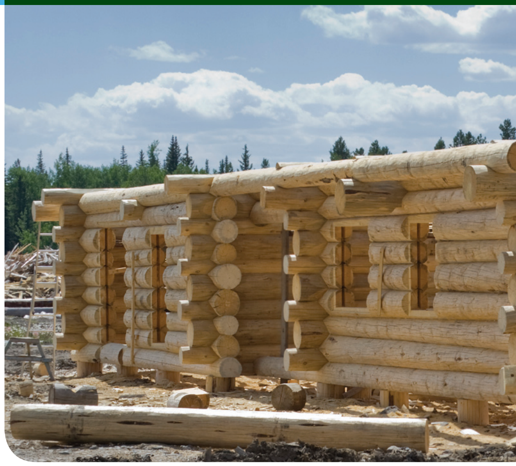
Technology Profile

2013, 01



Implications of Current and Future Canadian and US Energy Codes on Log Home Construction

The focus on reducing consumption of fossil fuels, compounded by the pressure to reduce environmental impact, have become the main drivers for achieving higher energy efficiency of buildings around the globe. Building codes are addressing this area through setting minimum energy requirements for buildings.

There are two primary approaches to achieve compliance with the code requirements. One approach is prescriptive, where a set of minimum standards for each component or system are set and must be met or exceeded by all projects. The second approach is performance based. How a project meets them is up to the designer and builder. However, to prove compliance, calculations, testing or simulation using computer models are required.

In Canada, most jurisdictions require building envelope components to have prescribed minimum thermal resistance (R, or RSI) values. However, the performance approach has also been in use for more than 20 years through various programs such as R2000 certified homes, Built Green and more recently, LEED Canada for Homes. Currently, the EnerGuide Rating System (ERS) is the performance modelling tool of choice.

ERS makes use of a software tools developed by Natural Resources Canada (http://www.nrcan.gc.ca/home) called Hot2000. Based on design specifications of the entire home, estimated energy consumption is calculated using complex simulation. The software compares the result to a benchmark and assigns an ERS score, a rating on a scale of 0 (poor) to 100 (very good).

A recently built “code typical home” achieves an average ERS score between 65 and 72. A home achieving an ERS 80 or more is currently considered an energy efficient home. Minimum thermal resistance values for the building envelope in the 2012 National Building Code of Canada (NBC) are equivalent to ERS80 if the building with these prescribed values was modeled using EnerGuide. Therefore, building systems, such as log homes that will not meet the minimum prescriptive thermal resistance for walls will use EnerGuide to demonstrate their overall energy performance.

EnerGuide rating system (ERS), developed in Canada, uses complex simulation software to calculate home’s energy performance, based on standard operation assumptions. The achieved rating allows comparison of one house’s energy performance against another.

REScheck® is software is used in U.S. to verify building envelope insulation compliance with the applicable building code. the software can perform simple u-factor calculation to determine the overall ua of the building envelope and can be used to determine insulation trade-offs.

In the United States, the U.S. Department of Energy (DOE) (http://energy.gov) also works aggressively to reduce building energy consumption in order to meet the Architecture 2030 Net-Zero Energy Challenge (http://architecture2030.org). The DOE has been developing tools and resources for the building industry to achieve these targets with the DOE targetting a 15% reduction in energy consumption in the 2009 edition of the ICC International Energy Conservation Code (IECC) over the 2006 IECC. This target was increased to 30% savings in the 2012 IECC and the plan for 2015 is to produce buildings that save 50% energy in comparison to the 2006 IECC baseline.

Similarly to Canada, the easiest way to achieve compliance with the energy requirements of the IECC is to meet or exceed the minimum thermal properties of the building envelope. To account for alternative assemblies that may not meet the prescriptive requirements, a designer can perform simple calculations to determine the overall performance of the building envelope (thermal transmittance or "U –Factor" alternative, also referred to as UA). The UA calculation has been greatly facilitated by the introduction of REScheck® program developed for DOE and commonly used throughout the US.

The 2006 IECC had provisions for upgrading the efficiency of mechanical equipment to offset deficiencies in insulation levels of the building envelope. However both the 2009 and 2012 editions no longer allow this trade-off. The impact on the log building industry has been significant particularly in the colder climates of the United States. It remains unclear whether Canada and/or provinces will choose to allow mechanical systems to affect energy ratings in the future. Some jurisdictions in Canada have already decided not to allow mechanical trade-offs.

CASE STUDY

Comparing Identical Log Home under Canadian and US Energy Requirements –

In order to compare energy requirements between the US and Canada, one has to establish climate data using Heating Degree Days (HDD). The 2012 NBC aligns the Canadian climate zones with US zones starting at zone 4 with climate up to 3000HDD and continuing to zone 8, increasing in each zone by 1000HDD. The zone 7 the in Canadian building code is split into 7a and 7b to reflect the fact that the US zone 7 adds 2000HDD instead of the 1000HDD. While in the US there is a very small area that fits into zone 7 perhaps with the exception of parts of Alaska, in Canada, a significant portion of the country fits into zone 7. Zones 1 to 3C represent hot and humid areas in the US south and therefore they don't have a Canadian equivalent. Table 2 shows the alignment of the US and Canadian climate zones based on the 2012 IECC and the 2012 NBC.

