EQuilibrium™
HEALTHY HOUSING
FOR A HEALTHY ENVIRONMENT

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Ontario Region

Research and Information Transfer

www.cmhc.ca

Canada

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HOME TO CANADIANS

CMHC's EQuilibrium Initiative

EQuilibrium is a national residential design-build- demonstration initiative to challenge builders and developers across Canada to act as environmental stewards by:

- Designing low-impact affordable, healthy, highly energy and resource efficient housing

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EQuilibrium™ Housing Principles

Core Principles

- Health
- Energy
- Resources
- Environment
- Affordability

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CMHC's EQuilibrium™ Sustainable Housing Demonstration Initiative – Vision

- Uses readily available technologies
- Aims to reduce the homeowner's need for energy
- Can be applied to a variety of housing models
- Build interest and capacity

Solar hot water collectors

Slab hot water radiant heat distribution system

Photovoltaic roofing tiles

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Features of an EQuilibrium™ House

- Connected to the utility grid
- Can access additional energy
- Can sell energy production surplus

Inspiration—the Minto ecohome
Ottawa, ON

Benefits

Homeowner benefits:

- Lower utility bills
- Healthier space
- Reliable power
- Greener choice for the environment
- A better future

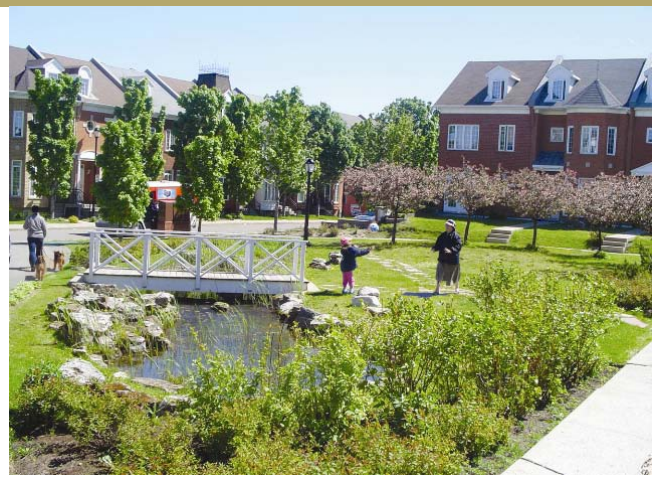
Avalon Discovery 3
Red Deer, AB

Benefits

Builder benefits:

- Establish a reputation
- Meet the needs of Canadians

Benefits



Community benefits:

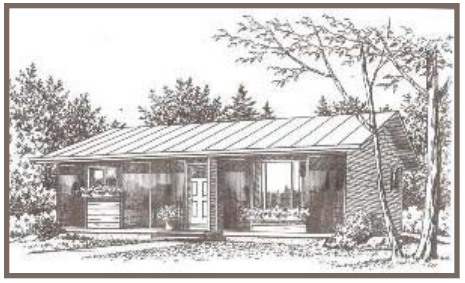
- Reduction of infrastructure
- Reduction of costs
- Healthy & liveable communities
- Land, water and habitat conservation
- Protection of existing ecosystems

CMHC EQuilibrium™ Demonstration Projects

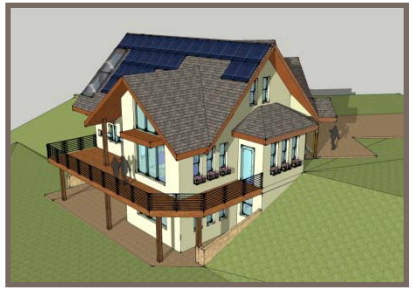
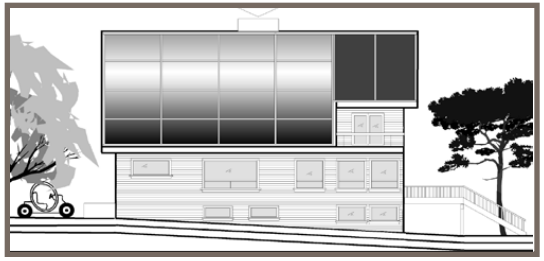






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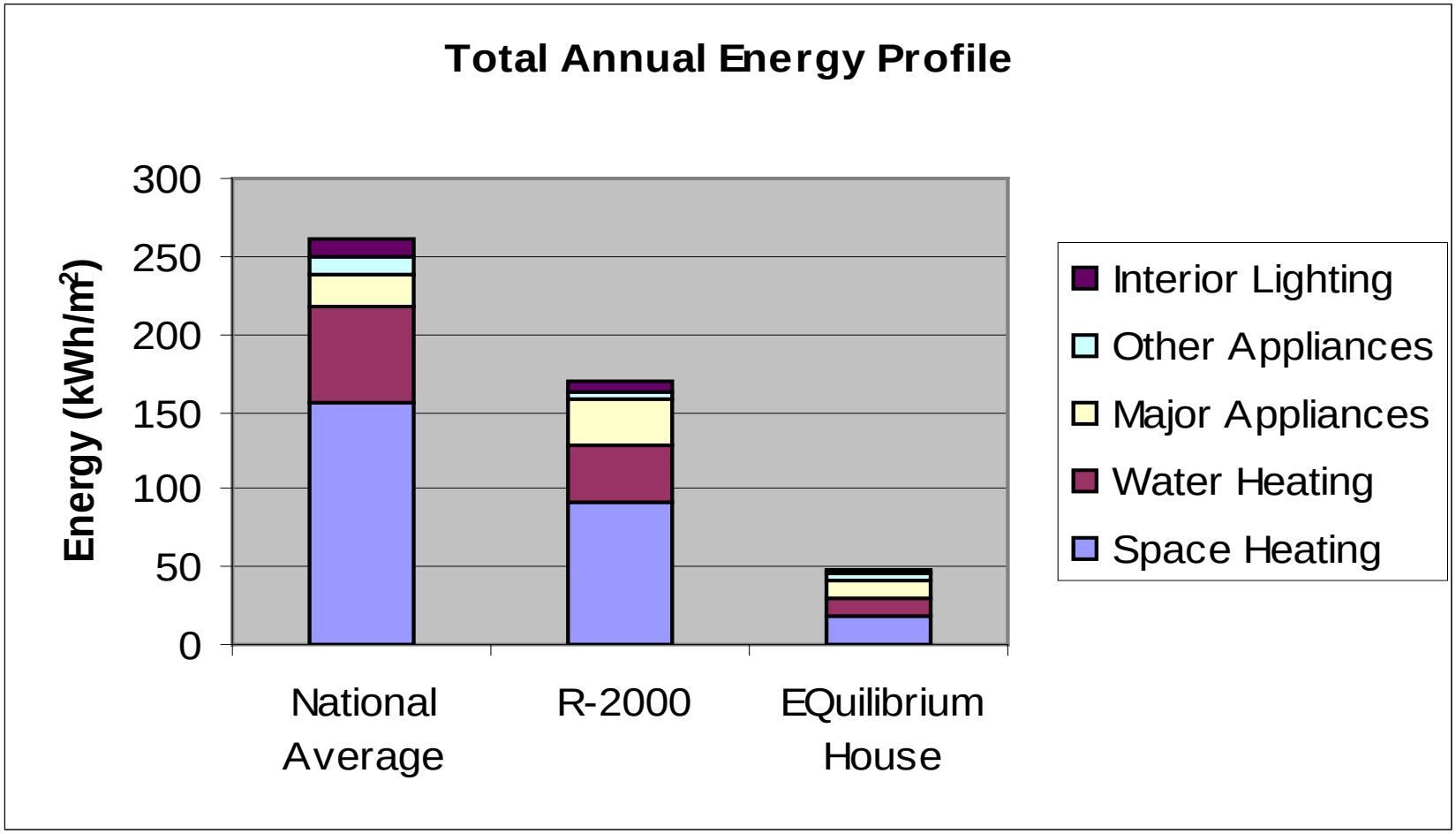
Targeted Performance Proposed by the Teams



