Energy Efficiency
&
Sustainable Housing Design

JOHN B. GODDEN B.E.S

Northern Housing Conference

February 15, 2011

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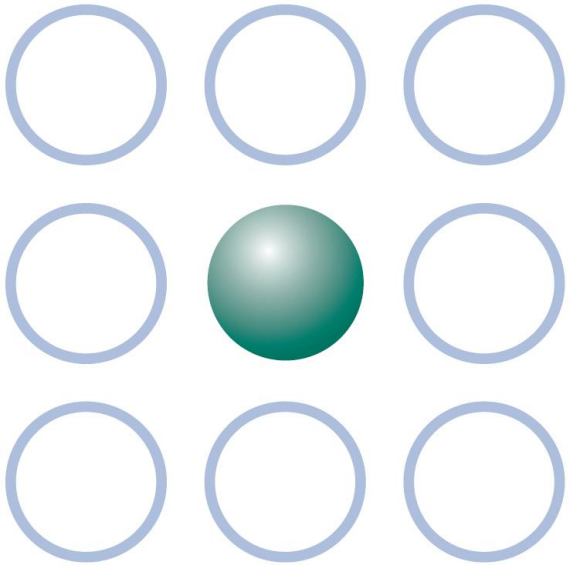
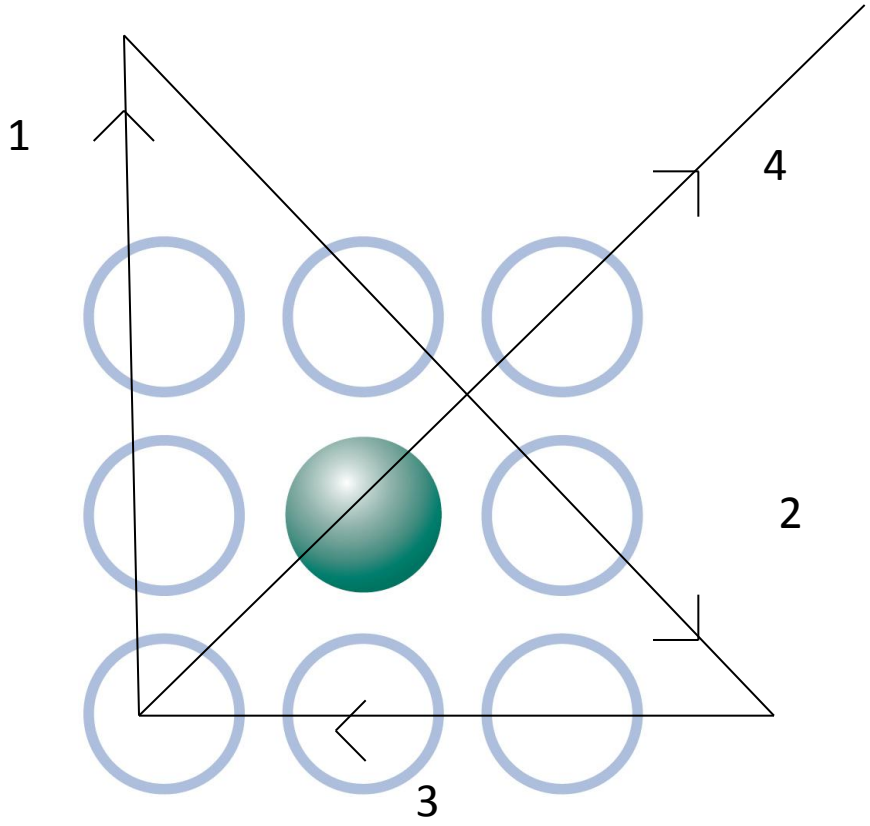
The Problem…



Nine dots are arranged as shown. The problem is to link up these nine dots using only four straight lines which must follow on without rising the pencil from the paper.

The Solution…



The message: Think outside the BOX!

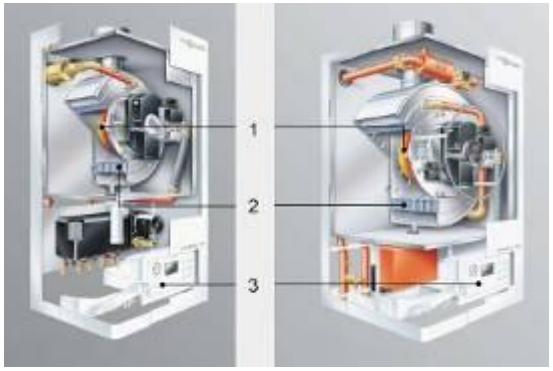
Our Thin Shell

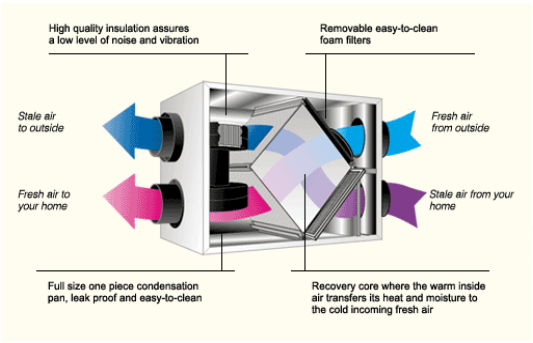
Earth's Troposphere

90% of the atmosphere is 12 km (40,000 feet) thick. The same as the distance from the foot of Yonge Street to Hwy 401.

What a high performance house is…

The Clearsphere Enviro Home





LOVE

- Agapē - divine, unconditional and self-sacrificing affection
- Philios - friendship or generally non-sexual affection
- Eros - affection of a sexual nature, being “in love”

What is “Green” or Sustainability?

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“Sustainability”

Meeting the needs of the present without compromising the ability of future generations to meet their own needs. (United Nations)

“Sustainable Building”

Sustainable homes are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, land and other resources
- Protecting occupant health
- Reducing waste, pollution and environmental degradation

Home Certifications Ontario

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Energy Certifications/Labels

1. Energy Efficiency

EnerGuide for New Home
- A rating number on the EnerGuide Scale

Energy Star for New Homes
- threshold certification 25% better than OBC
- Builder Option Package or performance ERS 80

Green Certifications

1. Energy Efficiency
2. Indoor Air Quality
3. Water Efficiency
4. Mat'ls & Resources

R-2000
- threshold certification
- performance ERS 83

GreenHouse
-threshold certification
- ES BOP or performance ERS 80

LEED for Homes
- four level tier certification
- performance ERS 76 or HERS 80

Built Green Canada
- four level tier certification
- EnerGuide for New Homes

ENERGUIDE

energy ENERGY STAR HIGH EFFICIENCY HAUTE EFFICACITÉ

R-2000

GreenHouse CERTIFIED CONSTRUCTION

LEED CANADA FOR HOMES

BuiltGreen™

Timeline - Energy Star (NRCan)

2000 - New Homes v.1 program launched by Environmental Protection Agency in US

2005 - ESNHv.1 pilot launched in Canada (NRCan)

2007 - ESNHv.2, full program released

2009 - ESNHv.3 released

2010 - ESNHv.4 & US ESNHv.2 released

2011 - ESNHv.5, Energy Star Common specification

2012 - ESNHv.6, EnerGuide 83 projected

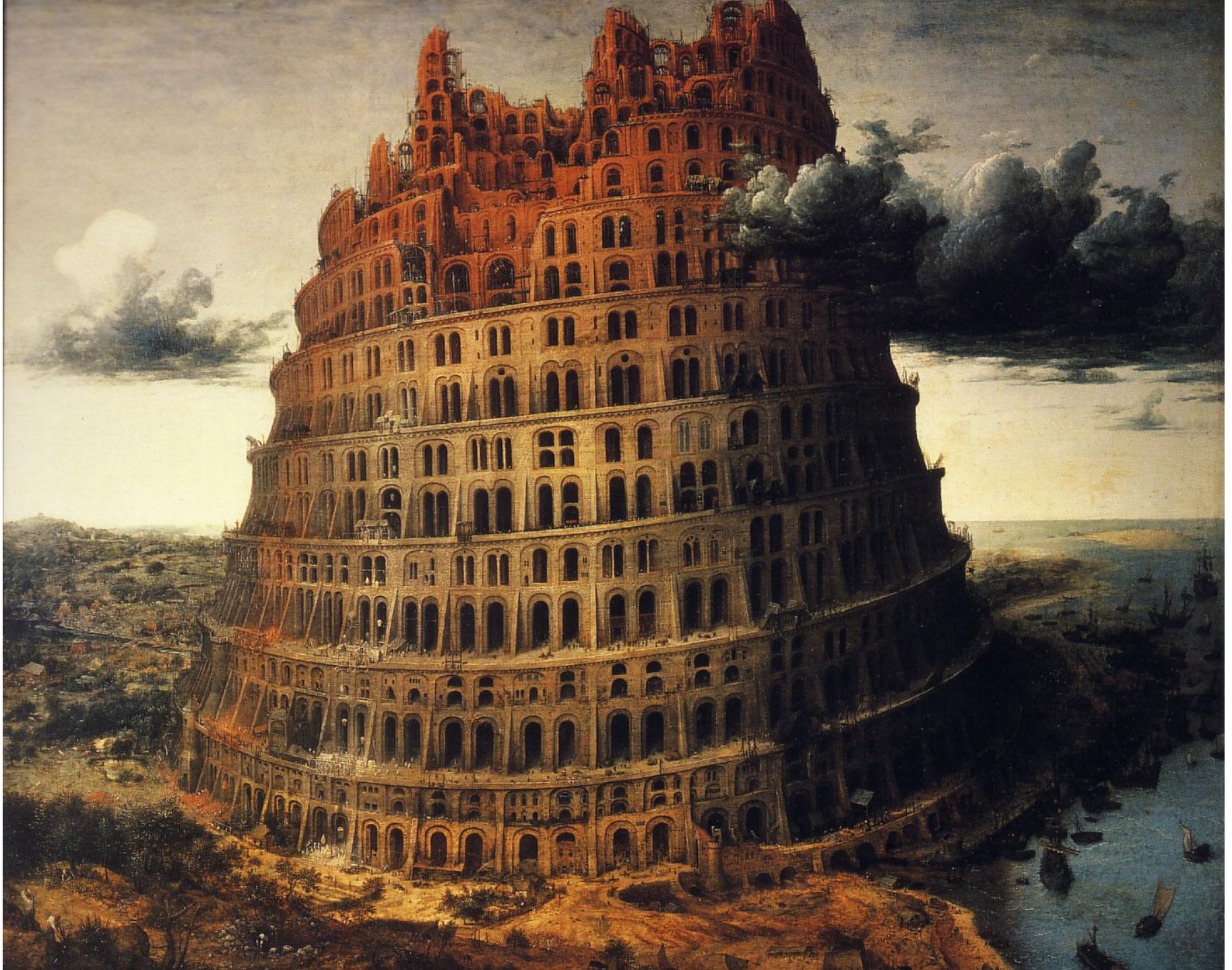
2017 - EnerGuide 86?

Energy Star has become successful production builder program in Canada.

Challenges:

- **Constant Program Changes** - 4 changes in 5 yrs
- **Uncertainty** - NRCan Version 4 or Version 5? 2012 projected to be an ERS 83
- **Municipalities**
- **Label Delivery at Occupancy**

Will current Energy Star builders continue building Energy Star in 2012?



