

**EXTERNAL**  
**ecoENERGY Innovation Initiative**  
**Demonstration Component**  
**Public Final Report**

Project Code: 380BS  
Project Title: Integrating Renewables and Conservation  
Measures in a Net Zero Low-Rise Residential Subdivision

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## 1 Project Snapshot and Business Case

<b>Project Title</b>	Integrating Renewables and Conservation Measures in a Net Zero Low-Rise Residential Subdivision
<b>Project Identification Number</b>	380BS
<b>Proponent</b>	Owens Corning Canada LP
<b>Number of Participating Partners</b>	27
<b>Total Project Cost (\$000s)</b>	\$5,096,451.89
<b>Total Contribution from Proponent and partners (\$000s)</b>	\$3,140,420.41
<b>Total ecoEI Contribution (\$000s)</b>	\$1,956,031.48
<b>Project Revenue and profit</b>	<p>Not applicable. These houses were built to demonstrate NZEH performance and sold.</p> <p>Each home was sold at the market price of a standard home. No profit was made on the net zero component of these houses.</p>
<b>Project Highlights</b>	<ul style="list-style-type: none"> <li>○ Constructed and sold 21 R2000 Net Zero Energy homes in Calgary, AB (5 singles); Ottawa, ON (1 single and 4 townhouses); Guelph, ON (5 singles); and Laval, QC (6 stacked townhouse units)</li> <li>○ Constructed and sold 5 R2000 Net Zero Energy Ready single detached homes in Bedford, Nova Scotia</li> <li>○ Developed knowledge transfer assets and formally presented at over 20 knowledge transfer events across Canada</li> <li>○ Many of the participating builders and partners are founding members of the CHBA Net Zero Energy Housing Council - to help launch the first private Net Zero Energy certification for housing</li> </ul>
<b>Date submitted to NRCan</b>	March 28, 2017

## 2 Background

*Why was the project proposed? Identification of partnerships.*

**Housing accounts for 15% of Canada’s secondary energy use and 15% of greenhouse gas emissions.** Growth in the housing stock has contributed to a net 14% increase in household energy use since 1990. The energy consumption and greenhouse gas emissions from this sector

will continue to grow if the industry does not move to build homes substantially more efficient. Net-Zero Energy Housing (NZEH) provides a means to accomplish these reductions.

The Canadian housing industry, though large, is highly fractured with thousands of homebuilders. Individual builders have limited capacity to pool resources and share the risk associated with research and development (R&D). For this reason, the vast majority of homebuilders rely on prescriptive packages from labelling programs such as R-2000 and Energy Star, and on the building code when designing the energy performance components of their homes. A small but growing fraction of homebuilders are now building near- and net-zero energy (NZE) housing. They want to know which technologies will have the highest impact in reducing the first cost of NZE homes, and how best to integrate them.

This project is aligned with ecoEII's goals of searching for long-term solutions to help eliminate air pollutants and greenhouse gas emissions from energy production. This project builds on the NRCan funded LEEP/TAP (Local Energy Efficiency Partnerships/ Technology Adoption Pilot) project to demonstrate the next housing platform in communities across the country.

NZE homes continue to be stuck in a research and development phase and pilot demonstrations, with little focus on the unique challenges that the housing platform presents for the production builder. To achieve wide acceptance and industry adoption, a community-sized demonstration by production builders is critically important.

Owens Corning Canada was the lead proponent who assembled a team of experts in the fields of building technology, building science, solar technology, and energy efficiency, each with experience mentoring production builders to adopt voluntary energy efficiency/renewable energy measures including NZEH.

Builders were selected based on their experience and successful adoption of voluntary measures in their products. The five builders are: Construction Voyer (Laval, Quebec); Mattamy Homes Limited (Calgary, Alberta); The Minto Group (Kanata, Ontario); Provident Development Inc. (Bedford, Nova Scotia); and Reid's Heritage Homes (Guelph, Ontario). buildABILITY Corporation is the Lead Consultant managing the project alongside five building science and technical consultant companies: Ameresco Inc., Building Knowledge Canada Inc., MMM Group., HAWK-EYE Technical Services, and Leidos Canada.

Project insights were disseminated through the Canadian Home Builders' Association (CHBA) and local Home Builders' Associations (HBA)s to promote and facilitate the construction of other NZEH communities. This was not only a demonstration project to show that NZE homes are feasible in today's market but it is also a knowledge transfer success story. Participants of this project do not believe that the NZE home recipe should be a secret. These innovative builders have become educators and mentors to their peers, sharing their learnings and designs at building industry events and training seminars across Canada.

