Adolphustown Schoolhouse Deep Energy Retrofit

Sue & Gord Scale
Greater Napanee, Ontario, Canada

A Thousand Home Challenge Case Study
25 November 2010
Pre-Retrofit - Building Summary

- Total renovation of a 1963 two-classroom elementary school that had been previously converted to a home
- Seriously substandard air quality & thermal envelope – a third of the building un-insulated
- Previously heated by a large wood stove & a condensing, 100,000 Btu/hr. forced air propane furnace – a third of the building unheated
- Wonderful high mass bones & wide span steel ceilings, but in dire need of total renovation
In Need of TLC

But:
- Great Location
- Fairly Good Solar Exposure
- Unbelievable Mass!
  - Walls: 143 tons
  - Ceiling: 7 tons
  - Floor: 15 tons
The Bad & The Ugly

Gutting, cleaning, & structural repair can be depressing, but things do improve!
Post-Retrofit Dwelling Summary

- Renovated to a rural farm “outbuilding” style

- Schoolhouse building now includes:
  - A one-story, 1,525 ft$^2$ detached single-family dwelling
  - A 965 ft$^2$ home occupation (hand-weaving studio)
  - 325 ft$^2$ of combined storage & utility space

- A new 316 ft$^2$ mudroom / solarium designed to resemble a “maple sugar shack,” for a total of 3,131 ft$^2$

- A new 860 ft$^2$ “carriage house” style garage & loft

- Household Size:
  - One couple & numerous hobbies

All Areas Exterior Measure
Schoolhouse Retrofit

Design Strategy:
A Quality, Comfortable Dwelling Where
Energy Efficiency, Heating Fuel Redundancy, & Fire Prevention Are Priorities

Sue & Gord Scale, Adolphustown, Ontario
Email: schoolhouseATliveDOTca
(Replace “AT” with “@” & “DOT” with “.”)
Meeting the Thousand Home Challenge

Determining the THC Threshold Allowance

- Had this home been located in Syracuse, NY it’s OPTION B threshold allowance would be 11,801 kWh/yr. The OPTION B allowance for Watertown, NY is 12,712 kWh/yr.

- It is proposed that this Canadian home’s THC OPTIONB Threshold allowance be the average of the two above sites, 12,257 kWh/yr.

NOTE: THC OPTION A, (75% reduction from previous use) cannot be used because the home’s pre-energy use cannot be documented.
Meeting the Thousand Home Challenge

Selecting a Weather Station

This home is located near Kingston, Ontario, Canada. The THC Threshold Calculator uses TMY3 climate data. TMY3 data does not appear to be available for Canadian locations. As a result, Syracuse and Watertown, NY have been chosen since their weather data is closest to that of our site. In fact, both the heating and cooling degree days are nearly midway between the two cities.

NOTE: One input to determine a project’s OPTION B threshold allowance is weather. The Thousand Home Challenge uses a home’s zip code to select the nearest weather station. There is an option to override that selection if the closed weather station does not represent the site. At this point the THC does not have data from Canadian weather stations, so Canadian applicants must choose a US weather station that best represents their site. [www.thousandhomechallenge.org]
Site Household Energy Use
(1 May 2009 to 30 Apr 2010)

Space Heating: (7,371 HDD typical @ 65°F)
- Wood (masonry heater): 2,620.7 lbs    5,300 kWh
- LPG fireplace: 5.3 gallons (U.S.) 142 kWh
- Electric baseboards: 36 kWh
  Total Purchased Space Heating: 5,478 kWh

Cooling: (420 CDD typical @ 65°F)
0 kWh

Everything Else:
- LPG kitchen range: 6.7 gallons (U.S.) 180 kWh
- Electric (including ventilation, well, & electric DHW): 4,864 kWh
  Total Everything Else: 5,044 kWh

Total Site Energy Use: Picton, ON (HDD 7,371, CDD 420) 10,522 kWh/yr.