ENERGUIDE formula

$$R2000 = 100 - 20 \left(\frac{\text{CONSUMPTION}}{\text{R2000 TARGET}} \right)$$

(EGNH 80)

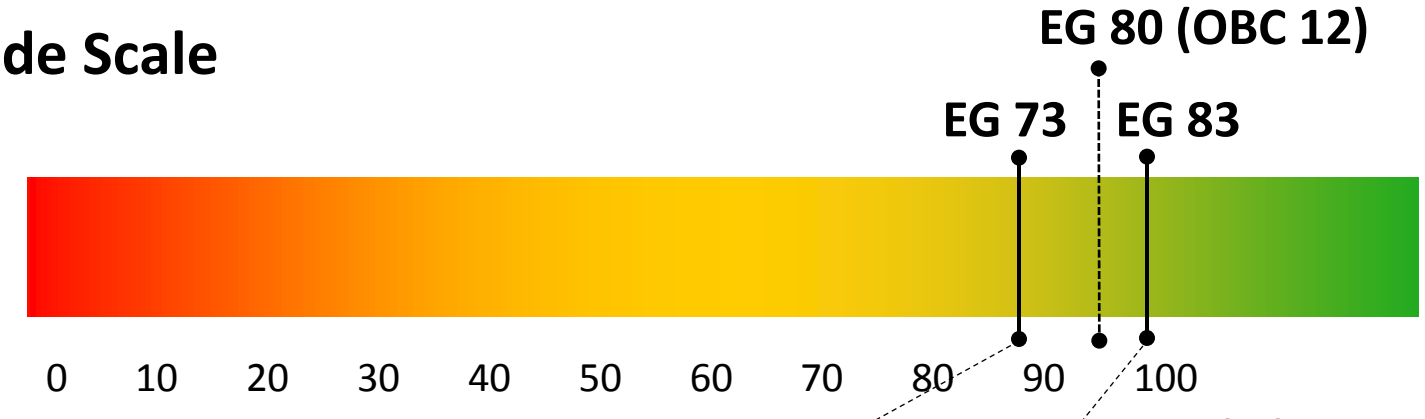
$$= 100 - 20 = \frac{(\text{SPACE HEATING+DHWH+ELECTRICAL “CONSUMPTION”})}{(\text{SPACE HEATING+DHWH+ELECTRICAL “TARGET”})}$$

$$= 100 - 20 = \frac{\text{SPACE HEATING CONSUMPTION}}{\text{SPACE HEATING TARGET}}$$

Two Popular Energy Rating Scales

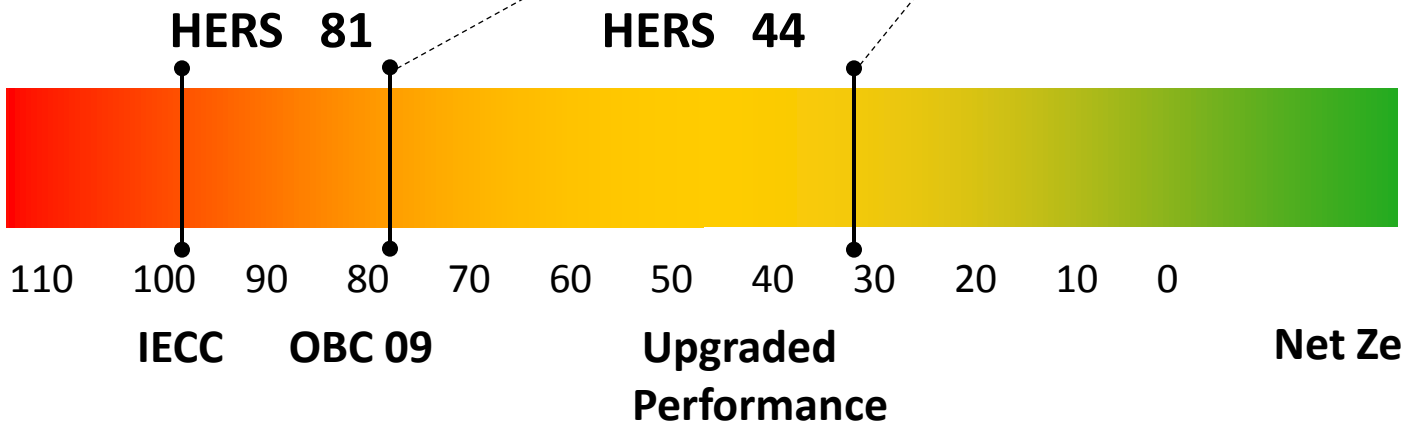
Type: **Single Family Detached** Conditioned Floor Area: **4022 square feet** Bedrooms: **3**
Bsmt: full R16, Slab: R10, Walls: R27, Roof: R50, EnergyStar Appliances, CFL lighting, Solar Air Panel

EnerGuide Scale



*EnerGuide includes space heating & defaulted DHW

Home Energy Rating Scale (HERS)



*HERS includes total energy use: space heating & DHW, renewables, electrical load (lighting, appliances, A/C)

Heat Loss 101

DHL = Conductive Losses + Ventilation

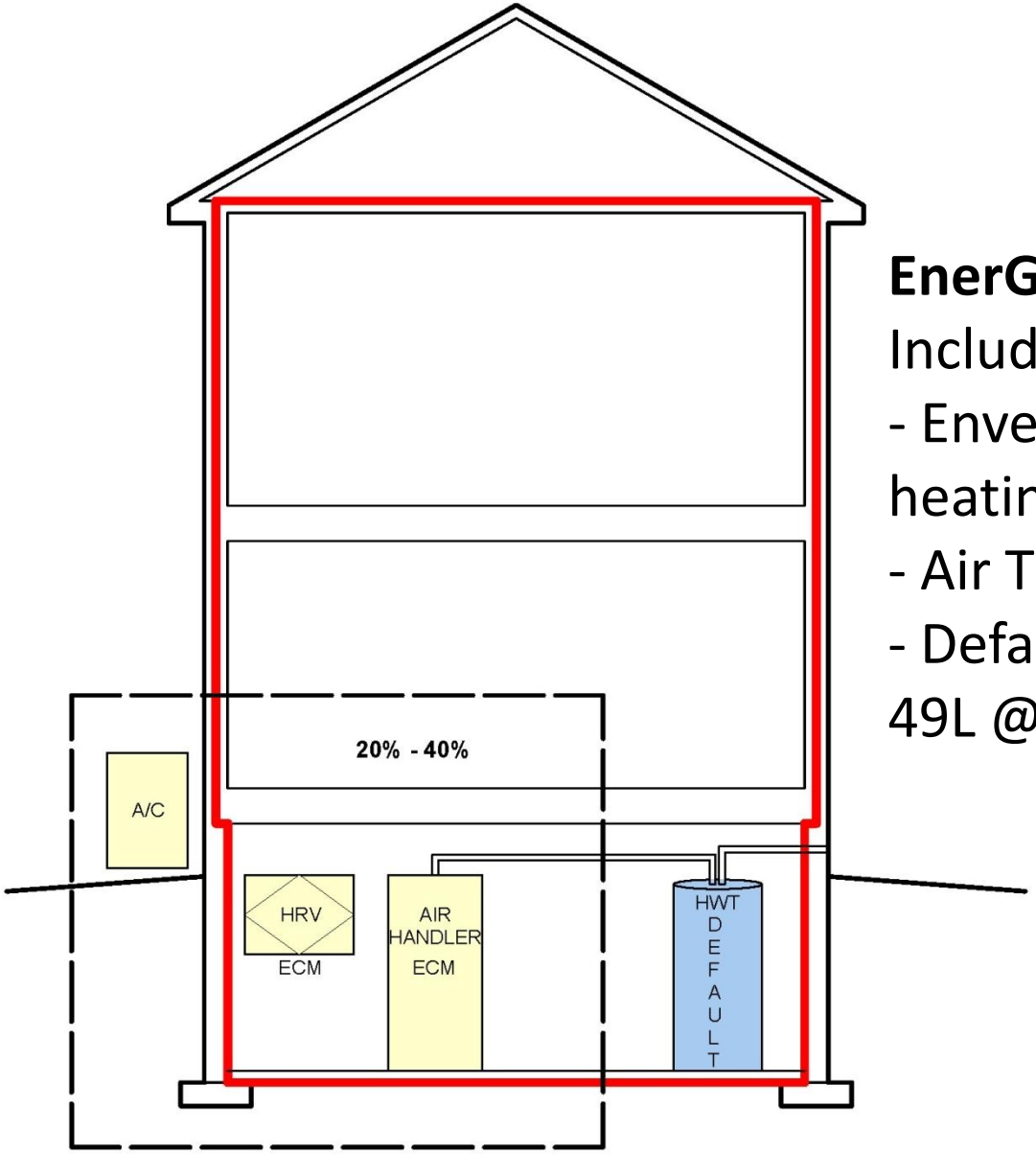
Conduction: $Q = \frac{A}{R} \times \Delta T$

Ventilation Losses = mechanical (HRV)

+

Natural Infiltration (air test)

What does EnerGuide Measure?

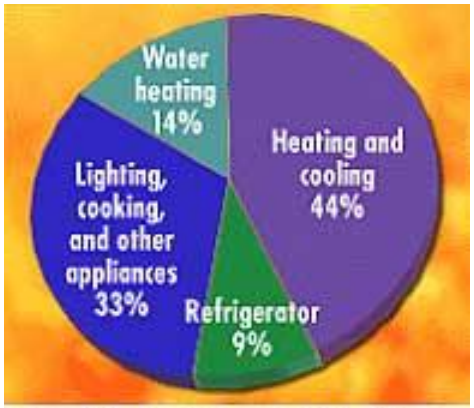


EnerGuide Scale (ERS)

Includes:

- Envelope R-values (space heating)
- Air Tightness and Ventilation
- Defaulted Hot Water , 49L @ 130F

Energy and Lighting



How We Use Energy In Our Homes
(based on national averages)
The largest portion of a utility bill for a typical house is for heating and cooling.

Energy consumption for all lighting in the Canada and the United States is estimated to be about 22% of the total electricity

North American Consumers and businesses spend approximately $40 billion a year to light their homes, offices, streets, and factories. (US DOE)

Advanced lighting technologies can significantly improve the energy efficiency of lighting and reduce energy consumption and costs.

