NET ZERO ENERGY HOME RETROFITS
What if your home had an energy bill of zero?

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President, The Now House Project Inc.

Sustainable Building/Renovating Housing Forum 2013
Kamloops Convention Centre
February 7, 2013
What if your house was a Now House?
1700 visitors in 3 hours
Proposal for CMHC's EQuilibrium™ Housing Initiative

Now House™
One small house.
One million opportunities.

Proposal for CMHC's EQuilibrium™ Housing Initiative

Solicitation File #: 0981-305
1. Our first Now House
5. Now House Windsor 5
9. The Windsor 95
OUR VISION: ZERO ENERGY HOME RETROFITS

One house  One community  One million houses across Canada
Why...

Because reducing home energy use is one of our best opportunities to save energy and meet Canada’s GHG emissions targets.
In Canada, the residential sector accounts for:

17% of energy use

15% of greenhouse gas emissions.

Source: Natural Resources Canada
Typical EnerGuide (EGH) Ratings for Homes

How energy efficient is your home?

Source: Natural Resources Canada.
EGH = EnerGuide for Houses is a Canadian Standard for home energy efficiency; on a scale of 1–100, higher scores indicate higher efficiency.
Are new, more energy efficient houses the answer?
13 million
Number of housing units in Canada

200,000
Average number of new houses built in Canada annually

65 years
Time it would take to replace existing stock.
66% The number of houses that will exist in 2050 that are already standing.

Source: National Round Table on the Environment and Economy
Fifteen areas of opportunity represent 75 percent of the resource prize

<table>
<thead>
<tr>
<th>Area</th>
<th>Total resource benefit in 2030, $ billion (in 2010 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency in buildings</td>
<td>686</td>
</tr>
<tr>
<td>Large-scale farm yields</td>
<td>266</td>
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<td>Food waste</td>
<td>252</td>
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<tr>
<td>Municipal-water leakage</td>
<td>167</td>
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<tr>
<td>Urban densification</td>
<td>155</td>
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<tr>
<td>Iron and steel energy efficiency</td>
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<td>Smallholder farm yields</td>
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<td>Transport efficiency</td>
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<td>Electric and hybrid vehicles</td>
<td>138</td>
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<td>Land degradation</td>
<td>134</td>
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<tr>
<td>End-use steel efficiency</td>
<td>132</td>
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<tr>
<td>Oil and coal recovery</td>
<td>115</td>
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<tr>
<td>Irrigation techniques</td>
<td>115</td>
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<tr>
<td>Road freight shift</td>
<td>108</td>
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<td>Power plant efficiency</td>
<td>106</td>
</tr>
<tr>
<td>Other</td>
<td>892</td>
</tr>
</tbody>
</table>

Source: McKinsey Quarterly; Mobilizing for a resource revolution
1. Our first Now House

5. Now House Windsor 5

95. The Windsor 95
Competition

EQuilibrium Sustainable Housing Demonstration Initiative 2007.
We proposed to turn a 60-year-old WWII house into a net zero energy home – one that produces as much energy as it uses.
Why retrofit a wartime house?
During WWII thousands of these houses were built for munitions workers and veterans.
Many more were built after the war. Today there is an estimated one million wartime houses and post-war bungalows still standing in Canada.
Why retrofit a wartime house?

Scalable: A million similar houses across Canada

Accessible: Make sustainable housing accessible to mid and lower income families
Now House is one of 12 winning teams from across Canada in CMHC’s competition for the EQuilibrium Sustainable Housing Initiative.

And the only team doing a zero energy retrofit.
The Green Dream Home is a new, two storey detached home with a finished walk-out basement level. Located in Kamloops, British Columbia, it is a 300.7 m² (3,237 sq. ft.) house with an attached garage on a residential lot in the Sun Rivers development. This golf course community development resides on Kamloops (Tk'emlups) Indian Band (KIB) reserve land, across the South Thompson River from the Kamloops downtown core. The builder team is a consortium of the Canadian Home Builders' Association Central Interior (CHBA CI) and Thompson Rivers University (TRU). Student Key Features

