Retrofitting to Net Zero:
Part 1: Knowing the Landscape

Let's Talk Green Economy Workshop Series

January – March, 2020
What is EnviroCentre?
Our mission is to provide people, communities, and organizations in Ottawa with practical solutions to lighten their environmental impact in lasting ways.
Our work focuses on four main areas:

- Green Homes
- Active Transportation
- Green Lifestyles
- Green Business
Carbon 613: EnviroCentre’s program for businesses

- Membership based program for Ottawa businesses
- Access to events, resources, discounts
- Comprehensive tools for Carbon analysis and target setting
- Local network of businesses committed to climate action
Energy services

- Home and MURB Energy Audits
- Business Energy Analysis and Audits
- Business carbon accounting (through Carbon 613)
- Green Audits
Who I am

• Greg Furlong, Senior Energy Analyst
• Energy Advisor – NRCan, CHBA Net Zero, ENERGY STAR etc.
• Certified Energy Manager (AEE)
• More than 700 private homes since 2003
• Over 100 MURBs assessed plus a dozen commercial audits
• Co-founder of a successful retail business in Toronto
Our goals today

• Net Zero background
• Comparing rating systems
• Easy retrofits
Part 1: Starting the Process
What is Net Zero?
Yearly household energy = Yearly energy generated onsite
Net Zero retrofit savings

- Lower energy consumption (65-100%)
- Electricity generation offsetting consumption
- Carbon reductions of up to 95%
Net Zero example

Net Zero Energy Retrofit on 1980s row house, as follows:

1. Mid-efficiency gas furnace to ASHP & electric furnace
2. Standard gas DHW to HP water heater & DWHR
3. Air leakage reduced from 4.6 to 1.5 ACH50
4. Lighting and appliance upgrades
5. All windows replaced with triple-pane fiberglass
6. 500 sq.ft. of solar panels installed to match reduced usage
Moving toward Net Zero

How?

1. Lower heating/cooling demand
2. Ultra-efficient heating
3. Electricity generation on site
Toward Net Zero: lower heating/cooling demand

- Plenty of insulation
- Low air leakage target (1.5 ACH50)
- Advanced windows
Providing ventilation

• 1.5 ACH50 translates to very low natural ventilation rates

• The answer is Fresh Air Machines: HRV or ERV equipment
Net Zero: low heating/cooling needs

- Heating: only 36000 btu/hr heating for a 2000 sf home

- Cooling is also necessary for:
  - ambient temperature above 26°C for extended periods
  - high interior energy use
  - high occupancy load (100 W per person)
  - excessive solar gain

- ASHPs are a good choice for this application
Toward Net Zero: Heating upgrades

If you have an electric water heater,
• Upgrading gas heating efficiency gets only 10% energy reduction, 15% drop in CO₂
• Upgrading AC to operational ASHP can get 33% energy, 75% drop in CO₂ (orig. furnace)
• Removing gas entirely and replacing with heat pump gets 35% energy, 90% CO₂
Toward Net Zero: Electricity Generation

• Rooftop available for PV tells you the maximum energy use you can offset
• 500 sq.ft. of South-facing: ~35 GJ yearly
• 10 kW net metering limit (Ottawa) means 45 GJ is max production
• Wind not generally available in Eastern Ontario
Toward Net Zero:
The balance

• 45 GJ max electricity production means:

• 45 GJ max house rating on the ERS scale

• House details need to be modeled in HOT2000 to match this level
Certified Energy Advisor

- Creates models based on plans
- Figures out the energy balance
- Recommends cost-effective solutions
- Performs blower testing and site inspections
- Provides the Net Zero label
Process vetted by CHBA

Each *Net Zero* and *Net Zero Ready* Home is verified by government-licensed third-party Service Organizations and recognized by CHBA for its achievement.
Results

- Outstanding comfort
- Tiny carbon footprint
- Very low operating costs
Net Zero Considerations
Solar Gain

• Can contribute up to 50% of heating
• Too little: heating system consumes more energy
• Too much: summertime overheating (cooling is necessary)
• Good solar design:
  • Strategic window sizing and placement
  • Overhangs for summer shading
  • Film treatment for East and West windows
  • Landscaping and deciduous trees can help
• **Superinsulation** usually better than passive solar
• For well-insulated houses, PV is a better way to collect solar energy
Vital Equipment: Heat Exchangers

- Transfer heat energy from one flow to another flow
- The flows do not touch one another
- Used in furnaces, boilers and automobiles (radiators)
- Are the basis of HRV, ERV and DWHR
- HRV/ERV takes heat from exhaust to fresh air (75%)
- DWHR unit: heat from drain to DHW inlet water (60%)
Vital Equipment: Heat Pumps

- “Pump” energy from one place to another
- Both heating and cooling

- **Air-source (ASHP)**: COP of 1.5 to 3.5, cost ~$10K
  - 50% energy, 95% less CO2 than natural gas
  - Operating costs now similar
  - Now effective in colder climates like Ottawa