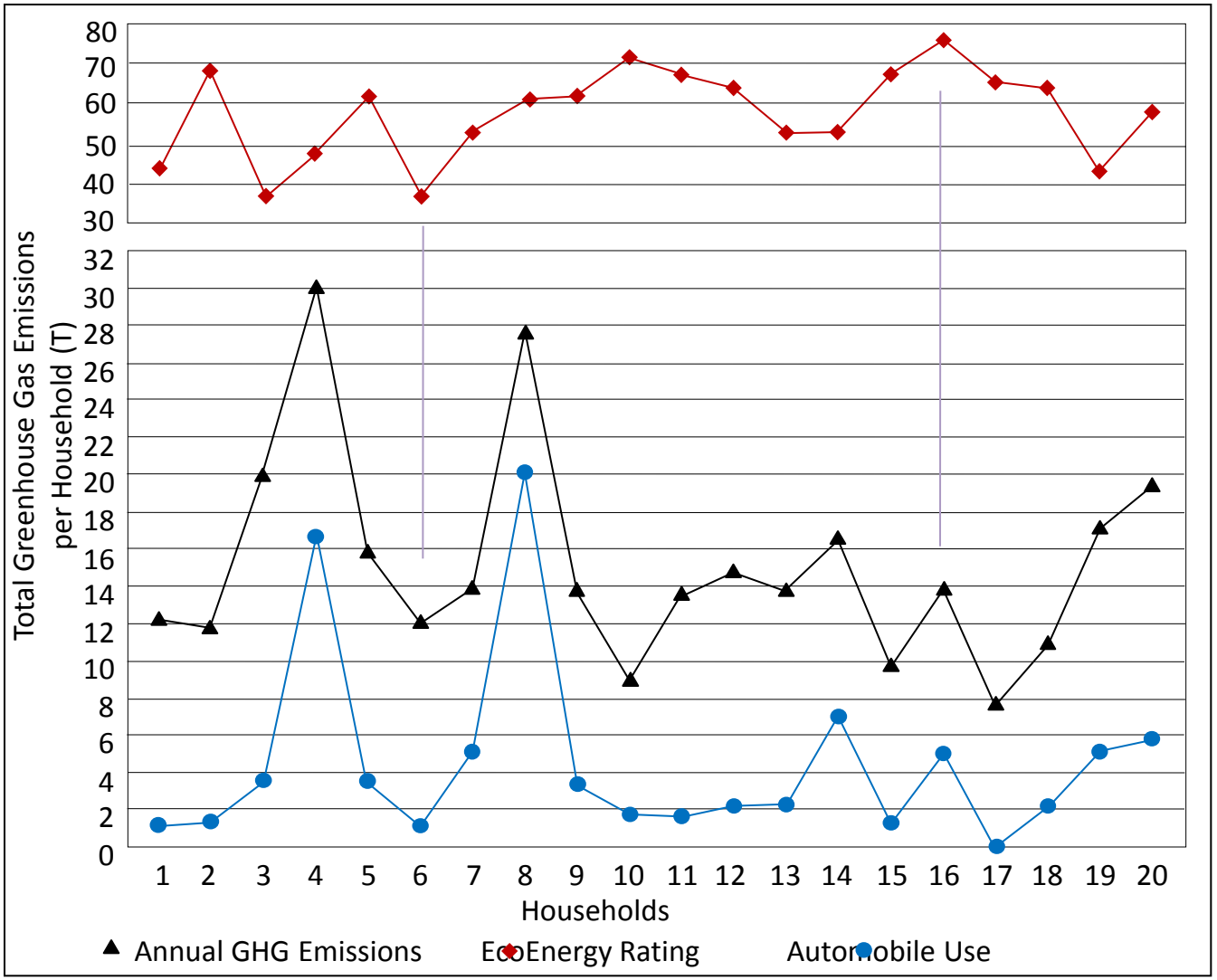
Canada's Ecological Footprint

The Globes Average Ecological Footprints (hectares)	
United States	9.6
Canada	7.6
Australia	6.6
U.K	5.6
Europe (EU-25)	4.8
Middle East and Central Asia	2.2
Latin America	2.0
China	1.6
Asia Pacific	1.3
Africa	1.1
GLOBAL AVERAGE	**2.2**

[David Suzuki and David R. Boyd. David Suzuki's Green Guide , 2008, p.4]

Greenhouse Gas Emissions

Our annual Greenhouse Gas Emissions closely correlates to EcoEnergy Ratings and automobile use in 20 existing Ottawa homes. Part of a CMHC study.



House EcoEnergy Rating

Annual GHG Emissions in Canada

Automobile Use

Reducing Energy = Reduced CO_2

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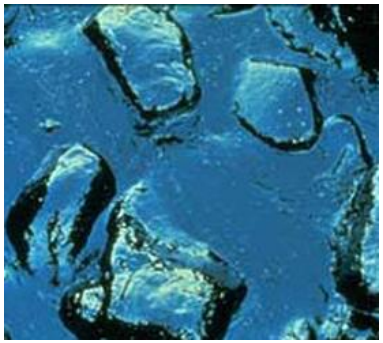
Energy Conservation and CO_2 Savings in a Home

Energy Conservation Measure — CO_2 Saving (imperial tons/yr)

	Gas	Oil	Electric	Gasoline
Replace 10 75-watt incandescent light bulbs with 23 watt compact fluorescents	–	–	0.7	–
Replacing typical 1987 refridgerator with energy-efficient 2007 model	–	–	0.4	–
Replacing a 65% efficient furnace or boiler with 90% efficient model	2.0	3.0	–	–
Replacing single glazed windows with triple-glazed, dual low-e, argon filled windows	1.0	1.4	3.7	–
Installing a solar water heating system	0.8	1.4	4.9	–
Super insulating new houses or major renovations	5.3	7.4	19.8	–
Eliminating two car trips per week	–	–	–	7.8
Replacing average vehicle with hybrid vehicle	–	–	–	26.6

Generation Losses



Source
100%
Fuel Energy

57% - 70%
Generation Losses

8% - 16%
Transmission and Distribution Losses

25% - 35%
Electricity reaching your home

Only 1/3 of fuel source energy reaches your home as electricity.

Smart Metering

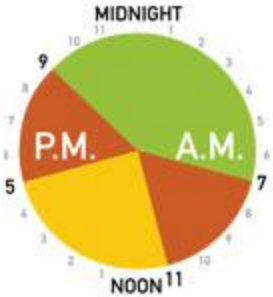
Time-of-Use Pricing (TOU)*

Summer Rates (May 1 - October 31)

In the summer, we traditionally have just one peak period in the middle of the day between 11 a.m. and 5 p.m. This is mainly due to air conditioning use during the hottest hours of the day.

Winter Rates (November 1 - April 30)

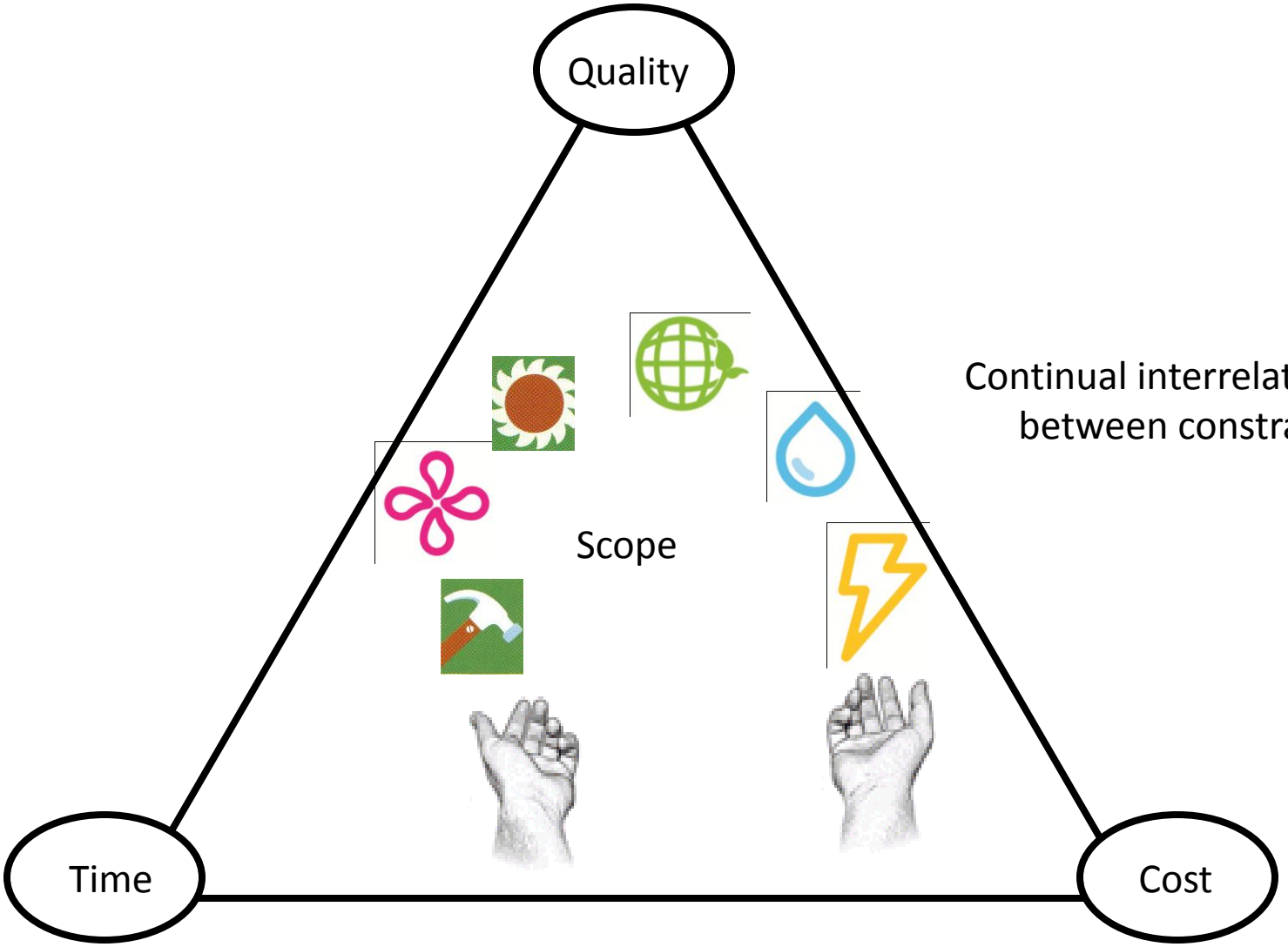
The winter gives us two peak periods. This is because our days are shorter and in the morning when most people get up, lights and appliances are turned on and heating systems are turned up. The pattern repeats later in the day around the dinner hour.



Weekends and Holidays (All year)

Demand, and electricity prices are lower on weekends and holidays - as well as overnight.

Decision Management

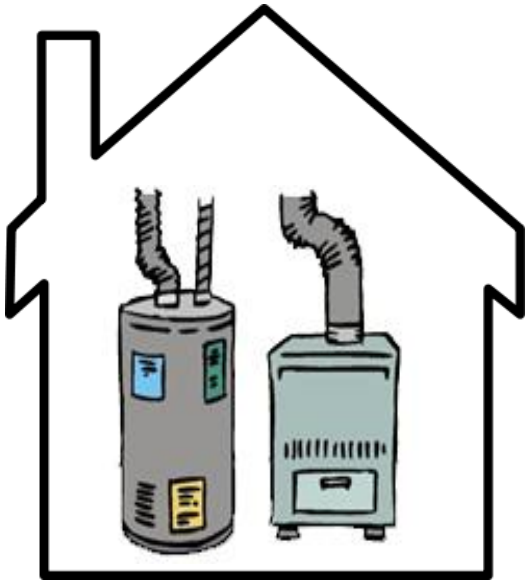


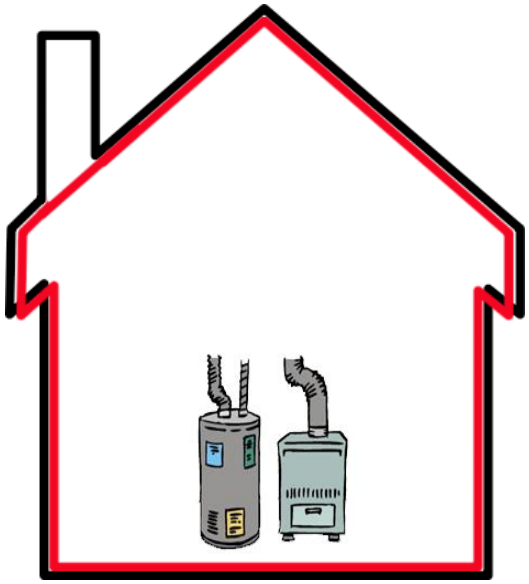
Continual interrelationship between constraints

Right Sizing HVAC System

An accurate heat loss of a building calculated using R-values of a building assembly, its air leakage rate and mechanical ventilation load on the coldest day of the year (Outdoor design temperature historically 2.5% of the time). I.E. Toronto (-18^{O}C or 0^{O}F)

Comfort in a home is highly dependant on the temperature of its surfaces rather than that of the air.





