gas and electric energy systems provides improved resilience and reduced electric peak demand impacts during colder periods. As increasingly hot summers strain BC's electric grid, Step 5 homes with innovative features can also help reduce electric peak demand during summer months. Furthermore, the home's solar PV array and battery storage provide backup power and an opportunity to pilot demand response programs, including feeding the excess power stored in the battery back into the grid during peak events.

Through projects like the Wilden Living Lab, developers, builders, contractors, and other community stakeholders are testing new approaches that will contribute to the future of the BC energy system, where gas and electric systems can work together to meet the province's energy needs in a sustainable and affordable manner.

RENEWABLE NATURAL GAS[1] (RNG)

For projects where the gas system is the preferred option from a technical and customer perspective, connecting to our gas system gives access to RNG—a low-carbon[2] energy that can help customers reduce overall GHG emissions. Visit fortisbc.com/rngbuild.

[1]Renewable Natural Gas (also called RNG or biomethane) is produced in a different manner than conventional natural gas. It is derived from biogas, which is produced from decomposing organic waste from landfills, agricultural waste and wastewater from treatment facilities. The biogas is captured and cleaned to create RNG. When RNG is added to North America's natural gas system, it mixes with conventional natural gas. This means we're unable to direct RNG to a specific customer. But the more RNG is added to the gas system, the less conventional natural gas is needed, thereby reducing the use of fossil fuels and overall greenhouse gas emissions.

FortisBC Energy Solutions Managers are here to help. Contact us to discuss your next new construction project. www.fortisbc.com/energyteam

PROJECT DETAILS

ENVELOPE	
Airtightness	0.57 ACH_{50}
Roof Insulation	R65.8 (R60 insulation within truss system, 2" EPS exterior insulation)
Foundation Insulation	R29.4 (2x6 framing with R24 batt, 2" rigid exterior insulation)
Under Slab Insulation	R10
Wall Construction	2x6 framing with 24" centers
Wall Insulation	R26.7 (R24 batts in walls, 2" EPS exterior insulation)
Window/Wall Area	19.3%
Windows	Triple-glazed, U 0.97-1.08, 0.3 average SHGC with strategic design based on window orientation

MECHANICAL SYSTEMS	
Space and Water Heating	Dual-fuel system (modulated inverter-style ASHP and condensing natural gas boiler), iFlow fan coil system providing zonal control of both supply and return air to 4 zones, indirectly fired hot water storage tank (93% thermal efficiency), drain water heat recovery
Cooling	Modulated, inverter-style air-source heat pump (HSPF 8.2/SEER 16)
Ventilation	ERV (83% SRE @ 0ºC; 67% SRE @ -25ºC) with dedicated ventilation loop and ECM fan motors
Other Gas Equipment	Range, fireplace, gas barbeque

LOADS & REBATES	
Heating Load (TEDI)	20 kWh/m^2 per year
Mechanical Load (MEUI)	17 kWh/m^2 per year
Natural Gas Consumption	8.9 GJ per year
% More efficient than Typical New Home	63.5% (EnerGuide)
FortisBC Home Performance Rebates*	$10,000 Step 5 Rebate $1,000 IDP Rebate $800 Energy Advisor Support

[2]When compared to the lifecycle carbon intensity of conventional natural gas. The burner tip emission factor of FortisBC's current Renewable Natural Gas (also called RNG or biomethane) portfolio is 0.27 grams of carbon dioxide equivalent per megajoule of energy (gCO_2e/MJ). FortisBC's current RNG portfolio lifecycle emissions for stationary combustion are -22 gCO_2e/MJ. This is below B.C.'s low carbon threshold for lifecycle carbon intensity of 30.8 gCO_2e/MJ as set out in the 2024 Greenhouse Gas Reduction Regulation amendments.

*Rebates are subject to change. For current rebate information, visit www.fortisbc.com/newhome

Photo credit: Wilden