THC Option B Threshold

Syracuse, NY: (HDD 6,803, CDD 551) 11,801 kWh/yr.
Watertown, NY: (HDD 7,681, CDD 301) 12,712 kWh/yr.
Avg. of Syracuse & Watertown: (HDD 7,242, CDD 426) 12,257 kWh/yr.
Site Household Energy Use
by Type of Use
(1 May 2009 to 30 Apr 2010)
Site Household Energy Use by Fuel Type
(1 May 2009 to 30 Apr 2010)

- **Syracuse**
  - Option B Threshold

- **Watertown**
  - Option B Threshold

- **Average**
  - Option B Threshold

- **Actual Energy Consumption**

  - **Electricity**
  - **Gas/fossil/wood**
Meeting the Thousand Home Challenge cont’d


For the 12-month period from 1 May 2009 until 30 April 2010, this home’s total site energy consumption was 10,522 kWh.

This home has significantly surpassed the customized THC OPTION B threshold allowance of 12,257 kWh/yr!
Meeting the Thousand Home Challenge cont’d

This household will officially meet the THC when the application is completed and documentation of one year of household consumption verifies that energy use is less than 12,257 kWh (net total site household energy).
**Thousand Home Challenge**

**Threshold Vs. Our Site**

**Household Energy Usage**

**THC Option B**: 12,257 kWh/Yr (Equiv.)

**Actual Usage May ’09-Apr ’10**: 10,522 kWh/Yr (Equiv.)

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Annual Use</th>
<th>MMBtu</th>
<th>kWh</th>
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<tr>
<td>Propane Gas – gal U.S.</td>
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<td><strong>TOTALS</strong></td>
<td><strong>35.85</strong></td>
<td></td>
<td><strong>10,522</strong></td>
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</tbody>
</table>

¹ **Option B Assumptions**: 7,371 DD @ 65F, 1.9 occupants, wood/fossil heat, 3,131 ft² finished floor area

For more information on the Threshold Allowance: [www.ThousandHomeChallenge.org](http://www.ThousandHomeChallenge.org)
Direct Indicators of Current Performance

Annual Site Energy Consumption:
- 35.9 MBtu or 10,522 kWh per household/yr.
- 18.9 MBtu or 5,538 kWh per person/yr.
- 11.5 kBtu or 3.36 kWh per FFA (finished floor area)/yr.

Annual Site Space Heating & Cooling:
- Total Energy: 18.63 MBtu or 5,478 kWh
- (Net Effective Energy: 13.51 MBtu or 3,974 kWh)
- Cost: ~ CAN $223 or ~ US $200/yr!
Indirect Indicators of Current Performance

**Total Site Energy:**
- 1.35 kWh per HCDD
- (heating & cooling degree day) per household
- 3.36 kWh/ft$^2$ finished floor area

**Space Conditioning:**
- 0.70 kWh per HCDD
- (heating & cooling degree day) per household
- 1.75 kWh/ft$^2$ finished floor area
Significantly improving the thermal envelope has tremendous energy saving potential! That means very little energy is required for heating & cooling.
Predicted Winter Space Heating
– Source: Owner’s Simulation Model
(all values Net Effective Site Heat Energy)

Nonpurchased Heating:

- Passive Solar Windows: 29.62 MBtu
- Internal & HRV Gains: 19.32 MBtu

Total Net Solar/Gains: 48.93 MBtu

Purchased Fuels:

- Wood (masonry htr.): 10.98 MBtu
- LPG (fireplace): 0.46 MBtu
- Electric (baseboard): 0.12 MBtu

Total Net Purchased: 11.56 MBtu
(Actual Net Purchased: 13.51 MBtu
Winter 2009-2010)

Total Net Heat Load: 60.49 MBtu

Solar, internal gains & the HRV provide 81% of the space heating. Purchased heating & cooling is peanuts!
Project’s Biggest Opportunities / Challenge

- Ability of using existing mass to virtually eliminate possibility of damage arising from heating emergencies
- Ability to provide an attractive level of foam insulation to the entire exterior to drastically reduce thermal loss, thermal bridging, & essentially eliminate infiltration
- Ability to adapt original window openings to provide nearly one-half of the heating need via passive solar glazing
- Ability to provide multiple means to cost effectively heat the dwelling in the face of uncertain energy supplies

CHALLENGE:

- The lack of appreciation by contractors & workmen for the importance of details required of a deep energy retrofit
Aspects & Issues

- The original school structure offered truly unique opportunities as a dwelling – including an acceptable solar orientation, large open playground for solar capture, mature trees shading the roof in summer while minimally affecting wintertime sun, prime park & waterfront views, & direct highway access conducive to a home occupation.