- Predicted positive net annual energy production
- Passive solar heating, grid-tied photovoltaic panels, solar hot water heating system and a ground source heat pump will meet the home's annual energy requirements
- Design work was done by Thompson Rivers University (TRU) architectural and engineering technology students, and TRU trades students built the house under the supervision of skilled instructors
- Landscaping was designed by TRU horticulture students and includes drought resistant native plants and edible plants
- Has been sold to the local YMCA/YWCA for their Dream Home Lottery fundraiser

Figure 1—Photo of The Green Dream Home Project

This Project Profile highlights The Green Dream Home, one of the winning entries in the Canada Mortgage and Housing Corporation (CMHC) EQuilibrium Sustainable Housing Demonstration Initiative—a national initiative to design, build and demonstrate sustainable homes throughout Canada. For more information on this initiative and the various EQuilibrium Housing projects, visit the CMHC website (www.cmhc.ca) and type the search keyword “EQuilibrium.”

1 These floor area values and others in the text include the exterior walls, and the stairway is counted on each floor. The heated floor areas for the main, second and basement floor levels are 96.4 m² (1,037 sq. ft.), 55.1 m² (593 sq. ft.) and 96.4 m² (1,037 sq. ft.) respectively, totalling 247.9 m² (2,668 sq. ft.).
The first Now House.
Before the retrofit.
The Community

Topham Park, Toronto is a post-war housing community with street names such as ‘Warvet’ and ‘Valor’.

Built in 1946.
Typical EnerGuide (EGH) Ratings for Homes

Source: Natural Resources Canada.
EGH = EnerGuide for Houses is a Canadian Standard for home energy efficiency; on a scale of 1–100, higher scores indicate higher efficiency.

Now House achieved EGH 68 in the “before” energy analysis.
Now House Design Process

Social/Technical
PARTNERSHIPS & SPONSORSHIPS
Now House Design Process

Social/Technical
**Now House Retrofit Overview**

1. **Envelope**
2. **Appliances, Lighting, Water**
3. **Mechanicals**
4. **Renewables**

- **Air Handler with Heat Recovery Ventilator** (required for fresh air circulation and moisture management due to tighter home envelope)
- **Low-flow Fixtures** (Showerheads and faucets)
- **Solar Thermal (South-facing)**
- **Solar Photovoltaic (South-facing)**
- **Tankless Water Heater**
- **Grey Water Heat Recovery**
- **Water Storage Tank**
- **In-floor Radiant Heating** increases comfort (powered by solar thermal)
- **Energy Star Appliances**
- **New Insulation** lowers energy use (in exterior walls and basement)
- **New Low-E Windows** reduce energy use (larger window on south side improves daylighting)
- **CFL Lightbulbs**
1. IMPROVE ENVELOPE

We waterproofed and insulated the exterior foundation walls.

Insulated the basement floor, and installed radiant floor heating.
1. IMPROVE ENVELOPE

Removed aluminum siding and asbestos siding which was underneath.
1. IMPROVE ENVELOPE

Replaced existing windows with fiberglass, double glazed, low-e, ENERGY STAR windows.
1. IMPROVE ENVELOPE

Enlarged south facing window to increase light and passive solar gain.
1. IMPROVE ENVELOPE

Insulated the exterior walls, roof, and attic with 5.5" of spray foam insulation.
2. APPLIANCES, LIGHTING, WATER

Install Energy Star appliances, CFL lighting and low flow water fixtures.
3. IMPROVE MECHANICALS

Installed a new HVAC system including: an air handler with variable speed motor, heat recovery ventilator, hot water storage tank, tankless water heater.
4. ADD RENEWABLE ENERGY

Evacuated tube solar thermal collectors produce heat for DHW and heating.
4. ADD RENEWABLE ENERGY

Installed solar photovoltaic (PV) panels.
Solar thermal system (left) provides heat for domestic hot water, home heating and radiant floor.