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Targeted Performance Proposed by the Teams

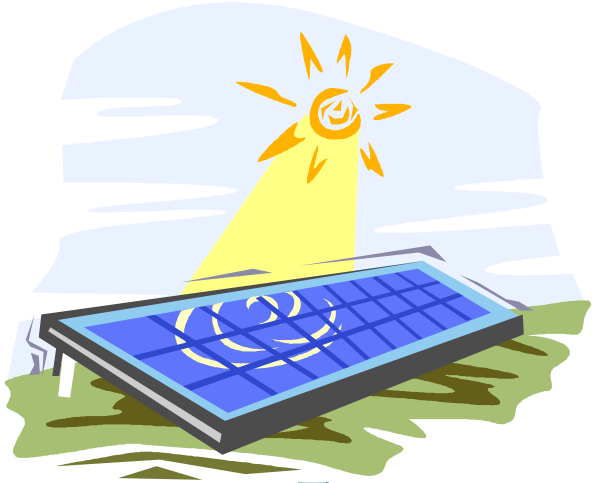
Estimated Average for the 15 Homes

- Building envelope EnerGuide* rating **86**
- Total energy modified EnerGuide* rating **99**
- Ceiling insulation level **R65/ RSI 11**
- Wall insulation level **R52/ RSI 9**
- Target air tightness **0.75 air changes/h@50Pa**
- Floor area **172m²** (1850pi^2)

*EnerGuide is an energy rating system for houses developed for Natural Resources Canada where a score of 100 = net zero energy house

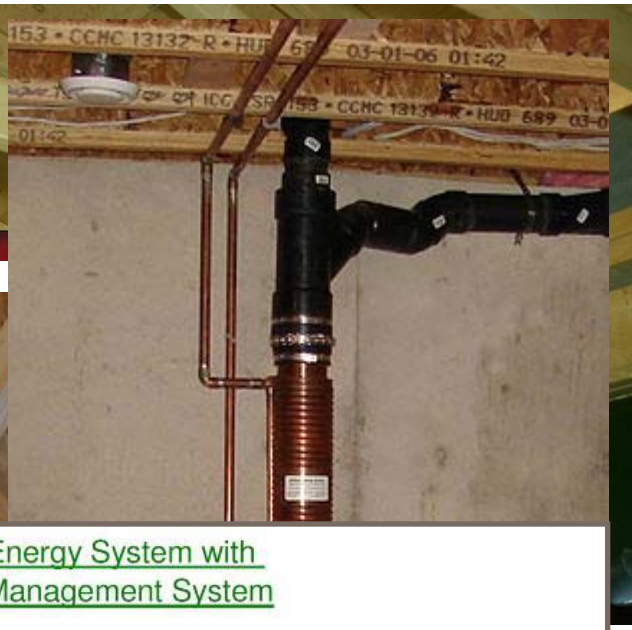
What is Net-Zero Energy Housing?

- A home that generates an equal amount of energy as it consumes on an annual basics.
  - Computer modeled
    - Hot2000
    - Retscreen
    - New software coming.

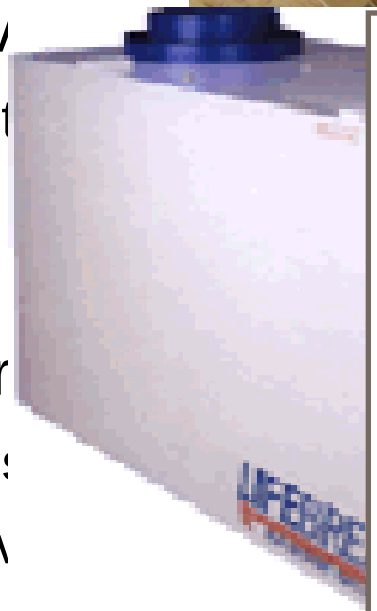


Strategy for Net Zero

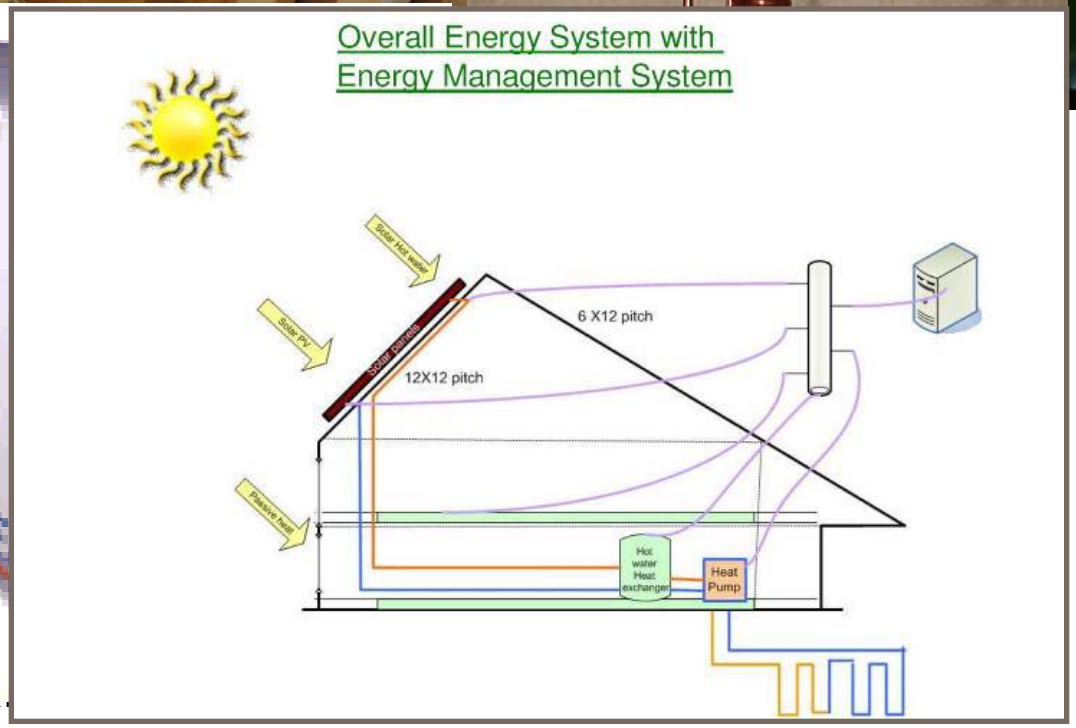
1. Conserve Energy
   1. Improve build



- Recov
  - Vent



- Gener
  - **Pas**
  - Activ
  - Grou
  - Wind



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Lessons Learned

Canada

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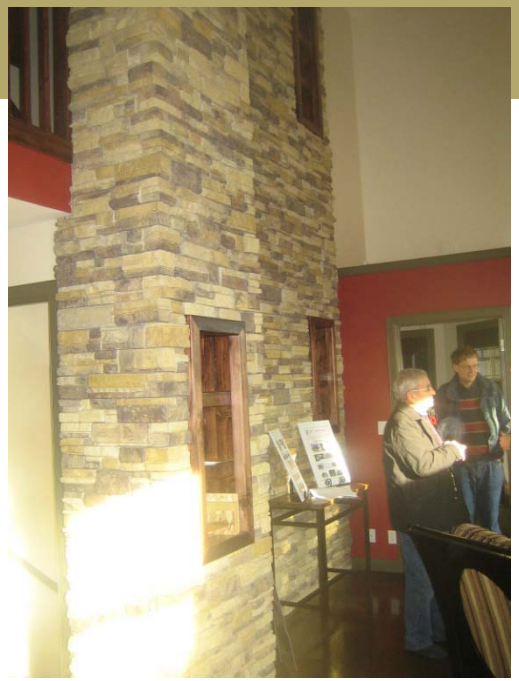
Messages from the builders..