- The original concrete block, brick, & slab structure was not conducive to major change. This required an “outside the box” planning & design thought process – but this proved to be a blessing!
The most rewarding aspect involved the planning, design, & integration of multiple heating systems to seamlessly cooperate – providing ultra-low operating costs, very low maintenance costs, resilience, low effort, stable temperatures with no stratification, good air quality & even better – elimination of summer cooling provisions!

In hindsight, preliminary provision for solar thermal hot water & possibly PV should have been made at the outset. It’s always more difficult later!
Walls are a variant of the Larsen truss: 2 x 4 SPF studs were mounted on 2” x 3” cedar blocking to the exterior of the masonry walls. 2” x 2½” horizontal cedar was strapped over the studs. The 7½” cavity was filled with medium density urethane foam insulation. Rainscreen is poly-mesh & Tyvec™. Exterior cladding is a stained cedar, “board ‘n batten” style. The wall assembly has an effective R of 40.
Exterior sliding door & all windows are Thermotech’s pyrolytic Low-E triple pane in fiberglass frames (typically LOF EA2 #3#5 argon, R: 5.9, SHGC: 0.59 to 0.61). All operable windows are awning style.

The original windows were given to a neighbouring farmer for constructing chicken coops.
Main (Schoolhouse) Enclosure Summary

- The original flat, asphalt/gravel roof was removed & replaced with 8”-10” of medium density urethane (R-50 to R-61). Panel steel covers a ridge style, wood-frame truss roof.

- The original slab on grade floor was tarped with poly & insulated with R-7.5 Type IV XPS foam.
Finished flooring in sunny areas is 20” x 20” x 1½” concrete patio paver stone – nicely warming to 80°F on sunny mid-winter afternoons.

Bathrooms are slate tile over two staggered ½” concrete panels directly over the foam (no sleepers to avoid thermal bridging). Oak hardwood flooring was nailed to two staggered ½” T&G fir ply panels directly over the foam.
Main (Schoolhouse) Enclosure Summary

- **What Worked Well?**
  We are very pleased with our flooring choices, particularly the concrete paver stone flooring.

- **What Would You Do Differently?**
  Had we not been in a rural, heritage area, to reduce maintenance, the exterior siding would probably have been a concrete composite.
New Addition: Mudroom / Solarium Enclosure Summary

Walls are concrete filled ICF. The exterior was then strapped with 2” x 2½” cedar and the void was filled with medium density urethane (effective R-26.3).

All windows & doors are Thermotech double pane, pyrolytic Low-E argon in fiberglass frames. Two sets of double doors create an entry air lock.
New Addition: Mudroom / Solarium Enclosure Summary

The rainscreen & exterior cladding are identical to the main (original) building.

Cathedral style roof was insulated with urethane. Roofing is panel steel, strapping, Ice & Water Shield™, & ply sheathing.
What Worked Well?

Slab on grade floor poured over XPS foam insulation: concrete was stained with “Hi Yield”™ Copperas, commonly called agricultural cuprous sulphate (actually iron sulfate). It causes a deep chemical reaction with fresh concrete, thus is unlikely to fade, yet costs only $15 for 50 lbs which easily stains 2,000 ft\(^2\) to 3,000 ft\(^2\) of flooring. Floor was then finished with Varathane™. It looks like fine leather!

Steel racks were installed along the north wall to store kindling & one full cord of firewood (7 tenths of one cord were required last winter). This proved convenient to load & unload, while insects are kept separate from the dwelling & easily controlled.
New Addition: Mudroom / Solarium Enclosure Summary

cont’d

What Would You Do Differently?

Double French doors & sliding patio doors are heavy!