Table 1
Comparison of US Climate Zones Based on the 2012 editions of IECC and NBC

2012 IECC Climate Zones		Canadian Climate Zones (2012 NBC)	
Zone Number	Thermal Criteria	Zone Number	Thermal Criteria
4C	2000<HDD18°C <3000	4	HDD18°C <3000
5	3000<HDD18°C <4000	5	3000<HDD18°C<3999
6	4000<HDD18°C <5000	6	4000<HDD18°C<4999
7	5000<HDD18°C <7000	7A 7B	5000<HDD18°C<5999 6000<HDD18°C<6999
8	7000<HDD18°C	8	7000<HDD18°C

Both HOT2000 and REScheck® consider relevant climate zones in the evaluation. In colder climates, a home of identical specification will have a higher energy consumption compared to the same home built in milder climates. Therefore, to achieve the same energy consumption, the home built in the colder climate has to be more insulated and air-tight. This may mean thicker walls, more efficient windows, more attic insulation which translates to a higher construction cost.

In our case study, we examined a 2440 sq. ft. two storey handcrafted log home built in Alberta in 2012. Squared 7"x12" spruce log walls with dovetail corners were used for the construction of the main floor. The wall thickness can be considered the worst case scenario and any log building with thicker walls would score higher in the energy analysis. ICC 400-2012 - Standard on the Design and Construction of Log Structures used in U.S. is also referenced in the 2012 edition of NBC to establish the R-value of log walls. This harmonization is a step in the right direction for the log home building industry on both sides of the border.

The log home in our study was equipped with many high efficiency features including ground source heat pump, triple pane double hung low-e windows and 12” Insulated Concrete Form (ICF) foundations. While all building components used in this actual log home met or exceeded the prescriptive requirements of both Canadian and US codes, the 7” log wall did not. In the REScheck® UA analysis, the wood species for the log wall would have to be changed to lower density Western Red Cedar in zones 7&8 in order to achieve the desired minimum overall UA despite all the above standard energy efficient components. In the EnerGuide evaluation, this home would achieve ERS 89 if it was built in a climate equivalent to Calgary, AB or Prince George, BC and if all mechanical and renewable features were factored in. However, if the EnerGuide evaluation was made on the building envelope alone (without mechanical and renewable trade-offs) the house would only achieve ERS74, which is below the 2012 NBC energy requirements target. This would be despite the fact that the house was remarkably well sealed and in the blower door test achieved 1.8 ACH50 (nearly 1/3 of an average published field tested log home value).

In order to achieve ERS80 on the envelope alone, this home would have to increase its effective insulating value in the ceilings to R60, the walls would have to be R30 and the foundations would need a minimum effective insulation of R20 with under-slab insulation, triple pane windows and energy efficient doors. Given that a typical log wall made of round spruce logs with an average 14” mid span diameter achieves approximately R15, the insulating value of the remaining building envelope components would have to be significantly higher than required by the code to offset the energy loss through the log walls.

Table 2 shows the comparison of the prescriptive energy requirements for opaque walls in 2012 IECC and in the 2012 NBC and the approximate log diameter (scribed log wall) to achieve the prescriptive values. The proposed NBC allows a lower R-Value for a building envelope in homes with Heat Recovery Ventilation (HRV) , something that is becoming a common appliance in energy efficient homes. This option may provide some relief to log walls in colder climates.

Table 2
Comparison of Minimum Effective Thermal Resistance of Opaque Walls between 2012 IECC and proposed 2012NBC and Approximate Log Diameter Corresponding with the Prescribed R-value.

Units	Minimum Effective Thermal Resistance of Opaque Walls																
	Zone 4			Zone 5			Zone 6			Zone 7					Zone 8		
	2012 IECC	2012 NBC		2012 IECC	2012 NBC		2012 IECC	2012 NBC		2012 IECC	2012 NBC				2012 IECC	2012 NBC	
											Zone 7a		Zone 7b				
		w/ HRV	w/o HRV		w/ HRV	w/o HRV		w/ HRV	w/o HRV		w/ HRV	w/o HRV	w/ HRV	w/o HRV		w/ HRV	w/o HRV
RSI (m^2•K/W)	3.08	2.78	2.78	3.08	2.97	3.08	3.66	2.97	3.08	3.66	2.97	3.08	3.08	3.85	3.66	3.08	3.85
R-Value (h•ft2•°F/Btu)	17.5	15.8	15.8	17.5	16.9	17.5	20.8	16.9	17.5	20.8	16.9	17.5	17.5	21.9	20.8	17.5	21.9
Wood Species	Approximate Log Diameter to Achieve the Prescribed R-value (inch)																
Douglas Fir	23”	21”	21”	23”	22”	23”	22”	23”	23”	27”	22”	23”	23”	28”	27”	23”	28”
WR Cedar	15”	14”	14”	15”	15”	15”	15”	15”	15”	18”	15”	15”	15”	19”	18”	15”	19”