- It can get expensive
  - Net Zero Energy Ready
- Conservation is key
  - Building envelope must be good.
- Passive solar is free
- Keep it simple

The ÉcoTerraTM design team calculated the annual gross space heating load to be 77 GJ (21,400 kWh) using HOT2000.

Usable passive solar gains are expected to meet 44% of the heating load, and internal gains 17.4%.

The space heating system is therefore expected to only have to deliver 29.6 GJ/yr (8,200 kWh/yr), a reduction of 13,200 kWh.

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Lessons from Riverdale

"Green" Features	Impact on Energy Bill	Cost
Better insulation, windows, heating systems, appliances, passive solar design	85%	$18K
Solar panels for hot water and indoor heat	95%	+ $36K
Solar panels for electricity	100%	+ $54K
	TOTAL	$106K

Source: slide 24,
http://www.hme.ca/presentations/Riverdale_NetZero_presentation_--_Kamloops_Green_Home_design_charrette_2009_04_27.pdf

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Lessons from Riverdale

$106,000 in costs to reduce home energy bills by 100%
(out of reach for most homeowners)

BUT

only $18,000 in costs to reduce home energy bills by 85%
(the final 15% is what costs so much)

Source: slide 24,
http://www.hme.ca/presentations/Riverdale_NetZero_presentation_--_Kamloops_Green_Home_design_charrette_2009_04_27.pdf

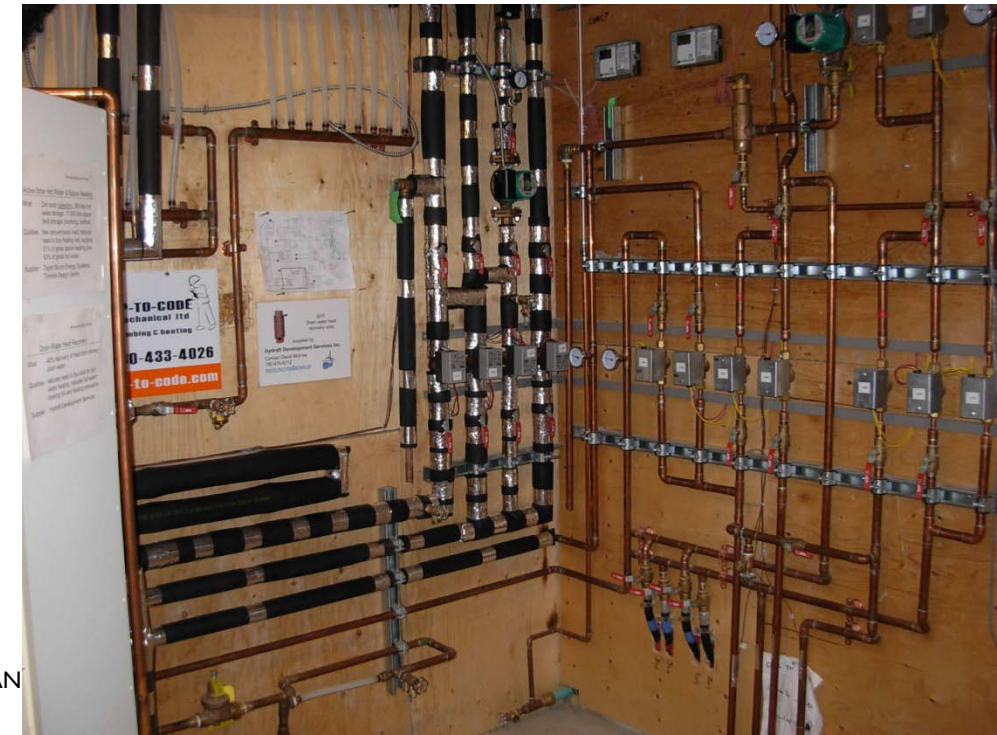
Riverdale and market demand

What have we found?

- EQ houses are performing well, not perfectly, but well
- Householders use more electricity than predicted by developers and energy modellers
- PV output meets predictions in summer but is less than predicted in winter

What have we found?

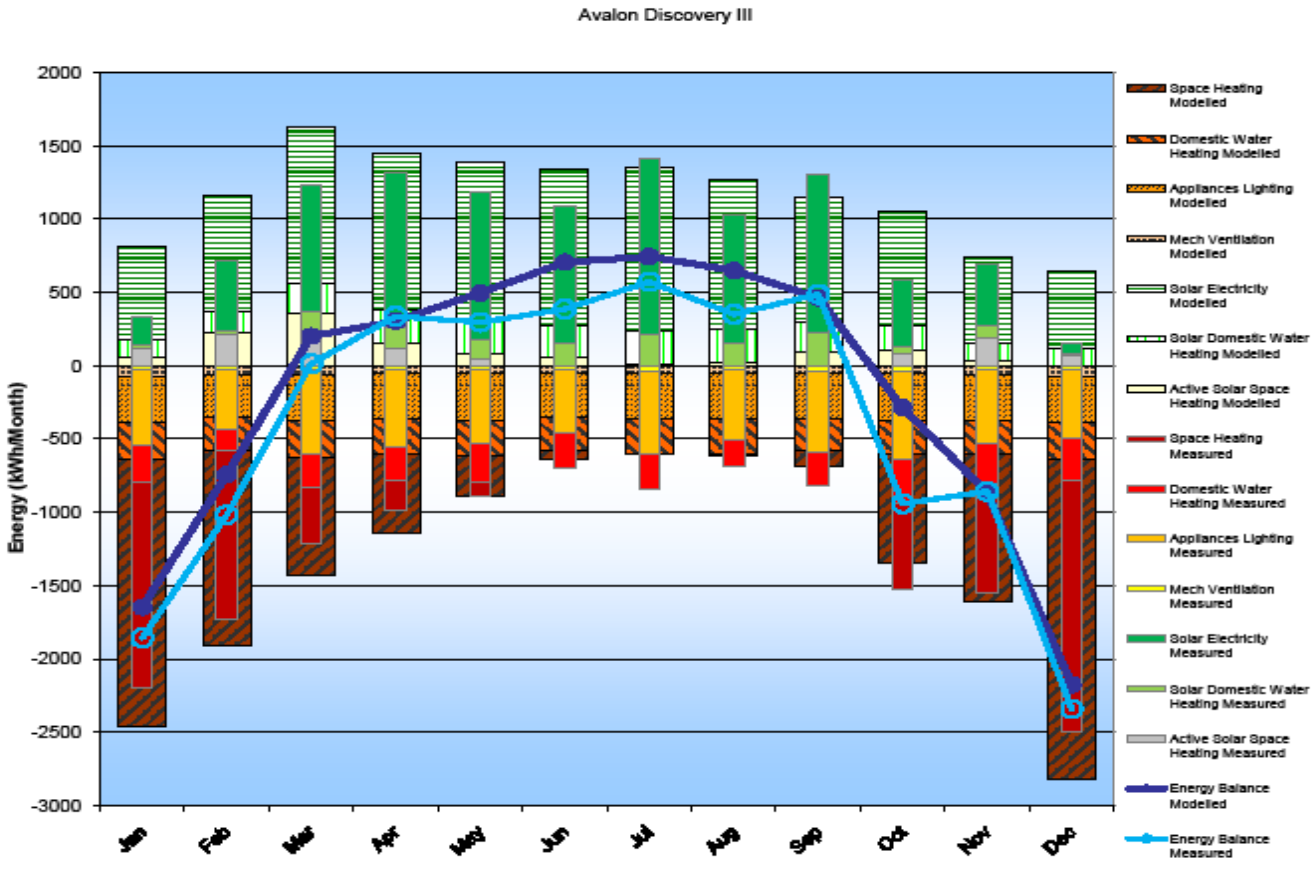
- Snow exists
- Complicated systems can lead to oversights
- Simple monitoring does not allow for complex analysis