Solar PV system (right) is grid connected to local utility which under Ontario’s FIT will pay 80 cents/ kWh for 20 years.
Now House achieved EGH 89 and with solar 97.3.
Project Timeline & Cost:

Partner and sponsor development: 2007
Retrofit: April – September 2008
Cost: $85,000
Tours: September 2008 – January 2009
CMHC monitoring.
POST-RETROFIT OPEN HOUSE
POST-RETROFIT OPEN HOUSE
SMALL HOUSE = BIG RESULTS

The first Now House achieved these post-retrofit measured results:

68 to 89 - Improved EGH
5.4 tonnes - GHG reduction
79% - gas reduction
35% - electricity reduction
$2,400 - annual earnings from solar PV
Net zero energy cost.
NET ZERO ENERGY COST

Now House Annual Energy Cost 2012

Electricity $779
Gas $506

$1,285

Solar PV Rebate: $2,396

Net income $2,396 - $1,285 = $1,111
LESSONS LEARNED

➢ Tankless water heater failure first winter
➢ Poor performance from solar thermal energy system
➢ Higher than expected electricity use from continuous use of HRV fan
➢ Heating and solar contractor(s) unable to solve solar thermal issues
➢ Solar PV panels unplugged by mistake.
LESSONS LEARNED
We received hundreds of queries from across the country
The major obstacles to NZE retrofits are:

➤ the cost to the homeowner
➤ lack of information
➤ limited expertise in the field.
1. Our first Now House

5. Now House Windsor 5

95. The Windsor 95
Now House Windsor 5

Now House and Windsor Essex Community Housing Corporation

An opportunity to solve the cost problem
PARTNERSHIPS

Project Partners

CITY OF WINDSOR CANADA

WINDSOR ESSEX
COMMUNITY HOUSING CORPORATION

Now House
One small house. One million opportunities.

Sponsors

ONTARIO POWER AUTHORITY

Whirlpool

JamesHardie

CMIC SCHL

TAKAGI

LIFE BREATH

Carrier

TIGER FOAM INC.

Gioele
RESIDENT EDUCATION
COMMUNITY OUTREACH
Typical EnerGuide (EGH) Ratings for Homes

Source: Natural Resources Canada.
EGH = EnerGuide for Houses is a Canadian Standard for home energy efficiency; on a scale of 1–100, higher scores indicate higher efficiency.

Now House Windsor 5 EGH before retrofit.
Technical Models

Windsor 5
Status Quo Average

Now House
Base Model

What’s in it?
- Air seal and insulation
- Condensing furnace EF=94%
- Hot water EF=86%

Now House
Near Zero Energy Model

What’s in it?
- Dual flush toilet
- HRV
- CFL light bulbs

What’s in it?
- All base model changes
- Low E Windows
- 2 kW solar photo-volataic system
- 2 panel solar thermal system

Now House
Windsor 9

What’s is it?
- A 9 family multi-unit building created by filling in between the 5 current homes.

What are the benefits?
- Centralized mechanical and power production system
- Eligible for extra grants
- More rental units
- The “fill-in” house can be attached to other homes, increasing them to net zero Now Houses.

What are the issues?
- By-laws
- Timeliness

Cost

EGH

$100,000
Now House Windsor 5: Testing 5 different approaches to deep energy reduction and zero energy to determine best approach for 95 similar house in WECHC portfolio.

MODEL ONE
- Base Model +
- High efficiency hydronic heating system
- Tankless water heater
- High efficiency central A/C
- Heat Recovery Ventilator

MODEL TWO
- Base Model +
- High efficiency forced air gas furnace
- Tankless water heater
- High efficiency central A/C
- Heat Recovery Ventilator
- 2.1 kW solar photovoltaic system

MODEL THREE
- Base Model +
- High efficiency hydronic heating system
- Tankless water heater
- High efficiency central A/C
- Heat Recovery Ventilator
- New energy efficient windows
- Solar thermal system
- 2.1 kW solar photovoltaic system

MODEL FOUR
- Base Model +
- High efficiency forced air gas furnace
- Tankless water heater
- High efficiency central A/C
- Heat Recovery Ventilator
- Heat Recovery Ventilator

MODEL FIVE
- Base Model only

*EGH: EnerGuide for Houses is a Canadian standard measurement for home energy efficiency. On a scale of 0–100, higher scores indicate higher efficiency.
Now House Windsor 5
Base model consisted of:

› Air sealing and insulation
› CFL lighting
› Low flow fixtures (shower head, toilet, aerators)
› ENERGY STAR refrigerator, front-loading washer
› Gas range and dryer.
INSULATION FROM INSIDE

• Exterior walls, cavity fill insulation
• Spray foam in basement and attic
Now House Windsor 5: Testing 5 different approaches to deep energy reduction and zero energy to determine best approach for 95 similar house in WECHC portfolio.