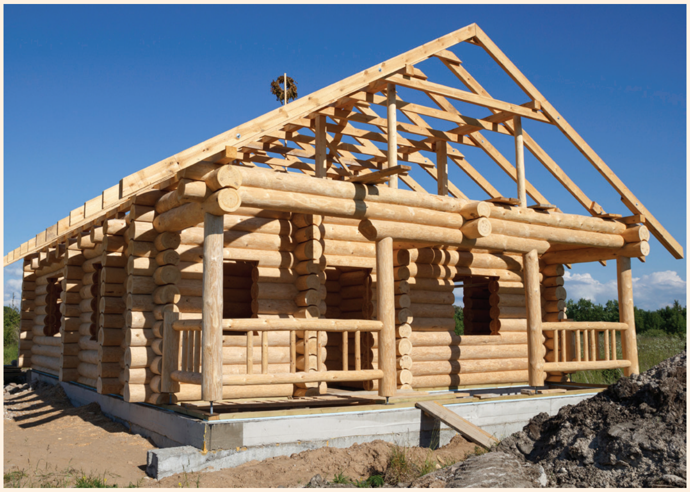
It is clear that solid log walls (unless made of low density wood or large logs) will be unable to achieve the prescribed effective R values, particularly in colder climates. As a result, in both the US and Canada, compliance of log homes with the code will be achieved by using a performance based path that uses the UA alternative or EnerGuide simulation for the majority of log homes.

In our case study, the contribution of high efficiency mechanical equipment and renewable energy sources to the ERS rating was significant (ERS89 versus ERS74). If reducing the environmental footprint is the ultimate objective of the building code (not just reduction of energy use), then use of renewable energy and appliances with efficiency above the minimum standard should remain part of the consideration. The environmental footprint is also directly tied to the size of the building, which building codes currently don't address. However, the ultimate tool to quantify the environmental impact associated with construction is Life Cycle Assessment (LCA). Without considering LCA, it will be difficult to holistically address the environmental footprint of residential construction and achieve sustainability for future generations.

Design and Construction Recommendations for Log Homes

While future codes will require a higher degree of thermal resistance of the building envelope, there will be a greater focus on air tightness of the building envelope and a requirement for building envelope airtightness testing. There are several things that log home designers and builders may wish to keep in mind to meet the energy codes of today and the future.

- Work with an energy consultant early in the design process to optimize the building envelope for code compliance given that the practical R value of log walls is limited by log diameter and the species. Experienced energy consultants will advise on building envelope upgrades that will provide the biggest energy benefit at the lowest construction cost.
- Pay attention to all connection details between logs as well as their connection to floor/foundation and to ceiling/roof. Home energy audits have demonstrated that the single biggest source of air infiltration in log homes is where the roof/ceiling connects to the log wall. The log wall to the floor/foundation is number two, followed by interlocking corner joints. Use appropriate sealing systems for all penetrations and interfaces of the building envelope to meet todays and the futures air infiltration requirements. Remember that not all gaskets perform the same! Choose the right sealing system that will perform even after the low walls settle.
- Insulate the floor joist area and the rest of the foundation as much as practical. These are often points of large energy losses and infiltration identified by energy audits on log homes. Both closed cell spray foam insulation and blown in cellulose insulation have been shown effective in reducing air infiltration.
- Use interior walls or floors that increase internal thermal mass of the structure (e.g. brick, stone, concrete or even logs). This helps stabilize the indoor temperature and can be beneficial to overall energy efficiency when using the performance path simulations.
- Consider blower door testing on all projects whether they are required by code or not. It will make you a better builder and they will become the norm in the future! Completing them early in the lock up stage allows making necessary sealing adjustments before installing finishing materials. This saves time and money in the future. Certified personnel performing blower doors test and operating thermal imaging equipment will help identify problem areas seen on other projects and provide possible solutions to remediate them. The blower door test of the finished home provides only final verification.



For more information on this study, contact :

Dalibor Houdek at (780) 413-9031,
dalibor.houdek@fpinnovations.ca

Acknowledgement: This publication was developed in collaboration with Rob Pickett & Associates LLC. and Tyler Hermanson of 4 Elements Integrated Design, Ltd. FPInnovations also wish to acknowledge the financial support of Cariboo-Chilcotin Beetle Action Coalition and the BC Log & Timber Building Industry Association in developing this publication.

FPInnovations®

FPInnovations
HEAD OFFICE
Pointe-Claire
570 Saint-Jean Blvd
Pointe-Claire,QC
Canada H9R 3J9

T 514 630-4100

Vancouver

2665 East Mall
Vancouver, BC
CanadaV6T 1W5

T 604 224-3221

Québec

319 Franquet
Québec, QC
Canada G1P 4R4

T 418 659-2647

www.FPInnovations.ca