Are we there yet?

- We have a full year of monitoring on one house, and almost complete data on two more
- Have we reached the elusive net-zero goal?

Avalon Discovery 3



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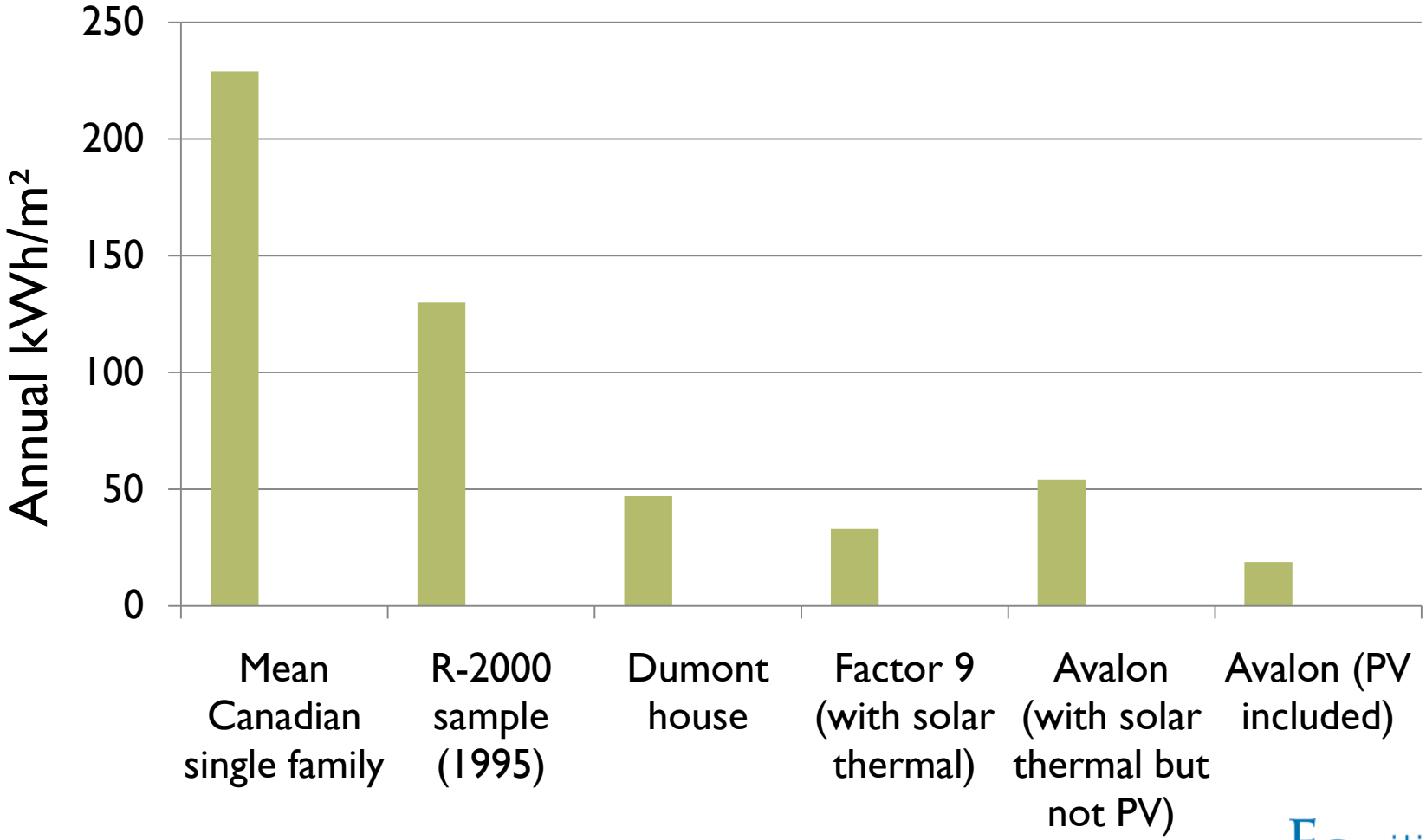
Energy usage by different Canadian houses

Note: Avalon and Factor 9 are net energy usage (energy used – energy generated)