It is important to "Right Size" your mechanical equipment.

When you increase the insulation and air seal, the heating/cooling load is reduced for the same house.

Mechanical Systems

Understand Your Mechanical System

- Ensure system is balanced and mechanicals are working at optimal performance.
- Homeowners need to know what the equipment is, basically how it works and what to do to maintain it. Like getting an oil change for your car.

How does LEED Define a Green Home?

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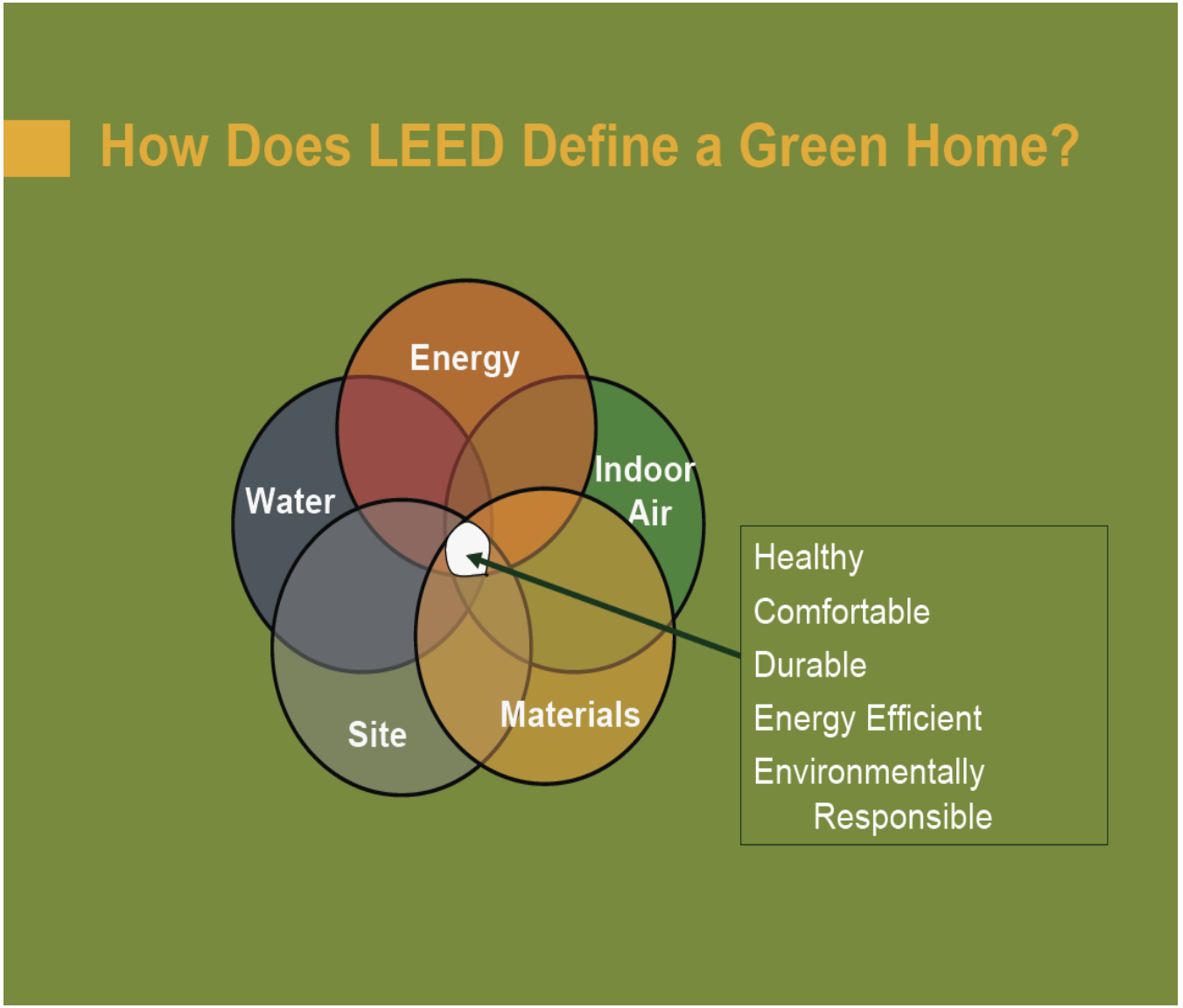

Solar Water Heating

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EnerWorks

SOLAR WATER HEATING APPLIANCES

Product Features

1 The **Self Limiting Solar Collectors*** are designed with a self-regulating mechanism to allow hot air to vent, preventing overheating on a hot summer day. The appliance is also freeze protected. The solar collectors can be roof, fence or rack mounted. * Patent Pending

1a **Freeze Protection**, the use of food grade glycol solution supports appliance operation even in extremely low ambient temperatures (-40 C).

2 **The Energy Pack** transfers free solar energy to heat the water. Hot water is available throughout the day to meet household needs. Solar heated water is produced during sunny periods; electricity, gas or oil heats the water during cloudy periods.

2a EnerWorks patented **Passive Anti-Fouling Protection** ensures that the heat exchanger module functions at optimal levels preventing clogging of the module, a common problem with many solar water heaters.

Solar Appliances

EnerWorks Solar Water Heating Appliances are the first in a series of renewable energy appliances suitable for new or replacement residential applications. The EnerWorks Water Heating Appliances act as the primary source of your family's hot water, while your existing electric, natural gas, propane or oil hot water heater functions as a auxiliary heating source.

EnerWorks appliances are the world's first in-home renewable energy products that supply energy for less than the cost of grid electricity. Solar energy at 6¢ CAD/ 5¢ US per kWh represents Real Savings. Choosing emission-free Clean Energy is a logical step to a clean environment and savings in your pocket.

EnerWorks appliances are built to **CSA F379** and **SRCC OG 300** standards.

How it Works

Solar energy is captured by 1 the solar collectors. The Energy Pack 2 transfers the energy to heat the water. The panels can be roof, fence or rack mounted, almost anywhere with a southern exposure.

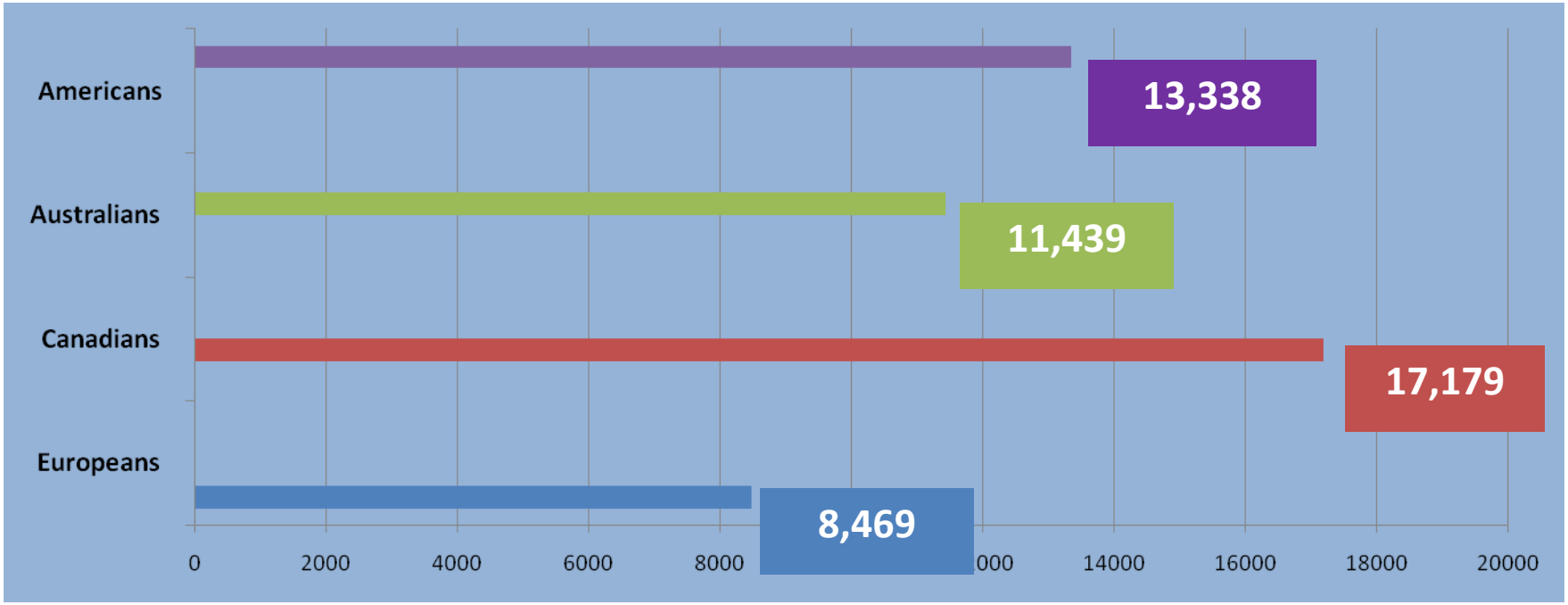
Solar Calculator: www.enerworks.com/flash/solar_calculator.swf

EnerWorks Inc. PO Box 9, 252 Hamilton Crescent, Dorchester, ON. Canada, N0L 1G0
Tel: 519-268-6500 Fax: 519-268-6292 Email: request@enerworks.com Web: www.enerworks.com
Located east of London, Ontario, Canada.

Feb. 18, 2005

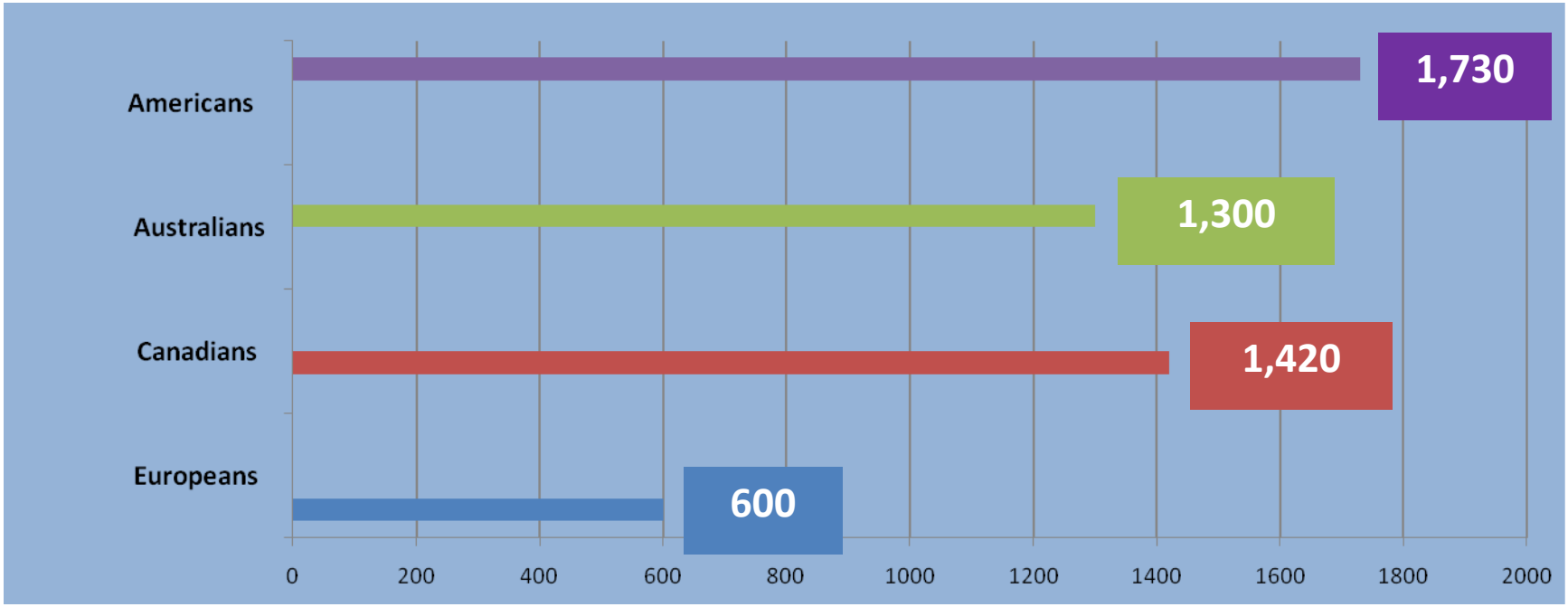
Project profile

Average electricity use per capita (kilowatt hours)