The project began with a national design charrette held in March 2013, which had Canada's leading housing and net zero experts meeting for two days to discuss the path to net zero housing and net zero communities, and the barriers that exist. The charrette was focused on two strategies: conservation and advanced renewable technologies. The first and primary strategy focussed on energy conservation by maximizing the envelope and air tightness levels, and exploring complementary high performance mechanical systems. The second strategy focussed on exploring market-ready renewables technologies, including photovoltaic panels, solar thermal, ground source heat pumps, and air source heat pumps.

The NZE homes built in the five communities used new EnerGuide Rating System for New Homes to measure energy use and in many cases the new R-2000 requirements as the jumping off point to achieve net zero. 2014 R-2000 builder training and CodeBord® Air Barrier System training was provided to all five builder alliances to prepare them for the design phase.

A total of 26 net zero energy or net zero energy ready homes were built. Construction of the homes began in 2014 and completed in March 2017.

### **3 Objectives**

- to demonstrate the feasibility of building Net-Zero Energy Housing (NZEH) Communities in Ontario, Quebec, Nova Scotia, and Alberta;
- to address challenges to building to NZEH performance levels specific to production housing; and
- to act as a platform for the broader adoption of NZEH across Canada.

#### ***3.1 Objective 1 – Demonstrate NZEH feasibility across Canada***

- The main objective of the project was to demonstrate that Net Zero Energy Housing Communities was technically feasible and could be implemented across Canada
- The final output included 4 Net Zero Energy Housing Communities (made up of 21 NZEH homes in Calgary AB, Ottawa ON, Guelph ON, and Laval QC) and 1 Net Zero Energy Ready Housing Community (made up of 5 NZE-ready homes in Bedford NS).
- The main objective of having 5 fully NZEH communities was not achieved as the market in Nova Scotia was not able to bear the cost of the solar photovoltaics
- However, the project has succeeded in demonstrating that NZEH is technically feasible.

#### ***3.2 Objective 2 – Address NZEH challenges in production housing***

- This project aimed to analyse and resolve NZEH feasibility challenges specific to production housing (track builders)
- The final output provided each production builder with a recipe /technical specification to achieve NZEH performance – this included technology partners and manufacturer relationships that helped to reduce cost

- The project succeeded in analysing and resolving NZEH feasibility challenges specific to production housing through a collaborative Discovery House methodology and securing technology and manufacturer partners
- The Discovery House methodology allowed the builders to test new technologies (e.g. exterior air barrier and added insulation installation) on a pilot home before adopting the tested technology into their NZEH recipe
- The Discovery House methodology also allowed the consultants and energy advisors to simulate, test, and iterate on the builders' popular house models – this sometimes included a change in roof design to accommodate the required number of solar photovoltaics
- By collaborating with and securing technology and manufacturer partners, builders gained access to NZE technology-specific experts (e.g. triple pane window details, exterior air barrier installation details etc.)
- Relationships with the technology and manufacturer partners also resulted in better pricing to reduce the incremental cost of achieving NZEH

### ***3.3 Objective 3 – Act as a platform for broad NZEH adoption in Canada***

- The knowledge transfer aspect of the project was critical from a replication perspective, this project aimed to act as a platform for other Canadian builders to build upon and adopt NZEH in the near future
- The team participated in over 20 knowledge transfer events and the project appeared in over 250 media clippings
- 6 documentary-style videos were also produced to help disseminate the project's learnings and story
- Each regional team connected with its local HBA to provide project updates and learnings
- The CHBA was formally engaged as a partner to help provide each builder with a 3<sup>rd</sup> party private certification of NZEH performance
- This project received numerous industry awards nationally and regionally – it continues to be referenced as a stepping stone for NZEH adoption across Canada

## **4 Results of Project**

### ***4.1 Project Achievements***

#### **4.1.1 Achievement 1 – National Design Charrette**

- A national design charrette was hosted by the team in March 2013 that brought together industry experts across Canada and the USA
- This charrette helped each builder better understand past case studies and lessons learned from previous NZEH projects
- During the charrette, each builder worked with their consultant to simulate and develop a draft technical NZEH specification

- This draft specification was the beginning of the design and planning for the project

#### **4.1.2 Achievement 2 – New R2000 Training Workshop**

- All 5 builders and their consultants were trained and certified with the new R2000 standard
- This occurred prior to the release of the New R2000 standard and new ERS requirements
- This training acted as a precursor and foundation for CHBA’s Net Zero training (that occurred 3 years later)