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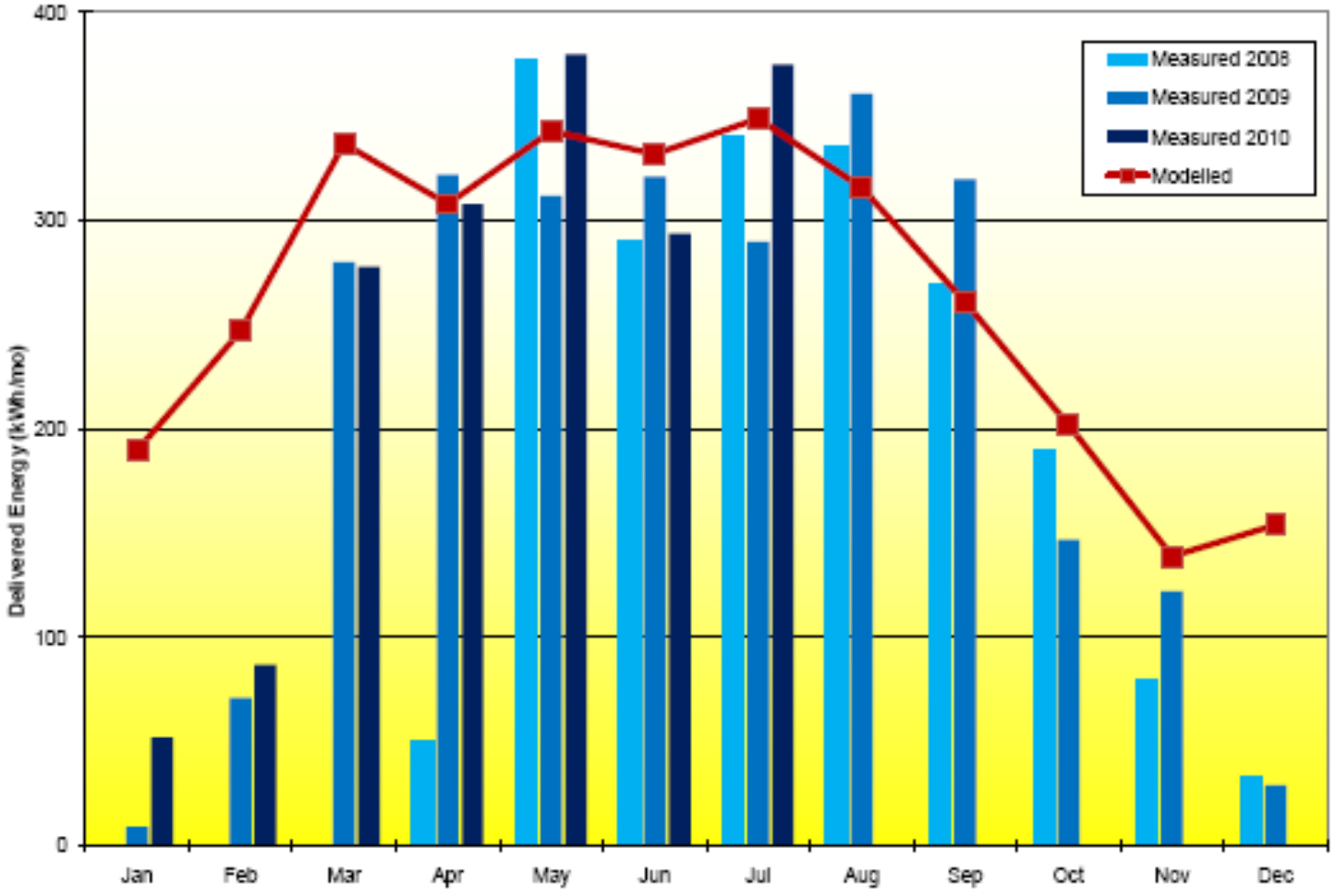
PV output: predicted vs measured

- Predictions generally made using RETScreen
- Many assumptions in that process
- Measured PV output is generally close in summer but lower in the darker six months
- Shading, snow effects are contributing factors

ÉcoTerra™



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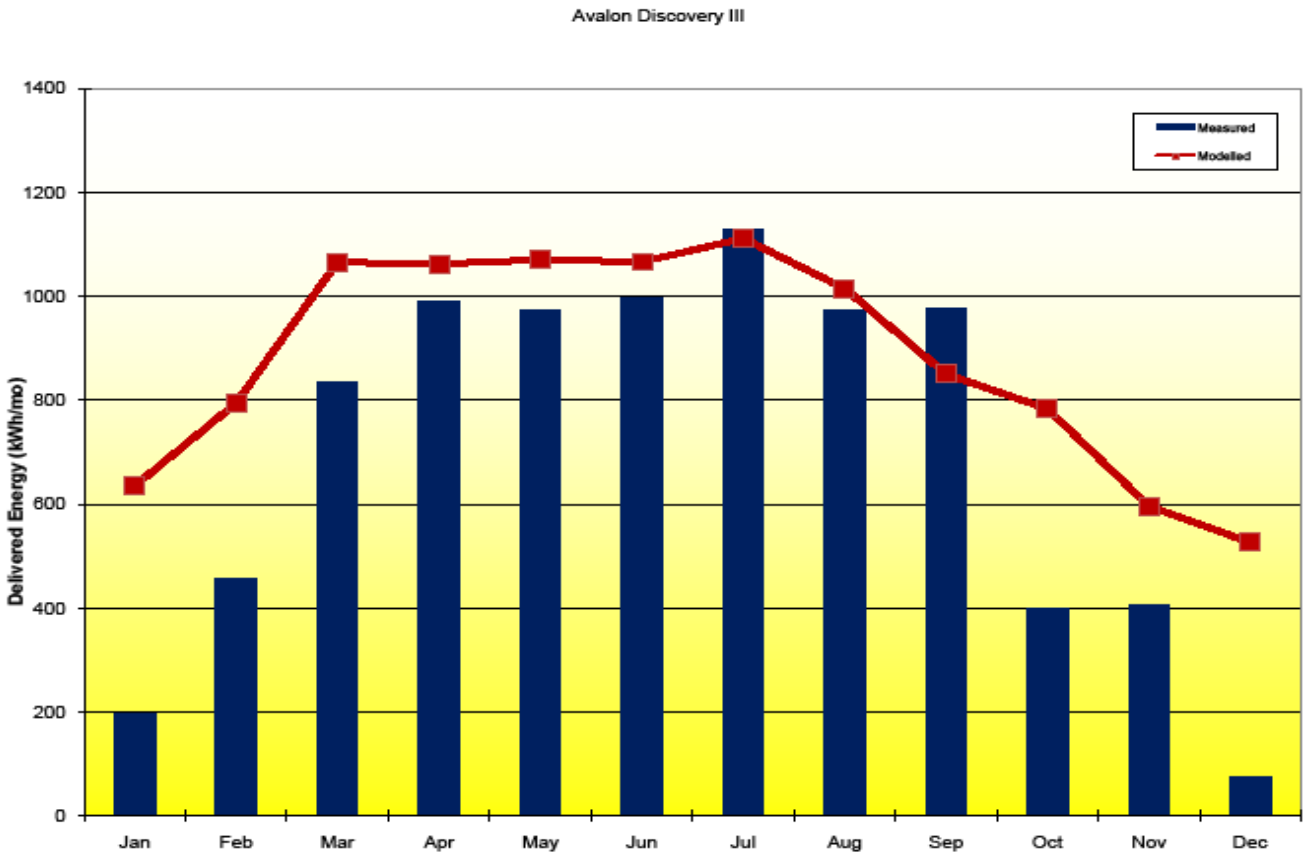
Avalon Discovery 3 (July 2009 – June 2010)