Conventional methods of support tend to be inadequate with exterior insulation retrofits, particularly if one is trying to avoid thermal bridging.

Detailed pre-planning is required to avoid damage to fiberglass thresholds!
Cool Stuff!
The Mudroom / Solarium Is a Great Multi-Purpose Space!

At first glance, it is a casual sitting area, quite comfortable year-round except mid-winter evenings – yet it is never heated!

Practical aspects include coat closet, plus kindling & firewood storage for more than one year. It’s sun bathed year-round for large house plants, & is an easily cleaned, air lock entry.
Cool Stuff!
The Mudroom / Solarium Is a Great Multi-Purpose Space! Cont’d

The design is a “maple sugar shack” (this is maple sugar country) – complete with doghouse roof! The upper clerestory windows can be opened to create a thermal chimney to cool the main house during summer evenings. In winter, these windows super-heat the air that has risen to the ceiling. A thermostatically controlled blower harvests the warmth & conveys it to the main dwelling!
Hot Stuff! The Masonry Heater

Heated Casual Seating, Bake Oven, & Centerpiece Art Form!

- High efficiency, low emissions, lifespan of centuries!
- Long duration heating (24-36 hours per firing).
- Low intensity radiant heat (~16 kBtu/hr. peak tapering to 6 kBtu/hr. @ 24 hrs).
- Extremely safe, as loading is done cold.
- In mid-winter, two 3-hour fires (50-60 lbs. each) are required every five days! Thus, 95% of the time there is no active fire to worry about.
- The bake oven is generous – holds 4 to 5 loaves, & baking can proceed in a sequence of 2 to 3 loads per firing! Bake oven is a “white oven”, thus pasta, casseroles, pastries, breads, & most anything is possible!
- Core was constructed on-site by Norbert Senf of Masonry Stove Builders Inc., Shawville, Quebec.
- Cut sandstone facing was provided by Jay Beckwith Masonry, Lansdowne, Ontario.
Hot Stuff! The Masonry Heater cont’d

Top Left: Norbert Senf of Masonry Stove Builders constructing the core.

Center Left: Jay Beckwith completing the sandstone facing.

Bottom Left: Steel rack for one bush cord of wood (Note: wood left over from 1st winter's heating. Even more wood left after 2nd winter!)

Safe, efficient, easy to maintain, & a work of art!
Shoving one's arm into the chimney flue of a wood stove with a roaring fire is not recommended. However, this photo provides a good idea of the extent to which the masonry absorbs the heat for radiation to the dwelling hours later. This unit is so efficient that firebrick baffles in the flue channels needed minor adjustment to prevent excessive condensation within the chimney.
More Hot Stuff!

This Open Hearth Kitchen Sports a 21st Century Computer Controlled Propane Fireplace

- Regency P40™ with thermostatic remote control..
- Variable heat output from 9-33 kBtu/hr.
- Powered blower directly heats living & dining rooms
- Powered blower & ducting convey heat to nearby bathrooms & utility room.
- Provides 9-10 kBtu/hr. even without electricity!
- In mid-winter, the LPG driver had been filling the 110 gal U.S. propane tank every other week to supply the furnace. At current usage, it may need to be filled only once every few years to supply both the fireplace & kitchen range!
Hot water warming on the crane, footed pot of goodies on the trammel, toaster on the hearth – we’re ready to start the 19th century!

The mantel is cherry from a deadfall, rescued from our woodlot.

The antique bricks were salvaged from our previous carriage house.

The direct coaxial vent can be seen rising above the LPG fireplace. It exits the north wall behind the brick masonry.

The flex ducting rising to the ceiling directs warm air to the bathrooms & utility room.

Even though fireplace has a “zero-clearance” rating, it is housed within a 1-hour concrete shroud.
The garage and loft are currently not insulated. If, in the future they are finished, the steel paneling on the south wall has been installed so that it can be converted to an 8 ft. by 32 ft. solar air heater.
Air Leakage (Pre- & Post-)

Pre-Retrofit:
- No need to measure with sensitive instruments – the gale might have lifted you off the throne if you weren’t frozen to the seat!