- **Ground or water source (GSHP, WSHP)**: COP of 3 to 5.5, but cost ~$25K

- **Heat Pump Water Heaters**: heat your water
Residential PV Economics

- Typical available roof is 500 ft²
- 10,000 kWh per year in Ottawa
  https://www.nrcan.gc.ca/18366
- Will support ~35 GJ energy consumption
- about $20,000 retail for this size system
- ARR = 7%
Why Net Zero?
Client demand in 2019
4 of top 10 “must-haves” are energy-related

- Walk-in closets
- Energy-efficient appliances
- High-efficiency windows
- Overall energy-efficient home
- Kitchen island
- Open-concept kitchen
- Linen closets
- HRV/ERV Air Exchange
- Large windows
- Two-car garage
Reduction in energy use beyond code:

• **Net Zero** 65-100% better than code, compared to
  • 20% for ESNH
  • 50% for R2000
  • 60-80% for Passive House
Exceptional value, greater comfort & environmentally responsible

- Operating costs same or lower than code house
- Better heat distribution and ventilation
- 65 to 100% less energy use
- More than 90% reduction in GHGs
Cost neutrality when considering lifetime operating costs

- Only 5-10% added costs
- 65% reduction in energy consumption
- Electricity bill: fixed costs only
- Closing the gas account saves fixed costs ($285/yr)
- Safer home: lower insurance costs
- Lower operating costs mean lower risk for mortgage lenders
Net Zero
Background
2006: NRCan and CMHC

CMHC Equilibrium Sustainable Housing Demonstration Initiative 2006 – 2012

• 12 completed houses including Minto’s Inspiration
• 11 monitored for actual energy performance
  • All less than 50 GJ
  • 7 less than 25 GJ
  • 3 less than 5 GJ (effectively Net Zero)
2013: NRCan


- 23 net zero energy homes built by 6 builders in 3 provinces
- 5 Homes built in Kanata by Minto (Arcadia II shown)
- All houses certified R-2000 and labelled with a zero gigajoule rating under ERS Version 15
- Technologies limited to pre-engineered products and systems
Canadian Home Builders’ Association

2015-2016: Net Zero Pilot Phase

2017: CHBA Home Labelling Program
• Net Zero and Net Zero Ready labels
• Performance based
• 33+ builders in 7 provinces
• Ontario: 3 labels in 2017, 43 in 2018, now more than 265 across Canada
• CHBA now expanding to renovated homes and mid-rise MURBs

This label indicates that this home is recognized by the Canadian Home Builders Association (CHBA) based on the certifications by the Builder, its Net Zero Qualified Service Organization and a Net Zero Qualified Energy Advisor, that the home has met CHBA’s Net Zero Home Program Technical Requirements, including the energy performance rating according to the Government of Canada’s EnR Guide Rating System. More information is available at www.NetZeroHome.com.
Municipal Tools for Catalyzing Net-Zero Energy Development

- 40 cities surveyed
- 8 sites evaluated
- Design and technology strategies
- Proposed incentives
Global Perspectives on Net Zero

- Widespread research on Net Zero in many countries
- USA: 5000 homes built since 2013
- California: All new homes must now (2020) have at least 2 kW of PV installed
- City of Copenhagen: Net Zero GHGs by 2025 (already 44% reductions since 2005)
- Canada: 30% below 2005 levels by 2030
- Net Zero GHGs by 2050: Denmark, Norway, UK, Canada
Building a plan
Qualification Status

CHBA Net Zero builder requirements

Membership
・ Builders and renovators must be a member of the CHBA

Training
・ Successfully complete the Net Zero Building Science Training – at least one staff person

License
・ Become an EnerGuide (ERS) registered builder with NRCan before starting the home

Registration
・ After the first Net Zero/Ready Home is labelled, you can register
Building the right skills

CHBA Net Zero builder training

CHBA has developed:

- **Building Science Training**
- **Energy Advisor Training**
- **Sales Training**

Training can be taken through qualified SOs including EnviroCentre

- delivered by qualified Trainers

Getting the timing right

Get Net Zero consultation early in the design stage

- A qualified Energy Advisor should have a seat at the design table
- Expert insight from the building science perspective
- Energy modeling
  - Takes in all the effects of each energy use
  - Is your best guide to upgrade impacts
- Ventilation and comfort need to be carefully considered
- Helps decide on the type of heating system that best fits the energy picture
The Net Zero Retrofit plan will affect

Foundations  Walls and Windows  Attic  HVAC systems
Along the way
On-site with the Energy Advisor

The **Energy Advisor** can provide:

- Feedback on the modeled effect of changes
- Pre-drywall blower testing
- Confirmation that the build meets technical requirements and is on track to qualify
CHBA Net Zero label

**Builder/Renovator:**

- is responsible for complying with the Builder/Renovator Agreement and meeting all program requirements
- is responsible for ensuring that their homes meet the Program Technical Requirements
- must provide attestation to CHBA that all program requirements have been met
- works with the EA and SO to get ERS and Net Zero/Ready labels for the home
Poorly insulated ceilings

Could reduce heating by 10%

• **Attics:**
  - Airseal first, based on blower / IR testing.
  - Insulate: blown cellulose is very economical.