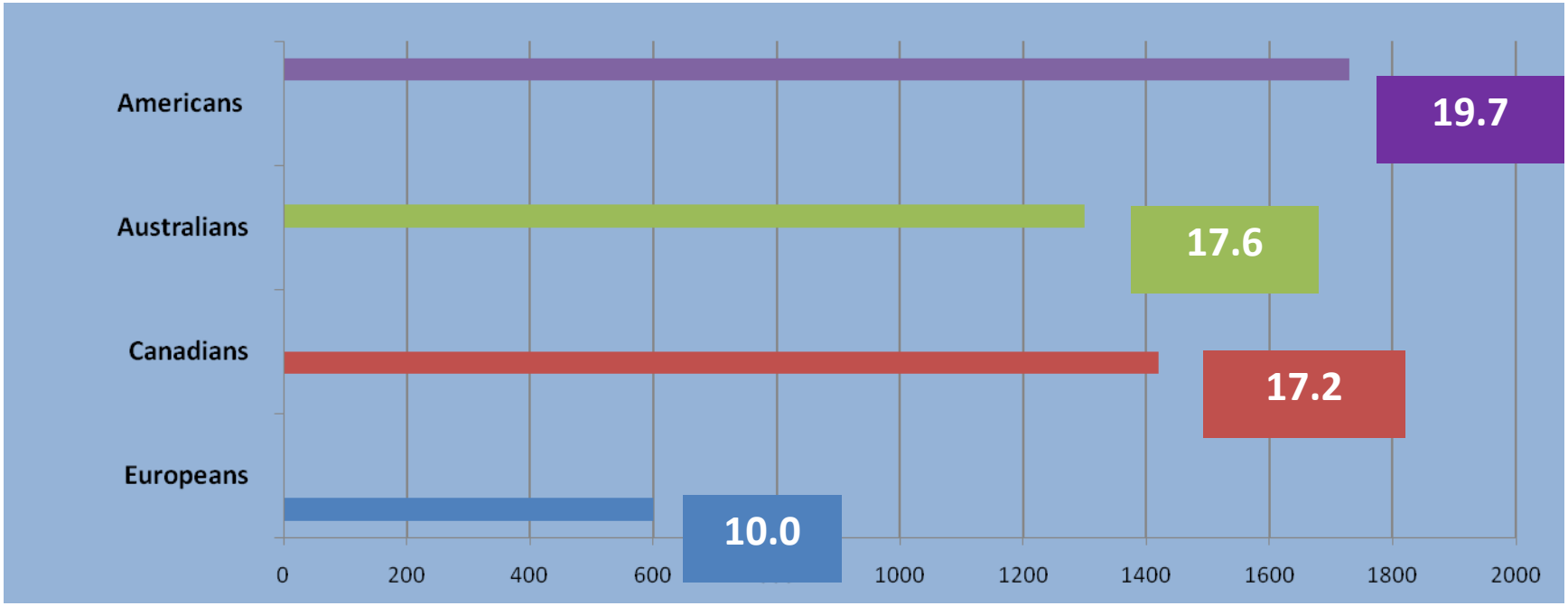
*p 6. David Suzuki and David R. Boyd. David Suzuki's Green Guide , 2008.

Average water use per capita (cubic meters)



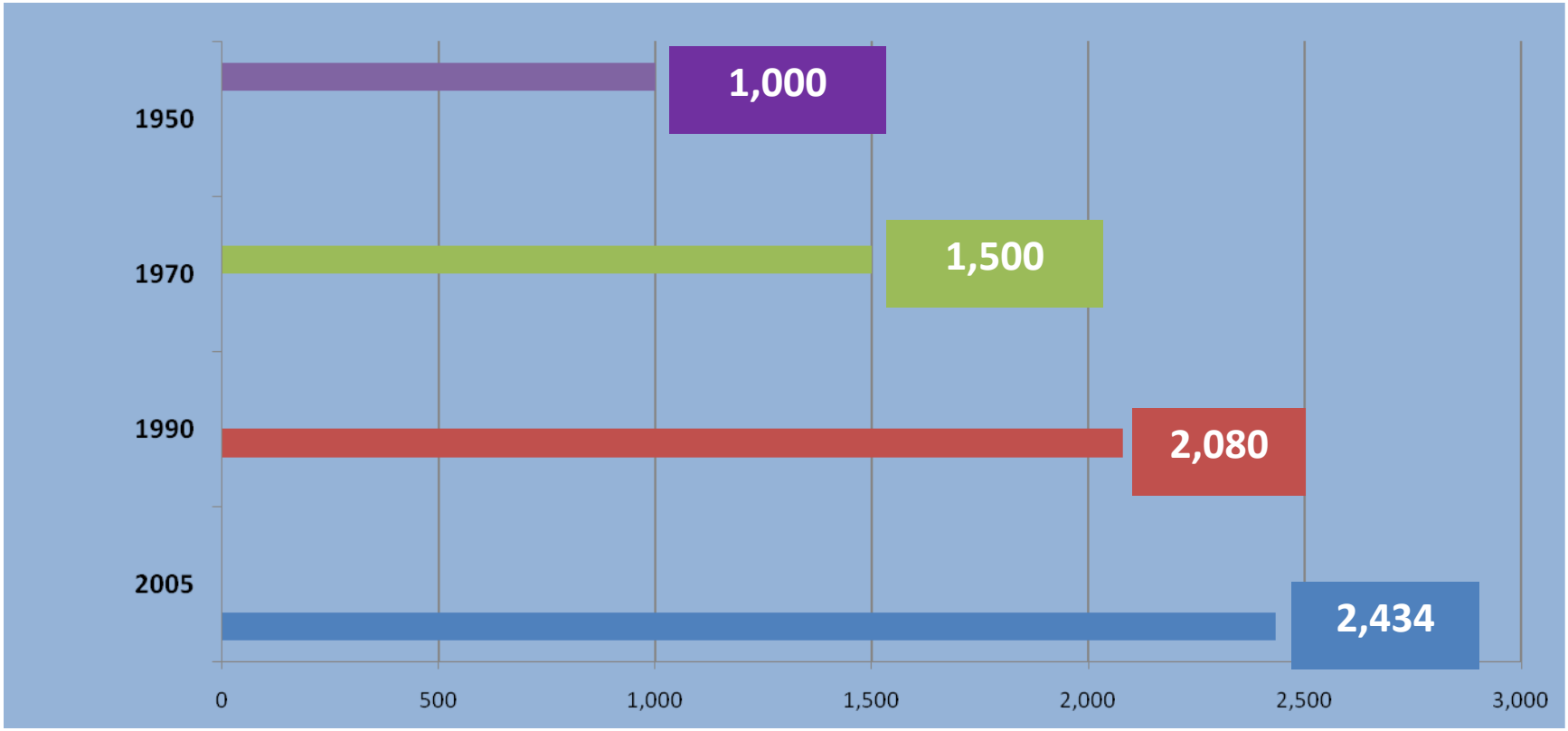
*p 6. David Suzuki and David R. Boyd. David Suzuki's Green Guide , 2008.

Average amuont of CO_2 generated by energy use per capita (metric tons)



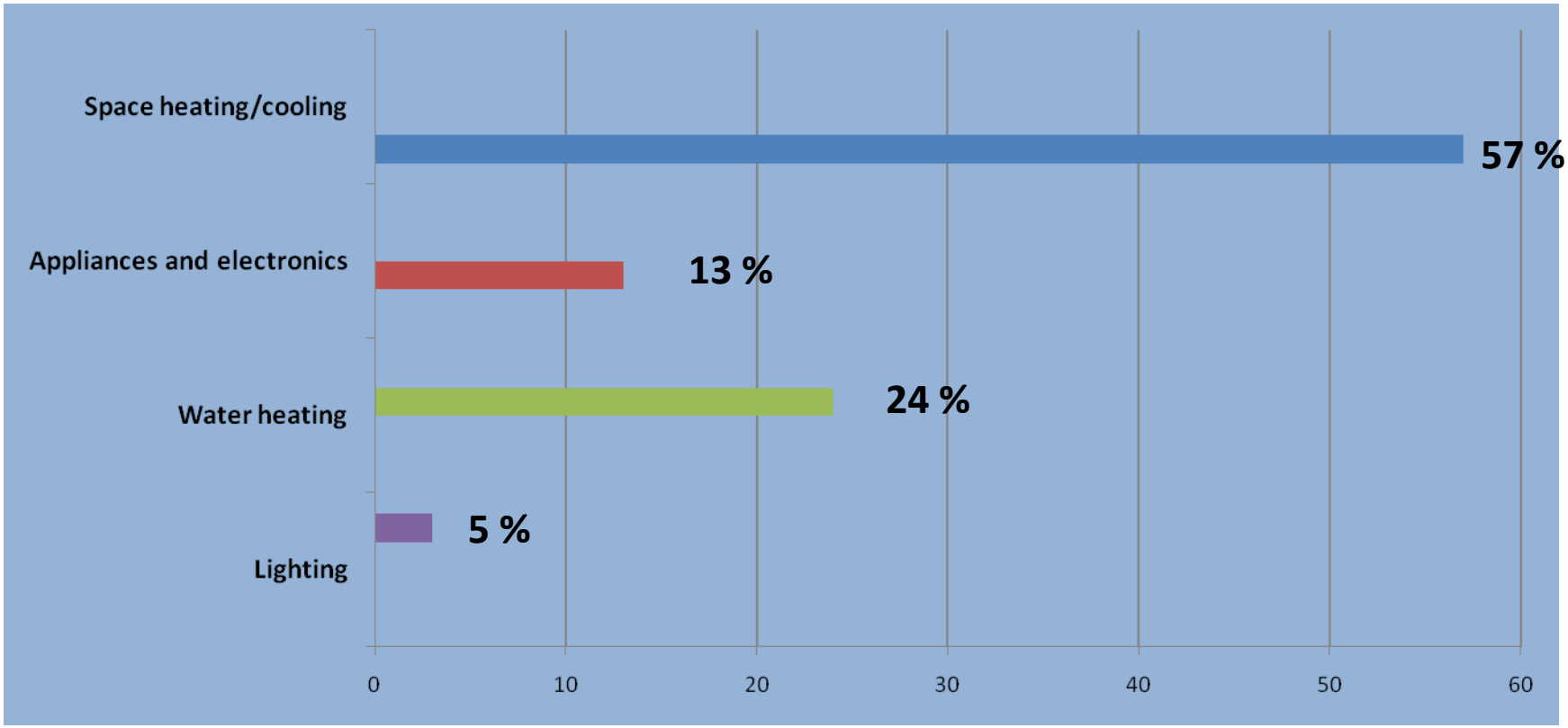
p 7. David Suzuki and David R. Boyd. David Suzuki's Green Guide , 2008.