#### **4.1.3 Achievement 3 – National Implementation Charrette**

- Collaborated with the Net Zero Home Coalition and became a headline event at the North American Net Zero Leadership Summit
- The 5 regional teams presented their updated designs and technical specifications to an international audience for feedback
- The teams also visited and toured the Solar Decathlon and even recruited a student to join the consulting team (Matt Schiedel of Team Ontario joined Building Knowledge and is now with Owens Corning Canada)

#### **4.1.4 Achievement 4 – Secured technology partners and collaborators**

- Secured national partners for NZEH technologies: JeldWen Windows, Rheem (air source heat pump water heaters), Mitsubishi Electric (cold climate air source heat pump), and Canadian Solar (solar pvs)
- These partners provided time, expertise, and preferred pricing to assist each regional team
- Formal collaboration with local HBAs and CHBA helped to disseminate the project’s learnings and increase exposure of each knowledge transfer event

#### **4.1.5 Achievement 5 – Knowledge Transfer Assets and Events**

- Developed 6 documentary-style videos that documented each builder’s journey and the project’s overall journey and learnings
- These videos have been and continue to be used in CHBA’s Net Zero training, each builder’s marketing of NZEH, and in other knowledge transfer outlets (e.g. NRCan’s own science and research videos)
- Each region’s grand opening included a media and knowledge transfer component that garner both public and industry attention, working with NRCan and local HBAs, key speakers attended to help disseminate the importance of NZEH innovation and adoption
- Working with NRCan’s Office of Energy Efficiency – case studies were commissioned separately to help create knowledge transfer assets for those that participated in the new R2000 NZEH pilot program, these case studies will be made available to the public

#### **4.1.6 Achievement 6 – Completion and construction of 26 NZE/NZEr homes**

- The final achievement being the actual completion and construction of the 5 communities made up of 26 net zero energy or net zero energy ready homes

### ***4.2 Benefits – Impact on Industry and Public***

#### **4.2.1 Benefit 1 – Energy Efficiency**

All 26 houses built achieved energy efficiency levels of the new R2000 standard or higher. This resulted in 60 – 80% reduction in simulated energy consumption for each home (lower band being the stacked townhomes). This will benefit:

- 1) Manufacturer of NZE products and technologies – demonstrated that their technologies contributes to energy savings
- 2) Builder – demonstrated that NZE ready energy performance is technically feasible
- 3) Occupant – significantly lower energy bills
- 4) GoC – demonstrated that NZEH is technically feasible and can be considered as a future regulatory target for all homes

#### **4.2.2 Benefit 2 – Environmental Impact**

21 of the houses built achieved simulated NZEH performance, meaning that each house could produce as much energy (renewable from solar pvs) as it consumes. These houses, not accounting for occupant behaviour that deviates from NRCan’s assumptions, would potentially contribute net zero GHG emissions. This will benefit:

- 1) Manufacturer of NZE products and technologies – demonstrated that their technologies contributes to GHG savings
- 2) Builder – demonstrated that GHG neutral is technically feasible
- 3) Occupant – contributes to national GHG reduction target
- 4) GoC – demonstrated that GHG neutral homes are technically feasible and can be considered as a future regulatory target for all homes

#### **4.2.3 Benefit 3 – Cost Efficiencies**

Although the NZE technologies used were off-the-shelf, the cost of these technologies were still priced out of a standard builder’s budget. Leveraging the exposure and benefits of the project, the builders were able to negotiate a steep discount with manufacturers. These manufacturers became national partners of the project, receiving exposure and new knowledge about their technology adoption. This discount will continue to be offered to the builders as they choose to adopt the technologies in their upgrade packages or on a case by case basis. This project helped to set a new ‘willingness to pay’ for the NZE technologies. This will benefit:

- 1) Manufacturer of NZE products and technologies – new relationship with builders and more customers through the builder network (influencers)
- 2) Builder – reduction in NZE technology prices, closer to an economically feasible NZE



- 3) Occupant – economically feasible NZE ready packages in certain markets (e.g. Guelph)
- 4) GoC – reduction in NZE technology prices, make it more attractive to adopt NZE technologies voluntarily – building the path for future regulatory adoption

#### **4.2.4 Benefit 4 – Knowledge and Regulatory Uptake**

All project details have been shared on the website ([www.zeroenergy.ca](http://www.zeroenergy.ca)) and on each builder's individual sales and marketing websites. Each builder and Owens Corning Canada has a documentary style video that summarizes each partner's intentions, lessons learned, and experience in the project. Working with NRCan's Office of Energy Efficiency, case studies were developed for each of the builders participating in the new R2000 NZE pilot. The website, videos, and the case studies will act as key knowledge transfer assets for the industry moving forward. They are visual, easily accessible, and educational.