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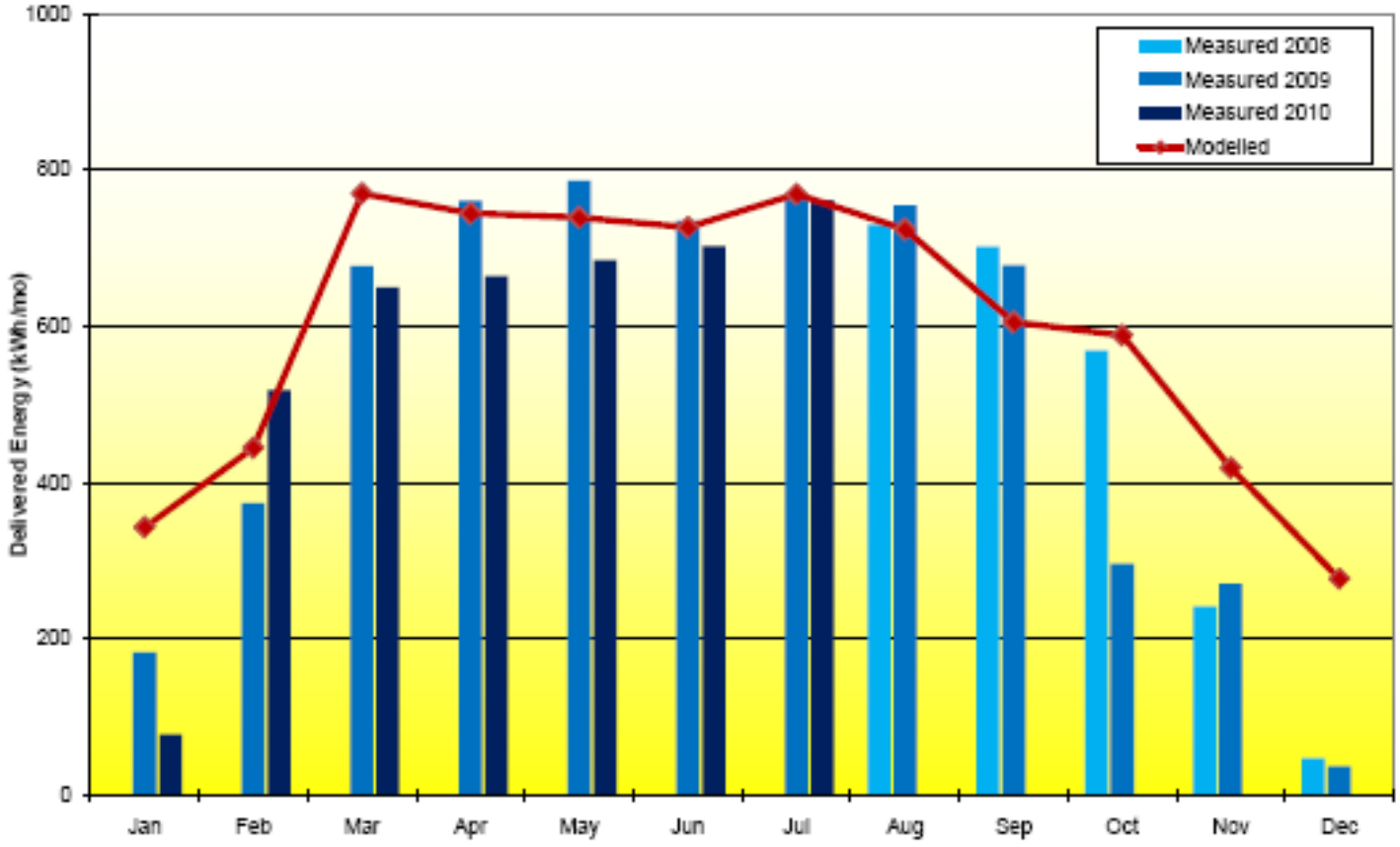
Riverdale West



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Riverdale


During the past 31 days the house consumed 1810 kWh and produced only 152 kWh. OUCH!

- Mortgage Loan Insurance
- Housing Market Information
- Affordable Housing Centre
- Building and Design
- Sustainability
- Research Highlights
- Grants and Awards
- Mortgage-Backed Securities
- Investments
- CMHC International

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Canadian Housing Observer 2010

Now House®

The Now House® home generates energy from a solar photovoltaic (PV) system on its roof.

As of: January 28, 2011 12:34 PM EST

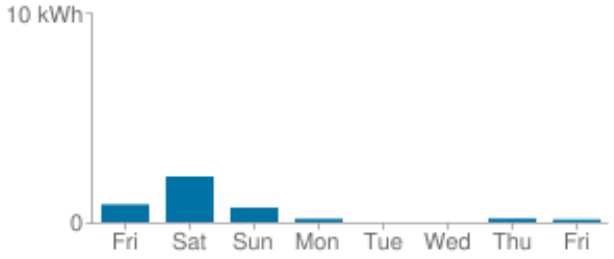
System Size: 2.000 kW DC

Currently Generating
59.0 W

Local Weather

Historical | Today | Week | Month | Year | Lifetime

Total Generated this Week
4.2 kWh



Saturday = 2 KWh

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January 20, 2011

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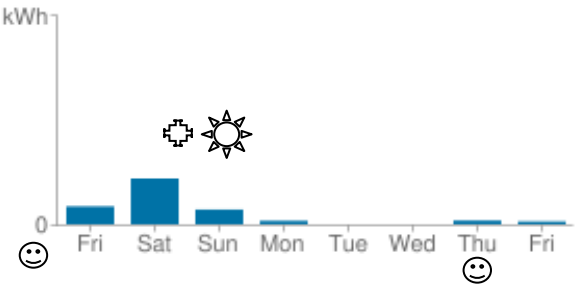

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January 27, 2011

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Now House®

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As of: January 28, 2011 12:43 PM EST

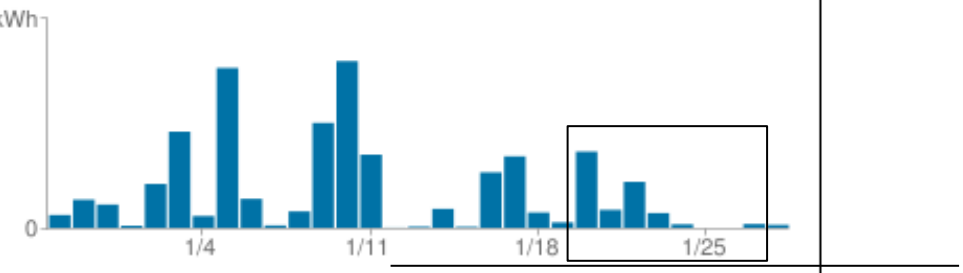
System Size: 2.000 kW DC

Currently Generating
59.0 W

Local Weather

Historical | Today | Week | **Month** | Year | Lifetime

Total Generated this Month
55.5 kWh



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CANADA MORTGAGE AND HOUSING CORPORATION

Now House®

The Now House® home generates energy from a solar photovoltaic (PV) system on its roof.

As of: January 31, 2011 12:07 PM EST

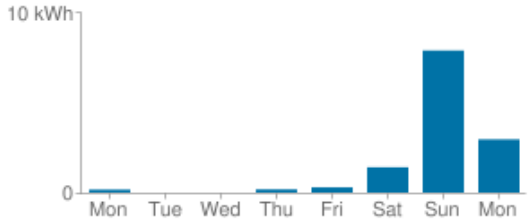
System Size: 2.000 kW DC

Currently Generating
1,547.0 W

Local Weather

Historical | Today | Week | Month | Year | Lifetime

Total Generated this Week
12.8 kWh



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January 31, 2011

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Sustainability > EQuilibrium™ Housing > Now House™

Now House®

The Now House® home generates energy from a solar photovoltaic (PV) system on its roof.

As of: February 1, 2011 10:55 AM EST

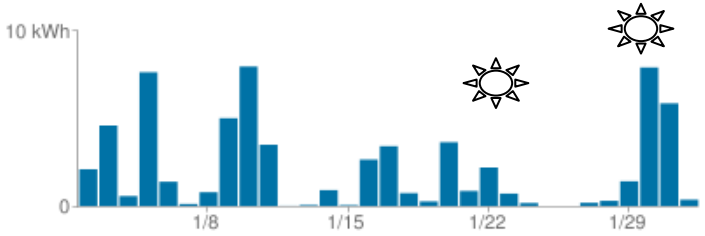
System Size: 2.000 kW DC

Currently Generating
344.0 W

Local Weather

Historical | Today | Week | **Month** | Year | Lifetime

Total Generated this Month
64.9 kWh



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Now House®

The Now House® home generates energy from a solar photovoltaic (PV) system on its roof.