Post-Retrofit:
- No formal measurements made, but an experiment was made to measure exfiltration of toxic CO gas as an indicator of infiltration. The methodology is relatively simple, but involves potential health risks & about an 8-hour test time. Extreme caution must be exercised!

- Due to odors, this test is not practical after furniture & possessions have been moved in!

- The test suggested a very low infiltration rate of about 0.014 ACH (Modeling assumed a more realistic 0.03 ACH).

Procedure Involves Various Health Risks & Is NOT Recommended!
Winter Comfort: Heating System

Building Design/Use Considerations

- Room allocation follows the sun: bedrooms in the east, a central kitchen & den, then in the afternoon, the studio & solarium have more daylighting.
- Intensively used rooms are along the sunny south wall, north walls reserved for storage & infrequent usage.
- Interior temperature typically 70°F (66 to 72°F range)

Heating Fuels

- Redundancy! Passive solar, wood, LPG, & electricity.
- All time record cold event (160% of Design Day) can be met even without electricity!

Type of System

- Purposely simple – Gizmos & gadgets eliminated!
Winter Comfort: Passive Solar & Solar Heater

Solar heater in mudroom/solarium
Interior of mudroom/solarium
17-inch window casings throughout

Solar gain windows mounted flush with trim to reduce shading.
Winter Comfort:
Active Solar Heater & HRV

In the mudroom/solarium, the air is warmed by both the two south facing patio doors and the west facing double French door, and then rises to the ceiling. Three clerestory windows in the doghouse further heat this air, and a thermostatically controlled blower conveys this heat to the main dwelling. The 6-port HRV enables harvesting surplus warm air from above the masonry heater, conveying it to the living & dining rooms.
Winter Comfort: Heating System

Creative Comfort

Chilled from the outdoors? Grab a book & a grog & settle down on the heated bench of the masonry heater!

What Would You Do Differently?

We had intended to have more glazing in the mudroom / solarium to enable the harvesting of more heat. ICF columns & lintels tend to restrict the size of glazing areas more than conventional stick framing. The cost, timing, & design disadvantages of ICF seem inappropriate.

What Worked Well?

Hey, we have about 35 wineries within a 40-minute drive (three within 5 minutes) – can’t beat the book, grog, & settling down on the masonry heater!
Summer Comfort

- Design eliminated the need for air conditioning!
- Two mature maple trees shade the roof in summer significantly reducing solar gain.
- Awning windows facilitate natural ventilation even in stormy weather.
- With this much mass, the summer is over just as the interior is about to become somewhat uncomfortably warm (mid-80° – 90° F throughout July and early August, yet 72° - 74° F inside).

Creative Comfort: Consider a small, high awning window directly over the headboard of your bed – the cool late evening breeze is awesome!
Hot Water

- Energy used for water heating is our primary concern!
- Our well water is hard, brackish, corrosive, & subject to lime scaling.
- This severely limits the life of metallic appliances & plumbing fixtures.
- There is no good alternative to an inexpensive electric hot water tank, but the electricity is very expensive!
- A solar thermal water heater is now nearing completion, but it has been difficult due to building constraints & water quality issues.

**Creative Solutions:** In response to peak metering rates, we have a timer on the water heater that additionally reduces the voltage from 230V to 115V (1/4 power!)
Good Air Quality

Key Pre-existing Problems
Original ducts were contaminated with dirt, animal allergens, & mold – solution was complete elimination of the old heating & ventilation system (recycled to adjacent farm for a corn dryer).

Building was sanitized prior to renovation.

A Nu-Air “Optima 176” HRV (Windsor, Nova Scotia) was installed to address air quality issues. Unit boasts a quality aluminum shroud & heat exchanger, ECM motors, programmable operation, & 6 ports for the recirculation of excess heat typical of wood fuel appliances.
The HRV is extensively ducted to kitchen, bedrooms, bathrooms, studio, & living room. Most ducts are 6” in diameter.

In hindsight, a larger duct size would have improved flow rates.