Average size of new homes in the U.S (square feet)



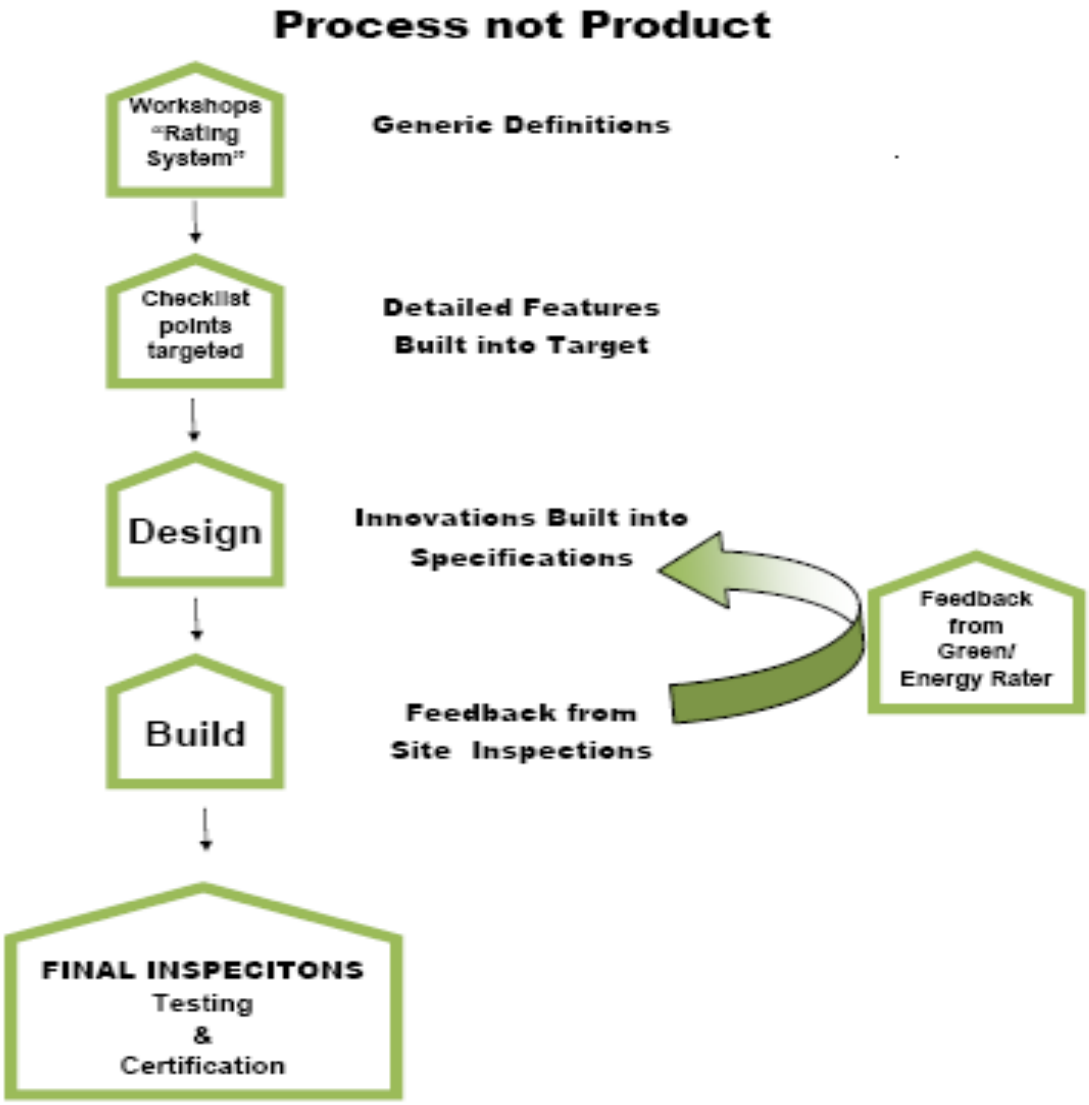
*p 22. David Suzuki and David R. Boyd. David Suzuki's Green Guide , 2008.

Major uses of energy in homes in Canada



*p 25. David Suzuki and David R. Boyd. David Suzuki's Green Guide , 2008.

Sustainability is…



The INTEGRATED DESIGN PROCESS
Charrette Photo

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Goals of the Charrette

- Review the plans and modeling info as to the potential
- Identify and review potential energy improvements to the plans
- Identify areas that need more research
- Review first cost implications
- Discuss potential sponsors/partners and identify roles
- KISS - Keep it Simple Saugeen!

S-11 SuperStud: R-50 walls

Potential Partners

- INAC – funding secured
- CMHC – in discussions
- Hydro One – in discussions

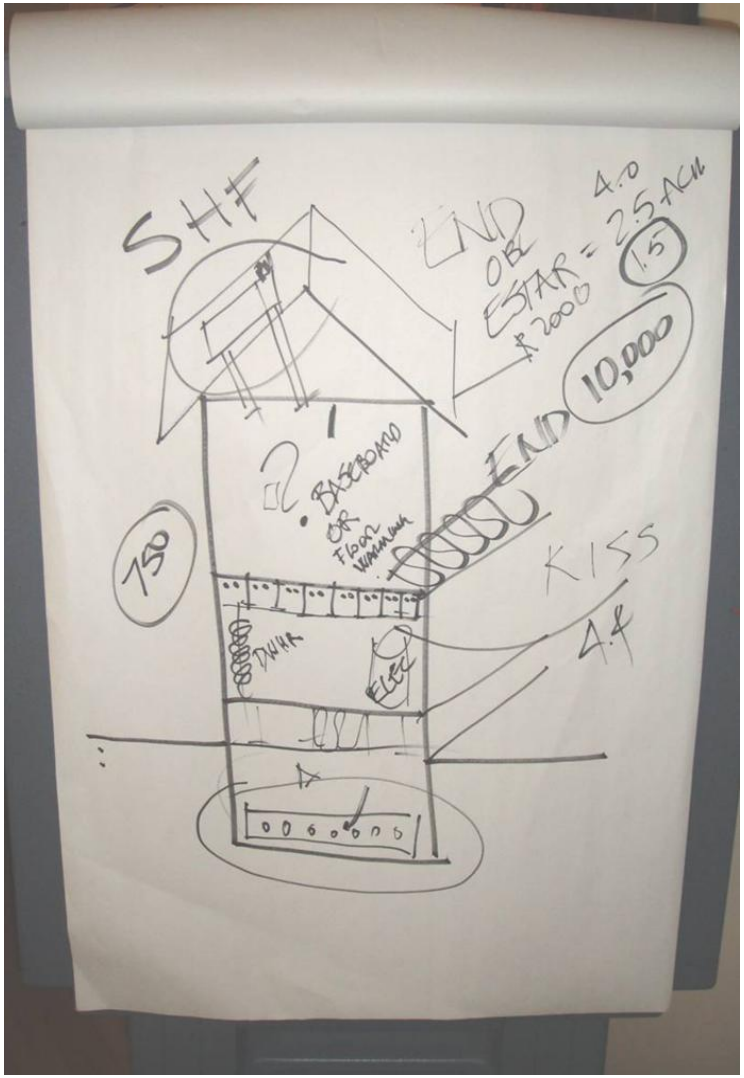
Sustainable Housing Foundation Sponsors

- Roxul Insulation
- EnerWorks Solar hot water
- PowerPipe (DWHR)
- Uponor
- VanEE
- Your Solar Home
- Dow sheathing – in discussions
- PV manufacturer – to be approached
- Windows – to be confirmed

Options Agreed Upon

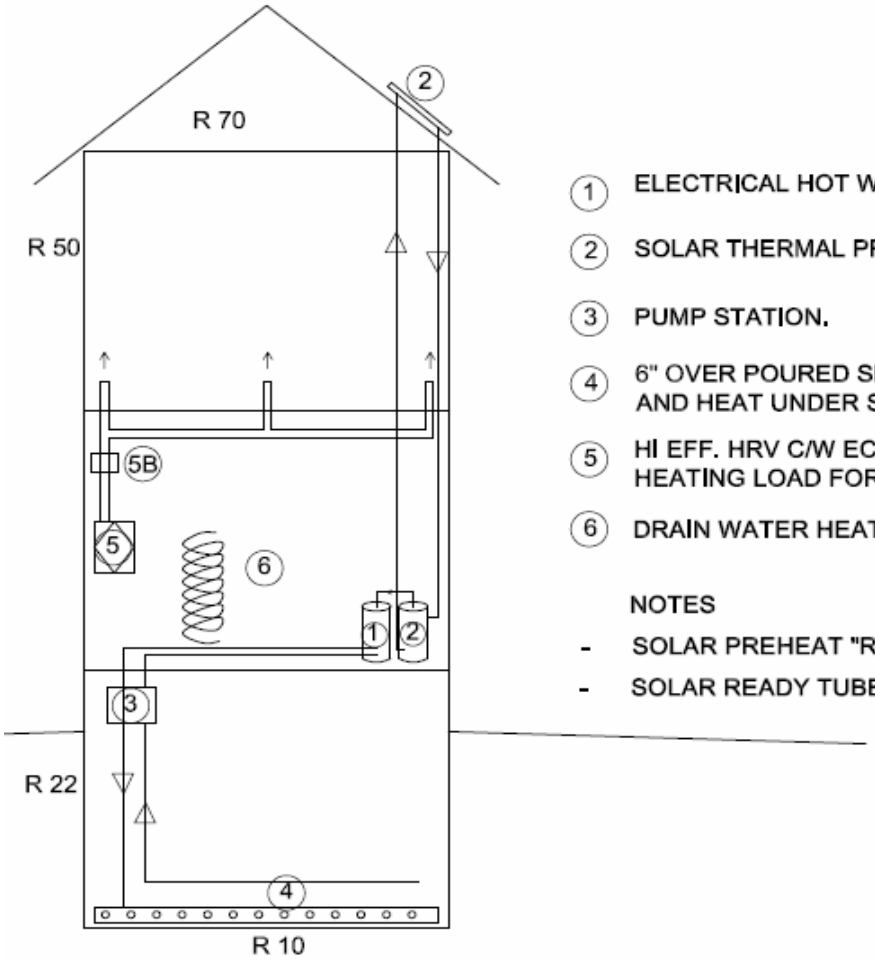
- R50 walls, R70 ceiling, R22 basement, R10 underslab
- Heat recovery ventilation (high eff. fully ducted)
- Drain water heat recovery
- Solar Hot water in 1 (roughed in on 7)
- No A/C needed
- Thermal storage off peak (Electric Hot Water Tank)
- Baseboard's on second floor or not (unit 1)
- Solar air panels to heat top floors of the unit one
- One home a net energy positive home
- Seven near zero passive homes

Charette


SHF
END
OR
ESTAR = 25 ACH
4.0
1.5
$2000
10,000
END
2. BASEBOARD
OR
FLOOR
750
KISS
4.4
DUCT
ELEC

Concept Drawing - KISS

CONCEPT DRAWING
KISS METHOD



1. ELECTRICAL HOT WATER TANK (CHARGES THERMAL STORAGE "OFF PEAK",
2. SOLAR THERMAL PRE HEAT.
3. PUMP STATION.
4. 6" OVER POURED SLAB TO STORE OFF PEAK ELECTRICITY AND HEAT UNDER SIDE OF FIRST FLOOR.
5. HI EFF. HRV C/W ECM. FULLY DUCTED SYSTEM PROVIDES HEATING LOAD FOR SECOND FLOOR 5B 2 KW HEATER.
6. DRAIN WATER HEAT RECOVERY