As of: January 28, 2011 12:39 PM EST

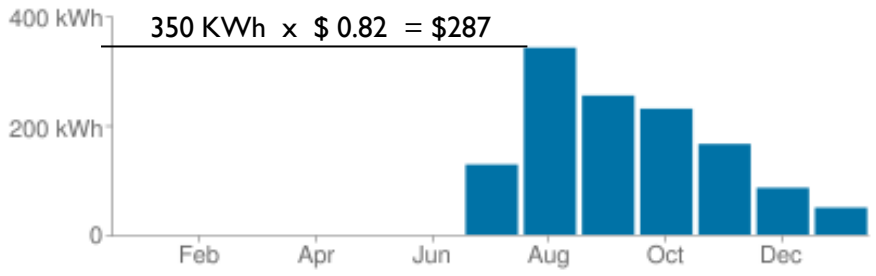
System Size: 2.000 kW DC

Currently Generating
59.0 W

Local Weather

Historical | Today | Week | Month | **Year** | Lifetime

Total Generated this Year
1,254.1 kWh



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As of: February 1, 2011 9:18 AM MST

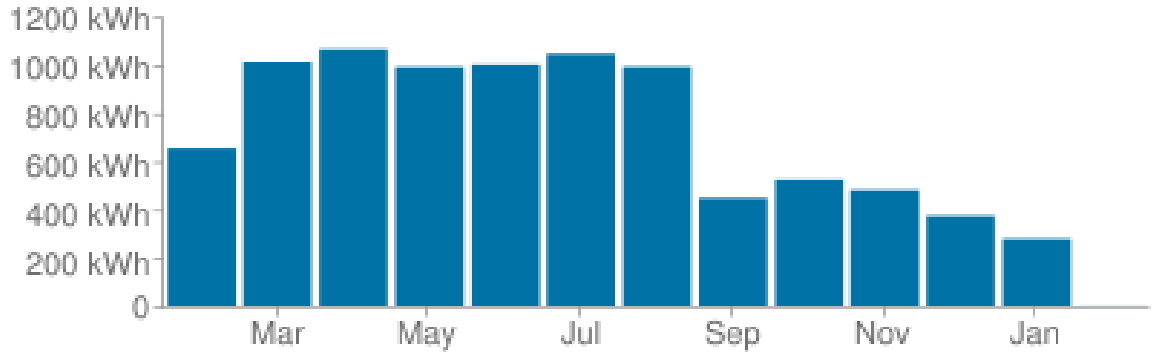
System Size: 6.732 kW DC

Currently Generating
2,445.0 W

Local Weather

Historical | Today | Week | Month | **Year** | Lifetime

Total Generated this Year
8,849.0 kWh



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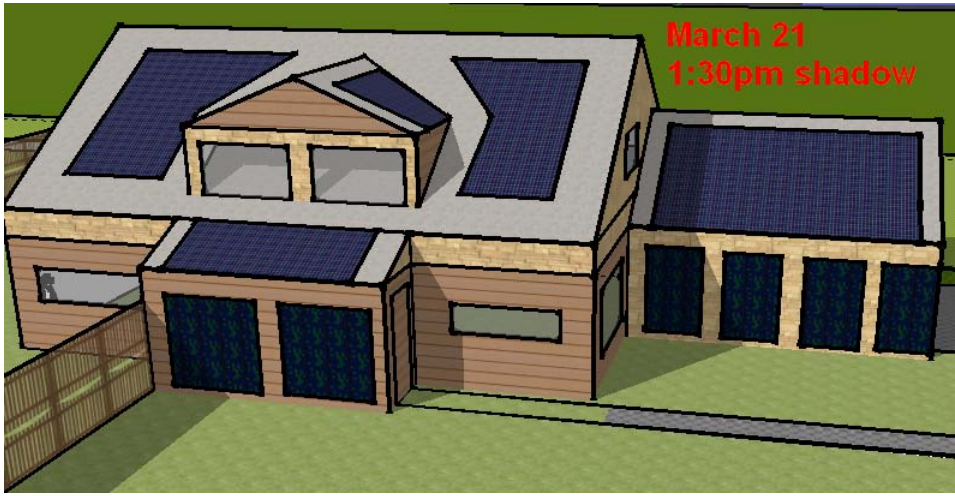
Compare PV output of Avalon and CHESS

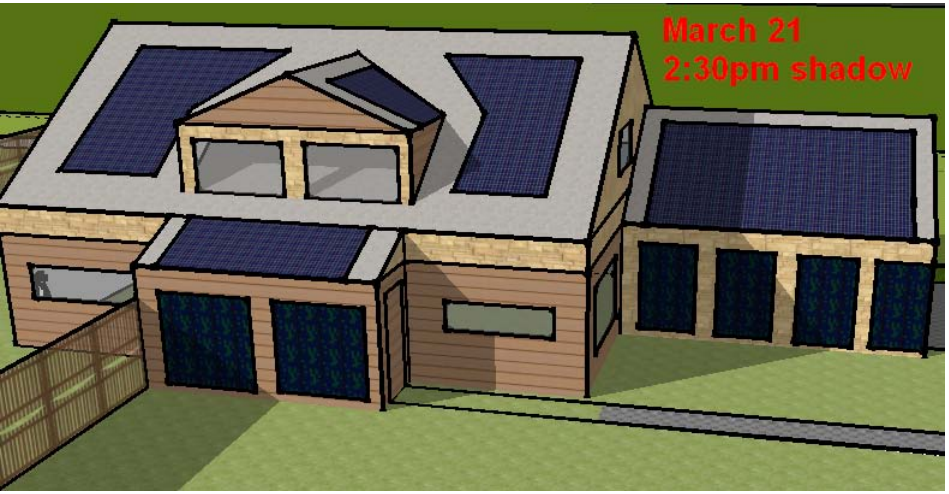
- Predicted outputs correlated with their installed capacity:
  - Avalon annual PV energy predicted to be 9720–10,563 kWh (calculations by different contractors) for a 9.2 kW system or 1185–1280 kWh/kW
  - CHESS annual PV production predicted to be 8300 kWh for a 6.7 kW system or 1240 kWh/kW, same
  - Wh/kW
    location and ideal slope

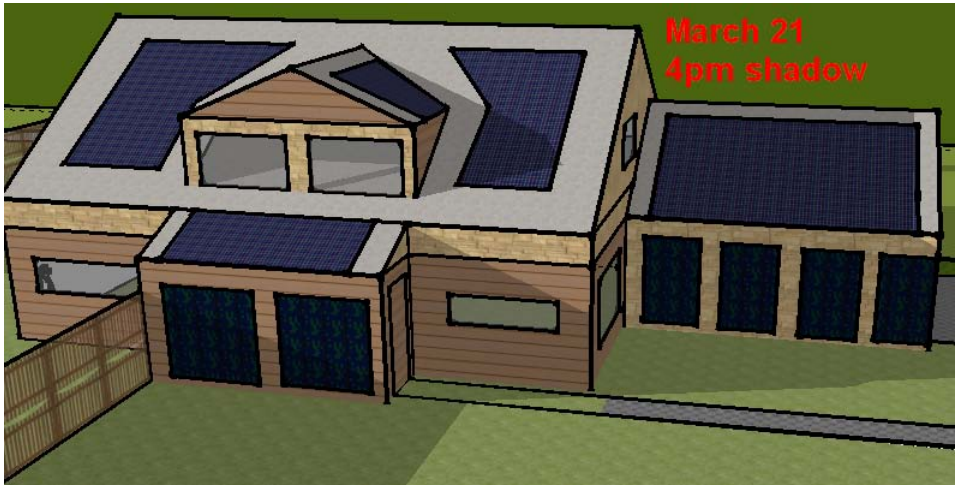
RED DEER PROJECTS

SHADING STUDY

Avalon Discovery 3 — March 21st shadow patterns







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CHESS system has no shading

PV output: Predicted vs measured (cont.)