Air volume on “low speed” is significantly lower, but energy consumption seems only marginally lower – the energy miser’s conundrum!
The filtering on the HRV was considered inadequate to our sometimes dusty rural environment. A large wooden shroud with washable, multi-layer filtering was constructed & installed outside at the fresh air intake.

The filter is now 11 times larger and close to HEPA quality standards.
To reduce thermal loss through the floor slab, major efforts were made to reduce ground moisture & insulate the frost wall. Four separate drainage systems:
1. New foundation drains
2. New eave downspout drains
3. Peripheral interceptor drains - all to daylight, plus
4. Surface swales & grading
System Optimization
High Quality Thermal Envelope

Concrete filled ICF mudroom/solarium
Variant of Larsen truss ready for foaming
Frost wall & window bucks taking shape
Medium density urethane completed
System Optimization
Interior Insulation Treatments

Above: Foamed in-place cathedral ceiling

Left: All slab floors insulated with 1½” XPS foam
To reduce thermal losses, all non-south windows were made as small as possible. However, extensive efforts were made to improve interior daylighting:

- **Top Right:** Sliding barn door between the bedrooms & venetian blinds in bedroom doors)
- **Top Left:** Installed interior window between the two bathrooms to bring in outside daylight
- **Bottom Left:** Reduced the size of all north windows
- **Not Shown:** Widened interior arches & doorways
Electrical Use

Installed or Major Appliances

- **Space Conditioning:**
  Small 160 W blower for solarium solar heater;
  Two small 160 W blowers in LP fireplace.

- **Mechanical Ventilation:**
  ECM motors within HRV (180 W total). Two high efficiency “Casablanca Concentra” ceiling fans.

- **Major Appliances:**
  Domestic hot water tank, dryer (rarely used),
  recent fridge, old freezer, front-load washer, well pump, 5 HP compressor for e-Looms;
  No dishwasher or air conditioner!
Electrical Considerations

- Rural electrical rates were among the highest in North America, & were recently jacked & converted to time of day/peak pricing!

- Lighting is almost all T8 or CFL (remainder is being converted to LED)
Timeline & Major Steps

- **Preliminary Analysis:** Aug ’05 - May ’06
- **Acquisition:** Nov ’05
- **Gutting, Structural Repairs, & Sanitizing:** May ’06 - Aug ’07
- **Detail Design & Analysis:** Jun ’06 - Sep ’07
- **Consultants – Design & Engineering:** Jan - Jul ’07
- **Reconstruction Contract:** Sep ’07 - Nov ’08
- **Initial Occupancy:** Nov ’08
- **Detailing & Fixes:** May ’09 - Jul ’10
- **Landscaping, Entry Steps, & Patios:** 2011?
Tracking Energy Use

- We commenced logging of our energy use in Oct. 2008.
- At the end of each month, the Watt-hour meter, gauge on the LPG tank, & pyranometer are manually logged.
- All firewood is weighed.
- Any electricity used for heating is measured with a Kill A Watt Meter™ (tends to be cozy spot heating in fall).
- LPG fireplace usage is timed & factored by the listed burn rate to estimate LPG use.
- LPG estimates are periodically reconciled to purchases.
Non-Energy Benefits

Peace of Mind:
Little need to worry about heating emergencies arising from equipment failure or availability of fuel supply.

This is Low Tech:
Easy to understand, easy to use, & minimal maintenance.
This renovation did not meet its budget. Numerous activities needed to be redone, some were redone yet again!

However:
The high quality envelope insulation & glazing treatment, & redundant heating system only cost about $75,000 more than what is typical of conventional housing.

New dwellings of similar size & style in this area can have a space heating cost upwards of (CAN) $4,000 per winter – perhaps more if heated just by electricity. This dwelling with home occupation costs just over (CAN) $200. The cost savings imply a simple payback period of about twenty years.
Lessons Learned

We were very fortunate to have assembled a design & consulting team truly skilled & sympathetic to reducing energy needs, however:

- Most tradesmen & unskilled workers seem sadly lacking in common college & secondary school skills;
- Vast numbers of building products seem to have been engineered to maximize the profits of substandard materials – yet through increased levels of promotion, there are high levels of product acceptance.