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**MODEL FOUR**
- Base Model +
- High efficiency forced air gas furnace
- Tankless water heater
- High efficiency central A/C
- Heat Recovery Ventilator

**MODEL FIVE**
- Base Model only
Now House Windsor 5 EGH rating before and after retrofit

<table>
<thead>
<tr>
<th>Model</th>
<th>Before</th>
<th>After</th>
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<tbody>
<tr>
<td>Model One</td>
<td>18</td>
<td>77</td>
</tr>
<tr>
<td>Model Two</td>
<td>35</td>
<td>79</td>
</tr>
<tr>
<td>Model Three</td>
<td>28</td>
<td>79</td>
</tr>
<tr>
<td>Model Four</td>
<td>55</td>
<td>81</td>
</tr>
<tr>
<td>Model Five</td>
<td>55</td>
<td>74</td>
</tr>
</tbody>
</table>

New ENERGY STAR houses = EGH 80
USER FRIENDLY
HISTORY
LOCAL GREEN JOBS
### Monitoring for 12 months post-retrofit

<table>
<thead>
<tr>
<th>Month</th>
<th>KWH Cost</th>
<th>CM Cost</th>
<th>Sewage</th>
<th>Surcharge</th>
<th>KWH Cost</th>
<th>CM Cost</th>
<th>Sewage</th>
<th>Surcharge</th>
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</thead>
<tbody>
<tr>
<td>Aug-08</td>
<td>14,000</td>
<td>$29.81</td>
<td>$44.72</td>
<td>$17.86</td>
<td>$29.81</td>
<td>$44.72</td>
<td>$17.86</td>
<td>$29.81</td>
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<tr>
<td>Sep-08</td>
<td>16,000</td>
<td>$30.60</td>
<td>$45.90</td>
<td>$20.67</td>
<td>$30.60</td>
<td>$45.90</td>
<td>$20.67</td>
<td>$30.60</td>
</tr>
<tr>
<td>Oct-08</td>
<td>17,000</td>
<td>$30.97</td>
<td>$46.46</td>
<td>$21.62</td>
<td>$30.97</td>
<td>$46.46</td>
<td>$21.62</td>
<td>$30.97</td>
</tr>
<tr>
<td>Nov-08</td>
<td>20,000</td>
<td>$33.29</td>
<td>$49.68</td>
<td>$24.63</td>
<td>$33.29</td>
<td>$49.68</td>
<td>$24.63</td>
<td>$33.29</td>
</tr>
<tr>
<td>Dec-08</td>
<td>20,000</td>
<td>$33.29</td>
<td>$49.68</td>
<td>$24.63</td>
<td>$33.29</td>
<td>$49.68</td>
<td>$24.63</td>
<td>$33.29</td>
</tr>
</tbody>
</table>

### Other Charges

- **Waste Water**: $29.81
- **Sewage**: $44.72
- **Surcharge**: $17.86

**Note**: The charges are subject to adjustments based on the utility provider's rate changes.
Now House Windsor 5
12-Month Resource Analysis

Compares the pre-retrofit period of November 2007–October 2008 to the same post retrofit period of 2009/10.

<table>
<thead>
<tr>
<th>Model</th>
<th>Electrical Reduction</th>
<th>Gas Reduction</th>
<th>Water Reduction</th>
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<tbody>
<tr>
<td>1</td>
<td>19.5%</td>
<td>43.2%</td>
<td>52.2%</td>
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<tr>
<td>2</td>
<td>42.7%</td>
<td>60.1%</td>
<td>63.8%</td>
</tr>
<tr>
<td>3</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>28.2%</td>
<td>55.6%</td>
<td>-17%#</td>
</tr>
<tr>
<td>5</td>
<td>17.4%</td>
<td>47.9%</td>
<td>27.7%</td>
</tr>
</tbody>
</table>

# Negative value represents an increase in usage. Model 3 was unoccupied during monitoring period.
Electricity savings ranged from 17% to 42%. The addition of solar PV to Models 2 and 3 will result in zero energy cost on an annual basis.
Gas savings ranged from 43% to 60%. 
Water savings ranged from -17% to 63%. 