• **Flat roofs or cathedral ceilings:**
  - Custom approach based on the situation.

• **Added benefits:**
  - reduced leaks, smaller icicles, lower maintenance costs.
Uncontrolled air leakage

Reductions of 10% or more:

• Air Leakage Testing will tell you where and how much (e.g. EnviroCentre)

• Airseal gaps, cracks and openings

• Weatherstrip doors and windows

• Added benefits:
  ✓ comfort, humidity control, health and safety (garages)
Any equipment producing heat or cold

Lots of energy use = Lots of opportunities for savings

- Air conditioner: Upgrade to air source heat pump
- Water heater: Upgrade to Heat Pump Water Heater
- Gas Furnaces or Boilers: Maintenance only – avoid “Lock-in”
- Refrigerators and freezers: Upgrade
Heat recovery from exhaust air

HRV or ERV - Fresh Air Machines recapture up to 75% of energy from exhaust

- **Heat Recovery Ventilator**: fresh air preheated for free
- **ERV**: preheated air with humidity regulation
- Low electrical consumption, but need regular cleaning maintenance
Heat recovery from drainwater

DWHR – Hot water energy booster recaptures up to 60% of energy from drainwater (mainly showers)

- Drain Water Heat Recovery units have no moving parts, no maintenance
- Water coming into the water heater is preheated for free!
- Installed by plumber

Image: ThermoDrain
Deeper Energy Efficiency Upgrades
Deeper Retrofits
(more details in Part 2)

Empty wall cavities:
• Filling with cellulose saves up to 20% on heating

Exterior Wall Insulation:
• Board Insulation under new cladding also saves up to 20%, but more expensive

Foundation:
• Savings up to 20% for interior or exterior insulation. Can be cost-effective, but requires expert advice.

Windows:
• Upgrading is usually necessary to reach Net Zero

Solar Energy:
• Big capital cost, but high returns
• Net metering to offset your entire annual electricity usage
• Site assessment is necessary
De-mystifying "Green" Certifications
Rating systems comparison

Figure 4-1: Overview of Canadian Green Housing Programs
Certifications

Natural Resources Canada (NRCan)

ENERGY STAR

Currently in transition in Ontario, but within the next year the following will apply:

• Software: New ERS (GJ rating)
• Energy: 20% better than code
• Performance or Prescriptive streams
• Construction: minimums based on effective, not nominal R
• Air leakage: ACH50 at most 2.5 / 3.0 for detached / attached
• Equipment: “shall comply with Canada’s Energy Efficiency Regulations.”
• 8,680 in Ontario last year
Certifications

Natural Resources Canada (NRCan)

R-2000

- Last updated 2012, continues to use the old 0-100 system software
- Energy: 50% better than code
- Performance only – each house modeled, inspected and tested
- Construction: minimums based on code, also environmental requirements
- Air leakage: ACH50 at most 1.5
- Equipment: minimums for HVAC, HRV must be balanced
- Extensive builder and advisor training necessary
- Only 3 in Ontario 2018; 7 in 2017
**Certifications**

**PASSIVEHOUSE CANADA**

Passive House and EnerPHit – PHI

- Very low energy, not necessarily with solar generation
- Primarily for new builds, but can also be retrofits

**PASSIVE HOUSE INSTITUTE US (PHIUS)**

- Similar but different passive house standards
- In some ways more suited to Ottawa climate zone
- Pre-certified or certified projects in 37 states and provinces
Certifications

Canadian Green Building Council (CaGBC)
- Zero Carbon Building Standard: Performance stream also applies to retrofits - $1500 base fee

Requirements of the Standard

<table>
<thead>
<tr>
<th>Requirement</th>
<th>ZCB- Performance (existing buildings)</th>
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<tbody>
<tr>
<td>Demonstrate Zero Carbon Balance</td>
<td>✓</td>
</tr>
<tr>
<td>Provide Zero Carbon Transition Plan*</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>Install Minimum 5% Onsite Renewable Energy</td>
<td>No requirement</td>
</tr>
<tr>
<td>Achieve Thermal Energy Demand Intensity Target</td>
<td>No requirement</td>
</tr>
<tr>
<td>Report Energy Use intensity</td>
<td>✓</td>
</tr>
<tr>
<td>Report Peak Demand</td>
<td>✓</td>
</tr>
<tr>
<td>Report Embodied Carbon</td>
<td>✓</td>
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</tbody>
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* where fuels other than zero emissions biofuels are used onsite
The Benefits of Net-Zero
Better homes

- **Comfort:** More constant, less drafty
- **Costs:** Operating and maintenance
- **Resilience:** Less affected by weather
- **Health:** Air quality
Better business

- Business reputation
- Buyer and Employee retention
- Operational knowledge and planning
Better city

- Climate Action
- Public Health
- Resilience
- Green Economy
- $ stay in town
What Part 2 will cover:

- Net Zero Details
- Incentives and Deeper Retrofits
- Worked-out Examples
Thank You!

Visit us at envirocentre.ca