NOTES

- SOLAR PREHEAT "ROUGHED IN" FOR EAVERY UNIT
- SOLAR READY TUBE ROUGHED IN FOR EVERY UNIT

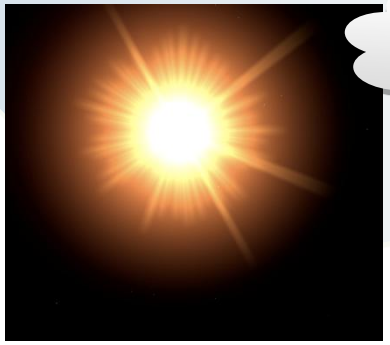
Total Household Energy Use

ENVELOPE and SPACE HEATING

ELECTRICAL LOAD ASSESSMENT

15% MINIMUM REDUCTION

- ✧ LIGHTING
- ✧ APPLIANCES
- ✧ AIR CONDITIONING



RENEWABLES

- ✧ SOLAR SPACE HEATING
- ✧ SOLAR HOT WATER
- ✧ PASSIVE SOLAR DESIGN
- ✧ DRAIN WATER HEAT RECOVERY

DOMESTIC HOT WATER

Solar Hot Water Collectors

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LEED Platinum
Solar Air Collectors

clearsphere

Water Efficiency

Low Flush Toilets

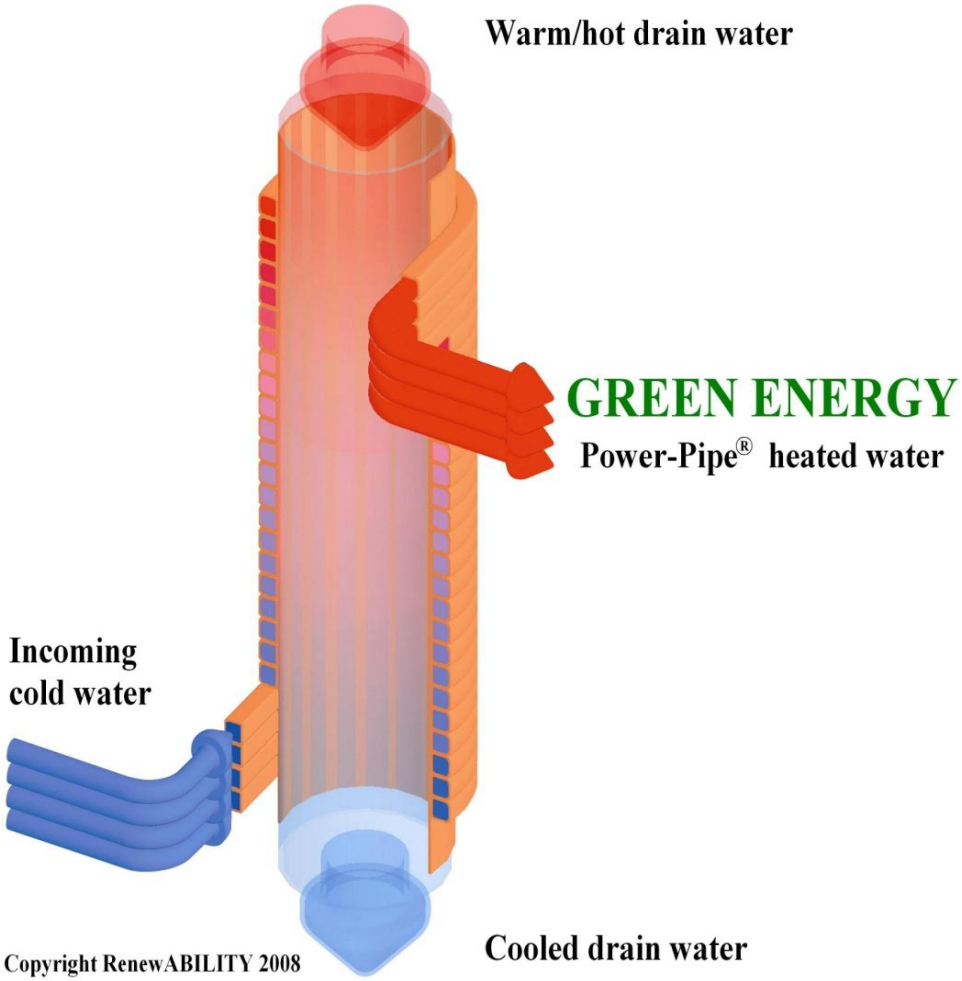
Rain Water Harvesting

Grey Water Recovery

Low Flush Shower Heads

Drain Water Heat Recovery Unit "Power Pipe"

- Concept has been known for over 40 years
- As liquid falls down a vertical section of pipe, it clings to the inner surface in a very thin film
- The energy from this film readily transfers through the copper and into the cold water that is in the outer coils
- The result is the cool coil flow is heated, while the warm drain flow is cooled
- MUST be vertical for this to happen



Combined Energy Factor

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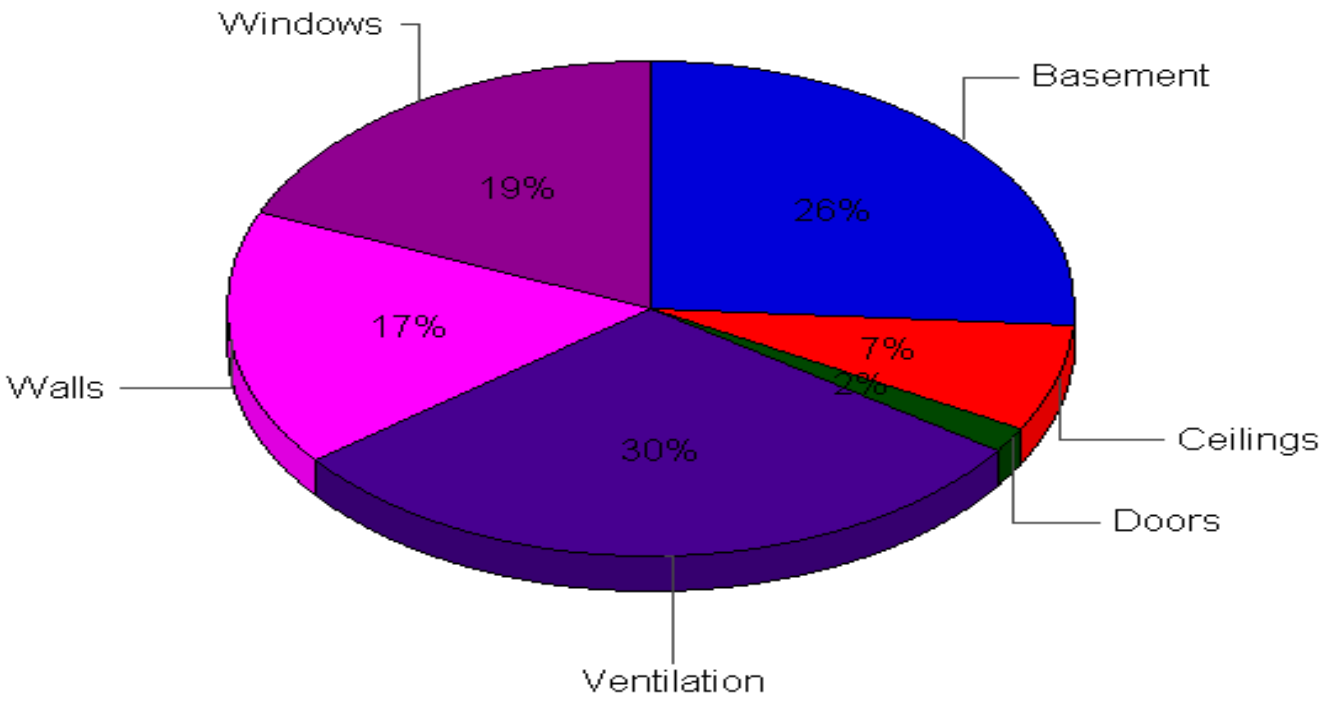
Calculation of Combined Drainwater Heat Recovery and Water Heater Energy Factors for Equal Flow Plumbing (i.e. Plumbed all the water in the house except the kitchen sink and outdoor service)

		Water Heater Make	GSW		Bosch Inst.		Electric	
		Water Heater Model	50SNVH		125FX		LTN030G	
		Recovery Efficiency (n_r)	75.0%		80.0%		100.0%	
		Energy Factor for Water Heater Only (E_f)	58.0%		78.0%		91.0%	
		First Hour Rating (gallons)	84.0		N/A		51.0	
		Rated Maximum Flow (usgpm)	N/A		2.7		N/A	
		Input [MMBTU/hr]	34.0		N/A		32.0	
		Volume [gallons]	50.0		117.0		30.0	
Power-Pipe Model Number	Rated Effectiveness at 9.5 lpm with equal flow (n_DHR,9.5)	% Reduction on DHW Energy Consumption	E_f (Combined DHR & Water Heater)	Combined First Hour Rating (gallons)	E_f (Combined DHR & Water Heater)	Combined Rated Maximum Flow (usgpm)	E_f (Combined DHR & Water Heater)	Combined First Hour Rating (gallons)
Water Heater Only			58.0%	84.0	78.0%	2.7	91.0%	51.0
R3-30	38.3%	23.6%	71.0%	136.2	101.3%	4.4	115.9%	82.7
R3-36	43.7%	26.9%	73.3%	149.3	105.8%	4.8	120.6%	90.6
R3-42	48.3%	29.7%	75.3%	162.3	109.8%	5.2	124.8%	98.6
R3-48	52.1%	32.1%	77.2%	175.4	113.5%	5.6	128.6%	106.5
R3-54	55.4%	34.1%	78.8%	188.5	116.9%	6.1	132.0%	114.4
R3-60	58.3%	35.9%	80.3%	201.5	120.1%	6.5	135.2%	122.3
R3-66	60.9%	37.5%	81.7%	214.6	122.9%	6.9	138.1%	130.3
R3-72	63.1%	38.9%	82.9%	227.6	125.6%	7.3	140.8%	138.2

Anatomy of Heat Loss
In an OBC Home



Energy Saving Matrix
Saugeen First Nations

clearsphere

Saugeen First Nations Energy Saving Matrix

Unit Type	Design Heat Loss	Consumption (kWh)	Consumption (LP)	Energuide #	Estimated Cost (Space and DHW)
End Unit	9,748 bth/h 2.857 kw	8218.5		85	$986
Middle Unit	7,179 btu/h 2.104 kw	6555.6		86	$787
End Unit	9,748 bth/h 2.857 kw		1447.8	85	$1,086
Middle Unit	7,179 btu/h 2.104 kw		1183.9	86	$888

The Design Heat Loss of the End unit as modeled = 9,748 BTU/hr.

The Design Heat Loss of the Middle unit as modeled = 7,179 BTU/hr.

Chart Key

Proposed Construction	R70 attic, R44 Roxul + 1" XTPS walls, R22 full crawlspace, R10 Type IV under slab, 80% ASE HRV, 0.92 EF High Efficiency DHWT, 2.0 ACH or better.