Over 20 knowledge transfer events took place where team members participated in regional, national, and international industry events to share learnings about the project. The project also hosted 7 formal events of its own for ground breakings, grand openings, and a final lessons learned wrap up session. These events increased the project's exposure resulting in over 250 media clippings and collaborations beyond the scope of this project. For example, many of the builders and manufacturers became founding members of the Canadian Home Builders Association's Net Zero Energy Housing Council. This Council has helped to extend and enhance the new R2000 NZE Pilot into a private voluntary certification program for NZEH performance. It's helped to modify the standard, develop new training, and even inform future regulatory changes.

Members of the team continue to be consulted by local municipalities who are looking to test and pilot a NZEH standard. For example, buildABILITY is working with the landowners in North Markham and the City of Markham to develop a community energy plan that leverages the learnings from this project.

The results of this project, qualitative anecdotes of the builders' experience and the quantitative simulations, have been shared with other departments of NRCan, CHBA, other HBAs, local municipalities, and provincial jurisdictions to help inform future policy making.

This will benefit:

- 1) Manufacturer of NZE products and technologies – deeper understanding of how to implement their technologies in a production builder's construction process, also a deeper alignment with regulatory and voluntary program requirements
- 2) Builder – first mover's advantage in testing out NZEH construction and performance with consulting and monetary assistance before adopting future voluntary NZEH programs
- 3) Occupant – NZEH is being derisked through this project and other pilot initiatives in the future before it becomes mandated
- 4) GoC – lessons learned and performance data to assist provincial, municipal, and federal jurisdiction in its roll out of NZEH requirements



## 5 Conclusion and Follow-up

This Net Zero Energy community project attempted to assess and resolve the challenges in relation to, among other things, site planning, construction, equipment, grid connections, cost, trade capability, warranty, reliability, sales, marketing, and homebuyer information/education.

The project successfully engaged production builders and completed 26 net zero energy or net zero energy ready homes. Team members continue to be involved in the net zero community and volunteer their time to move net zero forward as the country considers a near net zero or carbon neutral future.

This project demonstrated that NZEH is technically feasible for a production builder. The next step is to continue to disseminate this knowledge and encourage other influential production builders to build NZEH communities of their own. More field experience and data will help regulators move this target forward.

### 5.1 Potential for Replication

- The builders benefited from the subsidized consulting that the ecoEII funding provided. However the consulting fees associated with charrettes, project wide meetings and deliverables would not be required in a replication scenario. The cost to replicate NZEH communities will be lower as a coordinated effort across Canada will not be required. Builders can work with their energy advisors and use the technical specification disseminated through HBAs and in the CHBA training to start building their first NZEH at the same cost of any voluntary program. The incremental material cost of NZEH was borne by the builders in this project and will continue to be borne in other replications.
- The technical specification, simulation of NZEH technologies, and the lessons learned (grid connection and trades training) are all transferable and usable resources that other builders can use to replicate this project. In fact most of the data from this project has been used to validate and create the CHBA NZE certification program.
- As provincial and federal codes contemplate a carbon neutral future, the idea of NZEH has become an increasing reality. With the popularity of the CHBA NZE program and the option to certify Net Zero Energy READY homes, we expect to see at least 10 net zero ready homes in 1 year and 100 full net zero energy homes within 5 years (spearheaded by builders in this team). By 10 years time, we expect to see at least 500 NZEH. These numbers are conservative considering a potential NZE 2030 target (though it is unclear whether the target is carbon neutral or energy neutral).

### 5.2 Next Steps

- We expect to see net zero energy ready homes voluntary certification and adoption through the CHBA program. This will drive the prices of NZE technologies down and increase awareness of NZEH. New storage and renewable technologies (Tesla batteries and shingles)

have garnered public interest and will drive demand for more energy efficient and resilient homes – aligned with the NZEH concept.

- Members of the team will continue to work with local municipalities and provincial jurisdictions to map the path to NZEH regulation. The lessons learned from this project will be shared openly and the team will encourage the proper steps be in place to build industry capacity and adoption.
- It is recommended that the Federal Government continues to support NZEH demonstrations and knowledge dissemination across Canada. Although this project demonstrated that NZEH is technical feasible, more assistance is required to help drive market demand and reduction in cost