These two issues seem inextricably entwined at this time. The future of both green building & deep energy reduction in residential construction may well slide into a green-washing abyss unless standards of material quality & training are improved.
Lessons Learned cont’d

- There were no practical government incentives available at the time of this renovation, all costs were borne by the owners.
- This provided the incentive to carefully examine both our needs & the benefits/costs of various alternative design assemblies.
- The first task was a study of trends in purchasing power, income & investment, fuel/energy costs, & taxation to identify an upper limit to up-front cost vs. operational savings.
- A simple spreadsheet model was developed to test numerous design aspects – many highly promoted building systems, equipment, & materials simply didn’t make the grade!
- As the design slowly came together & better data was located, the model was revised (hundreds of times) – so that we could be confident that the building performance would closely meet our expectations.
Various Pics
Kitchen

Custom Cherry Cabinetry: thanks to Latif Crowder, Lethbridge, Alberta
Various Pics Cont’d
Den & Main Bath
Most Helpful Information Resources

We are indebted to the:

- Inspiration of Norman Saunders, William Shurcliff, & Amory Lovins; & to the

- Expertise, patience, & consideration provided by:
  
  Stephen Thwaites, P.Eng., Chief Engineer / Thermotech Fiberglass, Ottawa, (world-class window science)
  http://www.thermotechfiberglass.com/index.htm
  
  &

  Norbert Senf / Masonry Stove Builders, Shawville, Que., (preeminent Canadian fireplace consultant)
  http://www.heatkit.com/
We also wish to thank the numerous contributors to the “Greenbuilding” web list over the past few years:

http://lists.bioenergylists.org/mailman/listinfo/greenbuilding_lists.bioenergylists.org

We are especially thankful to the following superbly talented people for sharing their experience & wisdom:

Bibliography
Solar Publications
For Additional Information

This project is described in even more detail on Gary Reysa’s wonderful website:


Don’t forget to browse his entire site!

It is a treasure chest of practical energy saving ideas:

http://www.builditsolar.com
Bottom Line

- We started with an older, single floor converted dwelling that was seriously substandard (particularly the thermal envelope, heating system & air quality).
- Subsequent to the renovation, we feel that the comfort & performance are now simply outstanding.
- There are millions of older bungalows & ranch homes throughout Canada & the United States suffering from high heating & cooling energy bills.
- There are millions of older, under-utilized, and/or converted masonry buildings whose exterior facade is of low architectural significance.
- We’ve burned through our resources & just can’t replace our deficient housing stock.

Join the Challenge: a deep energy retrofit is simply pure joy!
For more information: www.1000HomeChallenge.org
A deep energy retrofit involves numerous decisions, effort, & sometimes frustration. However, when the renovation is completed, the truly difficult decisions aren’t all that bad!

A toast to your health, happiness, & the joy of your own Deep Energy Retrofit!  Sue & Gord
### Annex A

**THC Threshold Calc. V1.3 Mod 4**

**ACI – Thousand Home Challenge: Option B**

**Performance Threshold For Syracuse, New York**

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#### User Interface - Performance Threshold Calculator for Thousand Home Challenge

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<thead>
<tr>
<th>Home Description, Basic Inputs</th>
<th>Weather Station Info</th>
<th>Energy Unit Conversion Chart</th>
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<td>Number of occupants</td>
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<td>Number of households in building</td>
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<td>Attached home, % common</td>
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#### Option A: 75% Reduction (requires one year pre-retrofit energy bills)

| Current gas/fossilwood use (MMBtu/year) | 0 |
| Current electricity use (kWh/year)     | 0 |
| **Current total energy use kWh/year**  | 0 |

| Threshold gas/fossilwood use (MMBtu/yr) | 0 |
| Threshold electricity use (kWh/yr)     | 0 |
| **Maximum total energy use (kWh/yr)**  | 0 |