Notes

Propane consumption for space and domestic hot water heating only.
Propane cost includes , customer charge & delivery charge averaged at $0.75/L and electricity at $0.12/kWh.
All propane calculations are based on typical usage patterns and are consistent across models, actual usage may vary.

The above heat loss calculation refers to a house with most windows facing north. It is the responsibility of HVAC contractor to oversize to local design conditions and building codes. These numbers are meant for guide line purposes only.

Calculated by:

ALPHA-TEC
CONSULTING &
CONSTRUCTION

12 Rowley Ave., Toronto, ON
TEL 416-486-5724 FAX 416-486-9865

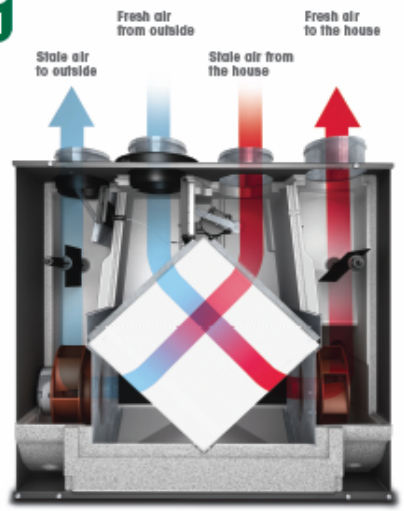
Heating and Ventilation

clearsphere

Ventilation - HRV

Premium features that make all the difference

vänEE 90H-V ECM



Quick and Easy Strap System
Duct mounting straps eliminate the need to seal with tape and protect the vapor barrier for quicker installations and easy maintenance.

Integrated Electronic Board on Motor
Optimizes performance, keeps the motors cool and minimizes noise.

HomeShield™ Defrosting System
Prevents ice build-up on recovery module without creating negative indoor air pressure.

Motor Assembly
Can easily be replaced in less than 7 minutes, allowing a simple and fast maintenance.

Heat Recovery Core
Offers superior efficiency by warming the incoming fresh, colder air in the winter before it is distributed throughout your home.

Core Maintenance
Enjoy quick and simple maintenance with a heat recovery core that is easy to remove and can be washed in water.

Balancing System
Pressure taps eliminate the need for an external flow meter and reduce installation time.

Easy to Reach Filters
Washable foam filters effectively filter airborne particles, such as pet dander, lint, dust and mold spores, while protecting the equipment from dust build-up.

PLATINUM
by vänEE

Included with the 90H-V ECM, Platinum is the most evolved wall control on the market. Fully programmable, it features an impressive choice of operating modes, such as the Smart Mode feature, as well as an appealing, customizable LCD display.

SMART Mode Features

- Automatically controls ventilation
- Uses indoor humidity level and outdoor temperature to modulate ventilation
- Triggers humidifier or dehumidifier (with optional module)
- Displays error code to simplify troubleshooting
- Reduces callbacks and provides peace of mind for your customers

SPECIFICATIONS SYSTEM	Rate of air flow CFM* (min./max.)	Rate of air flow l/s† (min./max.)	Diameter of ports	Filter	Voltage	Power	Dimensions (Height) (Width) (Depth)	Weight (approx.)	Type of Recovery	Main Wall Control (included)	Optional Wall Control (sold separately)	HVI Certification	Warranty on Core	Warranty on Parts
90H-V ECM	40-80 53-105 66-132 80-157	18.9-37.8 20.0-49.6 31.1-62.3 37.8-74.1	6 in. oval (15 cm)	Washable foam filter	120 volts	24 watts at 49 CFM 2.04 CFM/watt 32 watts at 81 CFM 2.53 CFM/watt	25 5/8 in. (65.08 cm) 24 7/16 in. (62.07 cm) 15 1/8 in. (38.13 cm)	51 lb. (23.1 kg)	HRV	Platinum	20/40/60-Minute Push-Button	Yes	Limited Lifetime	5 years

* CFM: Cubic feet per minute. Based on typical installation.
† l/s: Liters per second.

AVAILABLE AT THIS AUTHORIZED DEALER

Specifications subject to change without notice.

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Competition as a Motivator

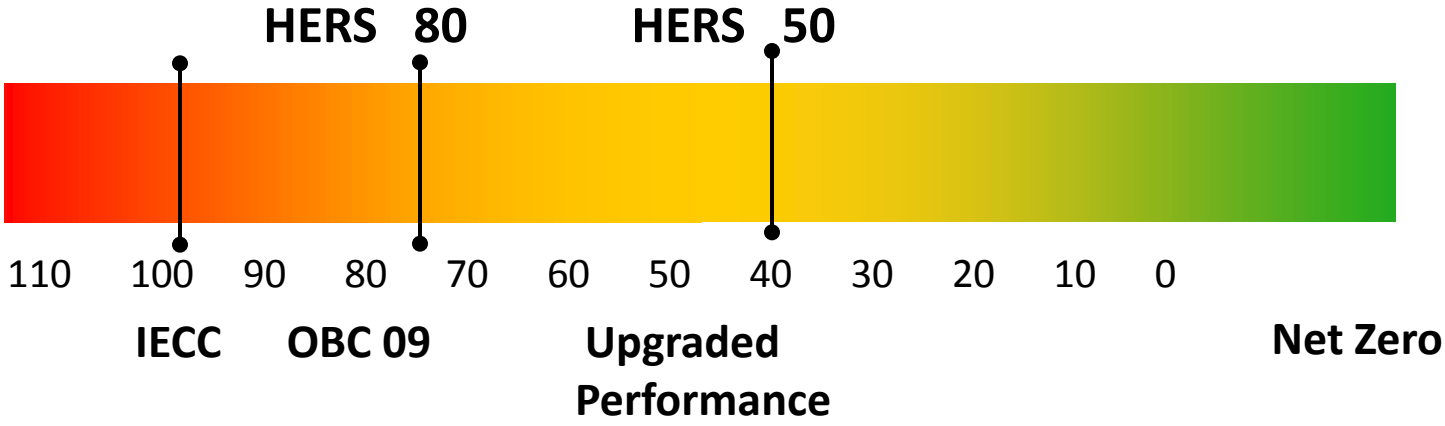
GREEN IS 50: BUILDERS' CHALLENGE

The primary goal of the **Green is 50: Builders' Challenge** is to encourage builders to adopt systems engineering approaches to the design and construction for a large portion of all their housing and reward them as they move along the continuum toward net zero energy.

The challenge is initially aiming for a 50% reduction in total home energy consumption.

A Program that Fits Canadian Market Needs

Measuring Exemplary Energy Performance – HERS 50 or better



Builders Participating

The leading builders have volunteered already…..

Green is 50 Builders' Challenge

Rodeo FINE HOMES

NORTHSTAR HOMES

BEAVERBROOK Your Neighbour for Life!

EMPIRE COMMUNITIES

BERKSHIRE HOMES Build the life you love

SABERWOOD HOMES

Gordon Tobey Developments Ltd.

Greenpark

CADORIN HOMES

ROSEHAVEN HOMES • EST. 1992

BALLANTRY HOMES

Gregor Homes

minto

Royalpark Building Traditional Values

Starlane HOME CORPORATION

ROYAL PINE

Thornridge HOMES

Baywood

GARDEN GH HOMES

MATTAMY homes

What does the Challenge Do?

GREEN IS 50: BUILDERS' CHALLENGE

- Through the Green is 50 Builders' Challenge builders have an easy way of differentiating their homes.

- Participating manufacturers help them do that with energy efficient products that reward them with a lower energy score, which is easy for consumers to understand.

The Sustainable Housing Foundation was founded from the Green is 50 Challenge

The following are examples…

SUSTAINABLE HOUSING FOUNDATION

This home meets the Green is 50 Builders' Challenge

Greenpark Princess Margaret Hospital Lottery Home

Rated by: Clearsphere Consulting

Rating Conducted: January 21, 2008

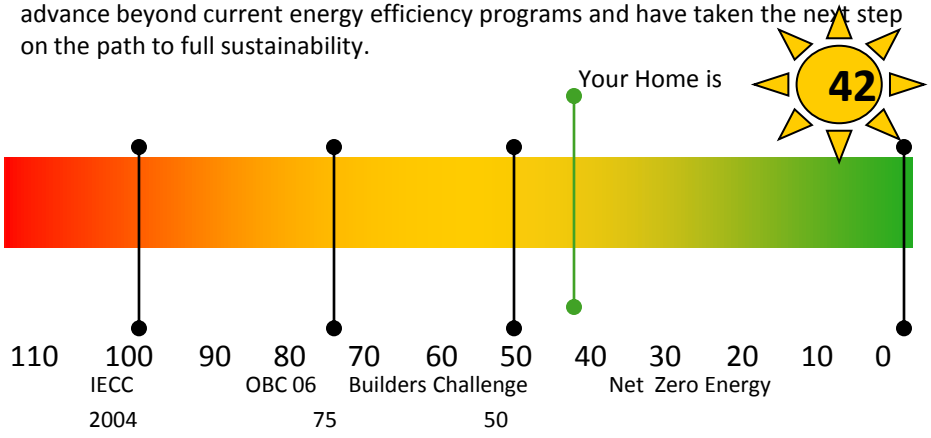
Built by: **Green Park Homes**

Conditioned floor area:	2,815 square feet
Estimated annual energy usage:	
Natural Gas Consumption	1, 820 m^3
Green House Gas Emissions	11.9 Tonnes
Estimated average monthly energy bill:	**$69.00**

Lenard Hart September 24th, 2009

Director, Sustainable Housing Foundation

This rating is available for homes built by leading edge builders who have chosen to advance beyond current energy efficiency programs and have taken the next step on the path to full sustainability.



This house is rated using the Home Energy Rating System (HERS), property of RESNET of Oceanside, CA. The Green is 50 Builders' Challenge is a Pilot Program sponsored by CRESNET and delivered by Clearsphere.

This home meets the Green is 50 Builders' Challenge

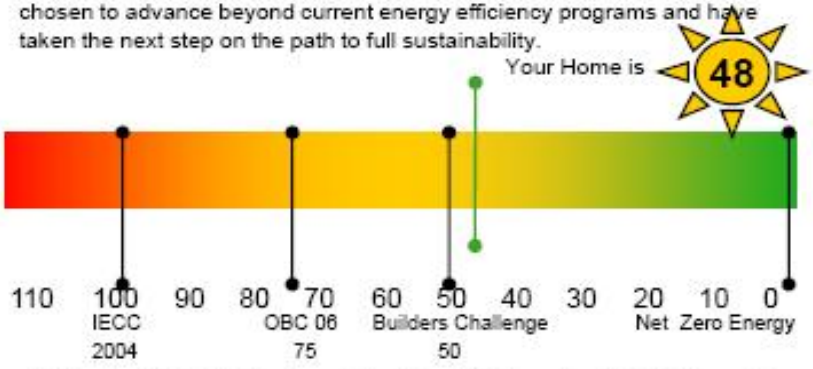
1034 Bob Scott Court, Newmarket, Ontario
Rated by: Clearsphere Consulting
Rating Conducted: August 25, 2008

Built by: Garden Homes - Stonehaven

Conditioned floor area:	2,695 square feet
Estimated annual energy usage:	
Natural Gas Consumption	1, 695 m^3
Green House Gas Emissions	8.54 Tonnes
Estimated average monthly energy bill	**$64.30**

Lenard Hart September 24th, 2009
Director, Sustainable Housing Foundation

This rating is available for homes built by leading edge builders who have chosen to advance beyond current energy efficiency programs and have taken the next step on the path to full sustainability.



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Sustainable Builder
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Thank You

Thank You

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