Achieving Step-Code:
A Modular Single-Family Home

Regional District of Kootenay Boundary

STEP CODE 4 EXCEEDED

This home meets the Step 4 requirements based on air tightness, low thermal energy demand intensity (TEDI) and low mechanical energy use intensity (MEUI).

KEY BENEFITS

Through the selection of cost-efficient design choices, the owners were able to design an affordable and energy efficient home that exceeded step code level 4 requirements.

Upgrades to window size, exterior wall siding and foundation construction improved the home's aesthetic and its insulating performance.

BUILDING SYSTEMS

Space Heating and Cooling	High-efficiency gas furnace (96% annual fuel utilization efficiency (AFUE))
Mechanical Ventilation	Constant volume utility room exhaust
Domestic Hot Water Heating	Electric resistance water heating tank
Glazing	Double-pane, Low-E, argon filled windows with PVC frames, 8.9% fenestration-door-to-wall ratio
Foundation	8" reinforced concrete footing and foundation wall with R20 insulation

BUILDING TYPE
Single Detached Family Dwelling

LOCATION
Castlegar, BC

ORIENTATION
East Facing

CLIMATE ZONE
5

SIZE, FLOORS
1,104 ft^2 / 102.6 m^2 – 1 Floor

YEAR BUILT
2020

ROOMS
3 Bed / 2 Bath

KEY FEATURES

Designed as a modular home suitable for a single family, this build is an example of a cost-efficient home that doesn't compromise on energy efficiency.

Architectural details:

- Open kitchen, living and dining room to improve natural light throughout the home.
- Large electric domestic hot water heater to provide low GHG emission hot water.
- Wall paneling to save on construction and labour costs with impacting envelope thermal performance.
- Moderately sized windows to balance cost and aesthetics while maintaining envelope thermal performance.

ESTIMATED COSTS

Total build cost:
$420,000 ($380/ft^2)

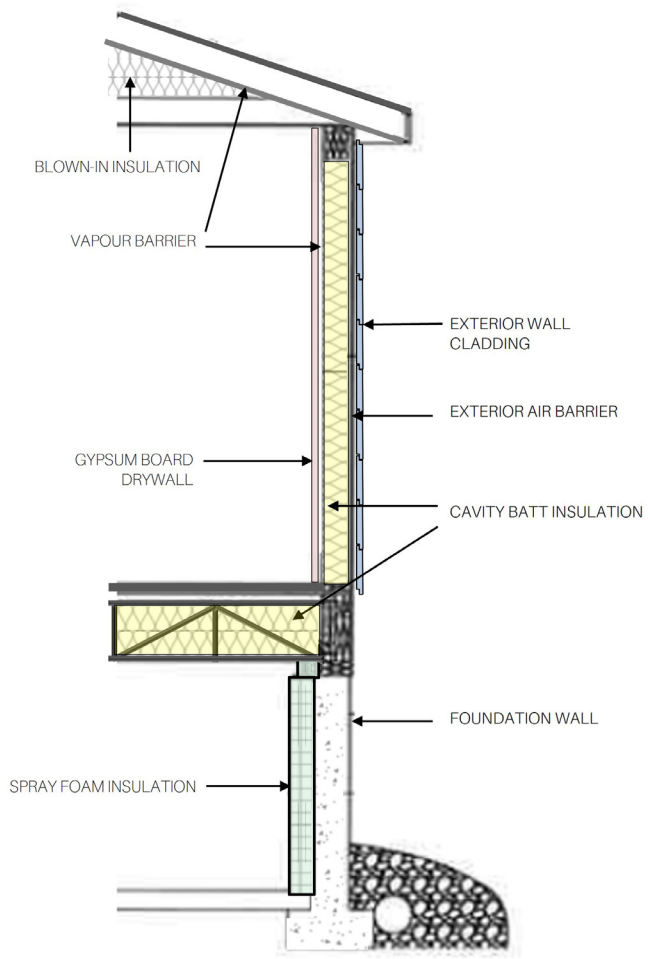
Step Code cost premium:
Selected from a catalogue of modular homes where all options meet step code.

Modelled annual energy cost:
$2,135

Building Envelope

CEILING DETAILS	
Roofing System	Asphalt shingles, pitched roof system
Roof Underlay	15/32″ OSB sheathing
Framing	Engineered trusses @ 24″ on-centre (OC)
Insulation	R-52 cavity insulation
Interior Finish	1/2″ gyproc board
EXTERIOR WALL DETAILS	
Cladding	Exterior panel siding
Air Barrier	Continuous building wrap
Framing	2x6 studs @ 24″ OC
Insulation	R-22 batt insulation
Vapour Barrier	6 mil UV vapour barrier
Interior Finish	Vinyl covered drywall panel
FLOOR AND FOUNDATION DETAILS	
Floor Slab and Insulation	14″ engineered truss @ 19.2″ OC.with 5/8″ OSB sheathing, R-33 batt insulation and 3″ rigid foam perimeter insulation
Foundation Wall	8″ reinforced concrete with R-20 rigid insulation

TYPICAL WALL SECTION



Electric water heater provides hot water for the home using a low GHG emission energy source.

R-33 batting insulation in floor cavity to reduce heat loss to foundation crawl space.

Two panel doors with polystyrene insulation to reduce door heat loss and improve overall envelope performance.

This home uses a high-efficiency Intertherm furnace located in the home's laundry/ mechanical room to provide space heating.