**Energy Unit Conversion Chart**

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<tr>
<th>Energy Source</th>
<th>Enter annual use</th>
<th>MMBtu</th>
<th>kWh</th>
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<tbody>
<tr>
<td>Nat Gas - ccf</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Electricity - kWh</td>
<td>4900.0</td>
<td>16.7</td>
<td>4900.0</td>
</tr>
<tr>
<td>Propane - gal</td>
<td>12.0</td>
<td>1.1</td>
<td>322</td>
</tr>
<tr>
<td>Cord Wood - lbs</td>
<td>2620.7</td>
<td>18.1</td>
<td>5300</td>
</tr>
</tbody>
</table>

**TOTALS**

- Nat Gas: 36.9 MMBtu
- Electricity: 10,522 kWh

---

#### Option B: Calculated Performance Threshold (see Threshold Calculator worksheet)

<table>
<thead>
<tr>
<th>If electric heat</th>
<th>If gas/fossilwood heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas/fossilwood (MMBtu/year)</td>
<td>0</td>
</tr>
<tr>
<td>Electric (kWh/year)</td>
<td>7,618</td>
</tr>
<tr>
<td><strong>Maximum total kWh/year (net)</strong></td>
<td>7,618</td>
</tr>
</tbody>
</table>

**Approximate $/yr at $10/MMBtu and 10¢/kWh**

- $762 |

---

### Annex B

**THC Threshold Calc. V1.3 Mod 4**

**ACI – Thousand Home Challenge: Option B**  
**Performance Threshold For Watertown, New York**

### User Interface - Performance Threshold Calculator for Thousand Home Challenge

<table>
<thead>
<tr>
<th>Home Description, Basic Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home’s 5-digit zip code</td>
</tr>
<tr>
<td>Finished floor area (ft²)</td>
</tr>
<tr>
<td>Number of occupants</td>
</tr>
<tr>
<td>Number of households in building</td>
</tr>
<tr>
<td>Attached home, % common</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weather Station Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station linked to zipcode</td>
</tr>
<tr>
<td>Preferred weather station</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Unit Conversion Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Energy Source</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Nat Gas - ccf</td>
</tr>
<tr>
<td>Electricity - kWh</td>
</tr>
<tr>
<td>Propane - gal</td>
</tr>
<tr>
<td>Cord Wood - lbs</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
</tr>
</tbody>
</table>

### Option A: 75% Reduction (requires one year pre-retrofit energy bills)

| Current gas/fossilwood use (MMBtu/year) | 0 |  
| Current electric use (kWh/year) | 0 |  
| **Current total energy use kWh/year** | **0** |  
| **Threshold gas/fossilwood use (MMBtu/yr)** | **0.0** |  
| **Threshold electric use (kWh/yr)** | **0** |  
| **Maximum total energy use (kWh/yr)** | **0** |  

Gas/fossilwood MMBtu converted to kWh, Excludes solar.

### Option B: Calculated Performance Threshold (see Threshold Calculator worksheet)

<table>
<thead>
<tr>
<th>If electric heat</th>
<th>If gas/fossil/wood heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas/fossilwood (MMBtu/year)</td>
<td>0</td>
</tr>
<tr>
<td>Electric (kWh/year)</td>
<td>7,964</td>
</tr>
<tr>
<td><strong>Maximum total kWh/year (net)</strong></td>
<td><strong>7,964</strong></td>
</tr>
</tbody>
</table>

Gas/fossilwood MMBtu converted to kWh, Excludes solar.  
Approximate $/yr at $10/MMBtu and 10¢/kWh | $796 | $504 |
Notes

Throughout this slide presentation, a number of commercial businesses & products have been identified for clarity of the discussion. Such references are not to be considered as either endorsement or criticism. The author wishes to make it known that there are no ongoing affiliations, commercial or otherwise, with these firms &/or products.

The planning & design process for a total renovation involves a near endless list of decisions. While they are a reflection of our needs, desires, & lifestyle, these decisions have been extensively influenced by the climate of the overall area, the cultural qualities of the neighbourhood, & the opportunities and constraints of the site. It is cautioned that choices we have made are not to be considered as advice or recommendations as they may not be appropriate to other locations, jurisdictions & situations. We cannot accept any claims of liability as may arise from distribution of this slide presentation.