Now House Windsor 5
Now House Windsor 5: Testing 5 different approaches to deep energy reduction and zero energy to determine best approach for 95 similar houses in WECHC portfolio.

<table>
<thead>
<tr>
<th>MODEL ONE</th>
<th>MODEL TWO</th>
<th>MODEL THREE</th>
<th>MODEL FOUR</th>
<th>MODEL FIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Model +</td>
<td>Base Model +</td>
<td>Base Model +</td>
<td>Base Model +</td>
<td>Base Model only</td>
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<tr>
<td>High efficiency hydronic heating system</td>
<td>High efficiency forced air gas furnace</td>
<td>High efficiency hydronic heating system</td>
<td>High efficiency forced air gas furnace</td>
<td></td>
</tr>
<tr>
<td>Tankless water heater</td>
<td>Tankless water heater</td>
<td>Tankless water heater</td>
<td>Tankless water heater</td>
<td></td>
</tr>
<tr>
<td>High efficiency central A/C</td>
<td>High efficiency central A/C</td>
<td>High efficiency central A/C</td>
<td>High efficiency central A/C</td>
<td></td>
</tr>
<tr>
<td>2.1 kW solar photovoltaic system</td>
<td></td>
<td>2.1 kW solar photovoltaic system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost: $41,000</td>
<td>Cost: $66,000</td>
<td>Cost: $80,000</td>
<td>Cost: $41,000</td>
<td>Cost: $31,000</td>
</tr>
<tr>
<td>EGH Before 18</td>
<td>EGH Before 35</td>
<td>EGH Before 28</td>
<td>EGH Before 55</td>
<td>EGH Before 55</td>
</tr>
<tr>
<td>EGH After 77</td>
<td>EGH After 79</td>
<td>EGH After 79</td>
<td>EGH After 81</td>
<td>EGH After 74</td>
</tr>
</tbody>
</table>

Model 3 unoccupied during monitoring period
MODEL 2 MOST COST EFFECTIVE

Factors measured:
› EGH Improved
› Operating costs saved
› Energy saved
› CO2 emissions reduced.
LESSONS LEARNED

➢ Economies of scale are possible with even five houses

➢ Control of the construction schedule is key to keeping the cost down

➢ West facing solar performed better vs both sides

➢ Engaging utility partners reduces roadblocks

➢ Hiring qualified local trades is possible.
Now House Windsor 5 was a success for the community and the WECHC who proceeded with the retrofit of 95 homes.
1. Our first Now House

5. Now House Windsor 5

95. The Windsor 95
MODIFIED MODEL 2 APPLIED TO 95 HOUSES
MODIFIED MODEL 2

Retrofits included:

- Exterior wall insulation
- Basement wall insulation
- Furnace replacement
- Windows and doors.

Achieved an average of 48% EGH improvement.
LESSONS LEARNED

An integrated package of technologies:
> Can be applied in the same way
> To similar houses
> Simplifying the “know-how” issue
> Achieving economies of scale.
LESSONS LEARNED

Retrofits are affordable at a community scale:
2008 – Now House proof-of-concept house $85K
2010 – Now House Windsor 5 Model 2 $66K
2011 – Modified Model 2 applied to 95 similar homes in Windsor $10.7K. (+ solar).
WINDSOR 95

Demonstrated that cost and knowledge barriers can be addressed with a multi-home, single-payer (housing agency) business model.
Is there a business model that would work in a multi-home, multi-payer context such as a community-scale retrofit project including dozens of homeowners?
What would it take to succeed?
LEADERSHIP

A catalyst to bring one of these projects into being...

From builders, communities, homeowners, municipalities, utilities.
WILLING PARTNERS

A coalition of homeowners, municipal government, builders, utilities, distributors/retailers, academics, regulators and financial institutions.
GROUPINGS OF SIMILAR HOUSES
IN CONCLUSION...
We started this journey thinking we had a technical problem.
Email invitation sent to interested respondents from survey and past participants.

Reminder email to brave the snow and attend the meeting.

Meeting topic posters and open spaces agenda.

Turns out we have a business and social engineering problem.
SOLVING THIS CAN HELP US ALL

Meet Canada’s emissions targets

Preserve our precious housing resources well into this century.
Now House®
One small house.
One million opportunities.

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