Balancing Design + Efficiency

When designing an inexpensive and energy efficient home a focus on balancing Owner preferences, cost and energy efficiency is required. Choices in the design process will affect home energy performance and can require additional considerations to achieve Step Code compliance.

For example, this home traded low operating costs with increased greenhouse gas emissions of a gas-fired furnace for space heating. Therefore to meet Step 4 it the building's final design included a well-insulated and low air leakage envelope assembly to maximize efficiency and minimize heating load on the gas heating system.

Envelope features such high-performance windows, insulated doors, continuous air barrier and cavity insulation in the roof, walls and floor improve the building's overall insulating values. This reduces its Thermal Energy Demand Intensity (TEDI) and Mechanical Energy Use Intensity (MEUI), allowing it to achieve Step 4 and qualify for the FortisBC New Home Program rebate.

Builder's insights

"Modular construction means reducing job site waste by creating an effective construction waste management plan, leveraging available recycling facilities and taking advantage of markets for recyclable materials. Efforts such as these allow us to reduce waste by at least two-thirds, reducing the burden on landfill space."

Moduline - Champion Homes

Tips for success

Choose Electric Equipment
Electricity, which is a low GHG emission energy source, more efficiently provides heating when compared to gas-fired equipment. By selecting electric equipment instead of gas-fired equipment when possible, energy consumption (TEDI and MEUI) and total greenhouse gases emissions of the home can be reduced.

Consider Window Size
Homes with a large window to wall ratios can be subject to significant heat gain and loss throughout the year, particularly when the windows are south facing. By opting for smaller and effectively placed windows, the heating and cooling load of the home can be reduced. Smaller windows have the added benefit of reducing the construction costs of the build.

Improve Air Tightness
Improving the air tightness of a building refers to the act of reducing heated air leaking out of the home through small gaps in the envelope. By adequately sealing seams and openings the amount of heat lost to the exterior is reduced, thereby reducing the amount of space heating and cooling required Throughout the home the air barrier was taped at junctions, windows and other envelope penetrations to maintain a continuous airtightness of the envelope.

"We entered into our home selection process focussing on maximizing value for our home budget. With some small upgrades and design choices we found our home is very comfortable and we will save on energy bills. In our experience home buyers don't feel the need to shy away from achieving a Step Code level based on budget."

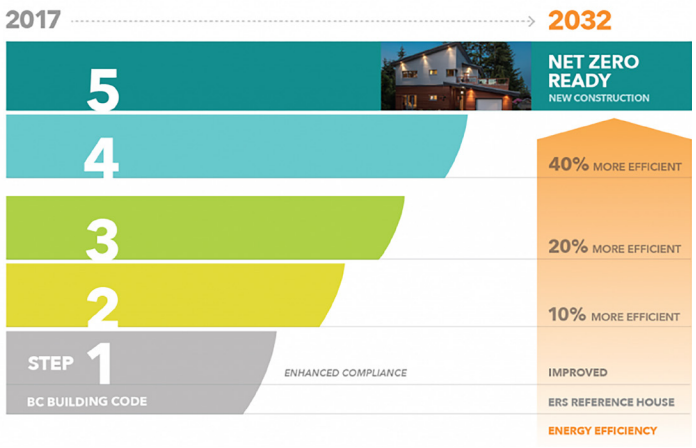
JASMINE LYSENKO – HOMEOWNER

The building's basement crawl space foundation includes R-33 batt insulation and rigid foam insulation around the foundation.

ENERGY ASSESSMENT RESULTS

PERFORMANCE CATEGORY AND METRIC	TARGET (STEP 4)	ACHIEVED (STEP 4)
Building Equipment and Systems Compliance Metric: Mechanical Energy Use Intensity (MEUI)	50 kWh/(m²·yr)	41 kWh/(m²·yr)
Building Envelope Compliance Metric: Thermal Energy Demand Intensity (TEDI)	30 kWh/(m²·yr)	21 kWh/(m²·yr)
Airtightness Compliance Metric: Air Changes per Hour at 50 Pa (ACH@50PA)	1.5 ACH	1.4 ACH
Energy Use Reduction vs. EnerGuide Reference House		22%
Annual Energy Consumption (Estimated from Energy Model)	Electricity	10,800 kWh
	Natural Gas	14.4 GJ

ENERGY STEPCODE
BUILDING BEYOND THE STANDARD



Mechanical Energy Use Intensity (MEUI) is the sum of energy used for space heating, cooling, domestic hot water and ventilation. Measured per square metre of heated floor area per year. – kWh/m²/yr

Thermal Energy Demand Intensity (TEDI) is the annual heat energy needed after accounting for internal heat gain and solar heat gain. Measured per square metre of heated floor area per year. – kWh/m²/yr

Air Changes Per Hour (ACH@50Pa) is the metric used for blower door airtightness testing. Measured per hour at a 50 Pascal pressure differential.

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Builder Eagle Homes
eaglehomes.ca
250-365-2121

Designer Moduline Industries - Penticton
modulinepenticton.com
250-493-0122

Energy Advisor Harmony Engineering
michele@harmonyeng.ca

CONTACT US

Regional District of Central Kootenay

1-800-268-7325
info@rdck.bc.ca
Box 590, 202 Lakeside Drive
Nelson, BC V1L 5R4
rdck.ca

Regional District of Kootenay Boundary

1-800-355-7352
info@rdkb.com
202 – 843 Rossland Ave
Trail, BC V1R 4S8
rdkb.com

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