- From January 2010 through mid-July:
  - Avalon with an 8.2 kW system produced about 5600 kWh
  - CHESS with a 6.7 kW system produced about 6000 kWh
- Predictive programs could not deal with the subtleties of shading

Actual electrical consumption larger than predicted

- Predictions were biased low to meet net zero targets and to avoid more expensive PV capacity
- Homeowners are not necessarily being as energy efficient as predicted
  - Monitoring equipment loads will also be a factor in some cases

Modelling Electrical Consumption

Internal use:

- Lighting: ~~3.0 kWh/day~~ 1.0 kWh/day (1,~~095~~ 365 kWh/year)
- Appliances: 9.0 kWh/day (3,285 kWh/year)
- Other: 8.0 kWh/day (2,920 kWh/year)

External use:

- All: 4.0 kWh/day (1,460 kWh/year)
  - Includes clothes dyer (140 litres)
  - External & garage lighting, openers, well pumps

Total: 24.0 kWh/day (8,760 kWh/year)

Modelling Appliances

- Refrigerator: 440 litres (15.5 ft3) - 537 kWh/year
- Stove: 4 burners; 60 litres oven. - 758 kWh/year
- Clothes washer: tub 60 litres. - 802 kWh/year
- Freezer: 283 litres (10 ft3). - 573 kWh/year
- Dishwasher: 150 litres volume - 615 kWh/year

Total: 3,285 kWh/year

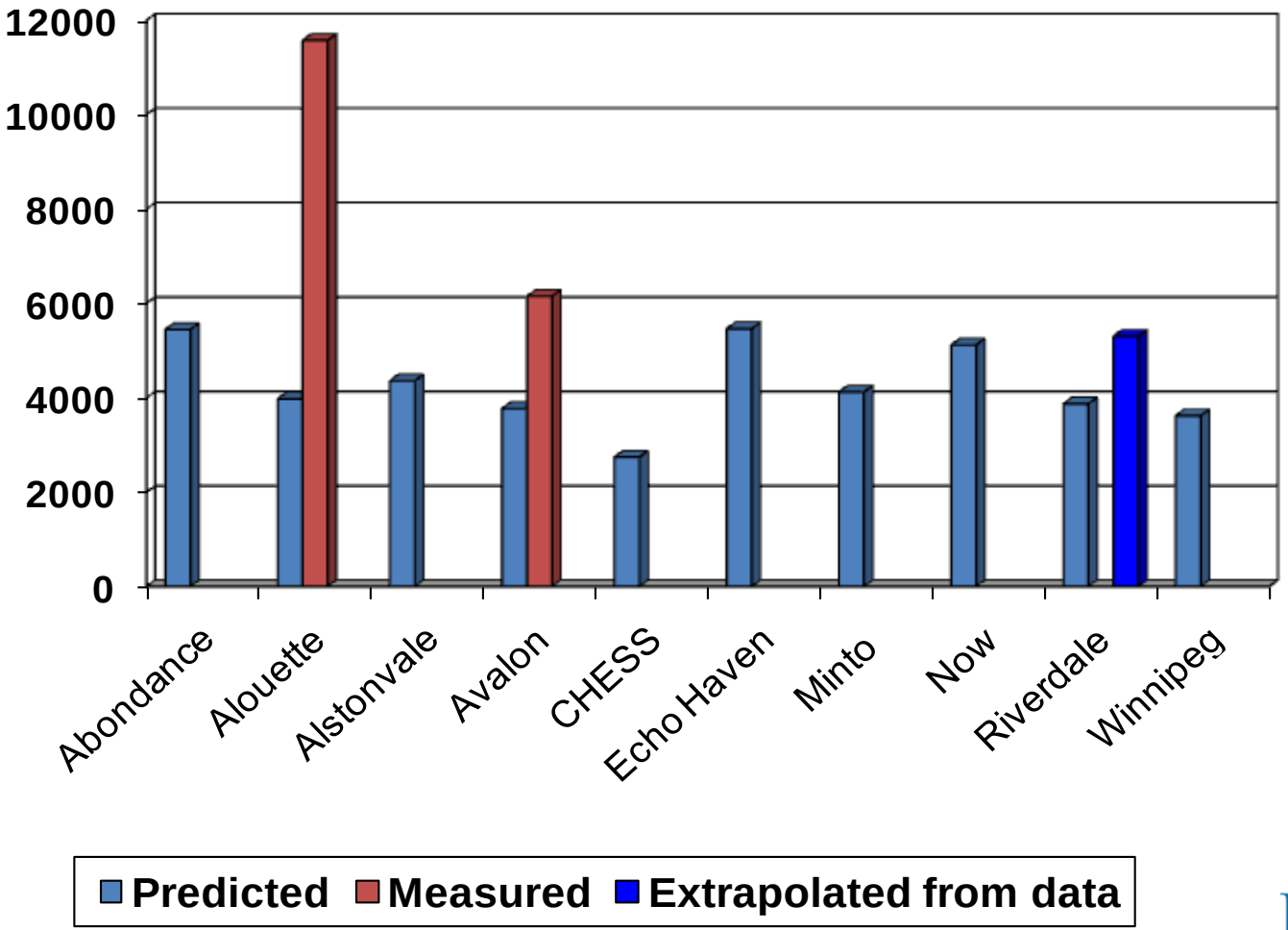
EnerGuide Appliance Directory published by Natural Resources Canada

Base load reductions for Other uses

Electricity use for other uses includes microwave ovens, small appliances, TVs, stereos, computers, and all other plug loads. **(8.0KWh/day)**

The design team may reduce these to a minimum of **3.0 kWh/day**, providing a technical justification for doing so.

Electrical consumption for lights and appliances



Complex systems can lead to errors or oversights

- If it isn't easy, errors are more common
  - Electrician shut down PV output in Now House while installing sensors and forgot to turn it back on. Several weeks of production were lost.
  - Solar thermal systems do not appear to be providing as much energy as predicted
  - Even solar DHW is often far below predicted production
  - Storage tank mix-ups have affected energy usage in at least two houses


Active Solar Hot Water & Space Heating
What:
Qualities:
Supplier:
Drain-Water Heat Recovery
What:
Qualities:
Supplier:
-TO-CODE
chanical ltd
mbing & heating
0-433-4026
-to-code.com
supplied by
Hydraft Development Services Inc.
Contact David Morrow
780.474-8212

Riverdale


Kamstrup
EnerWorks
Solar Domestic Hot Water Appliance
WARNING

Minto

Simple monitoring

- CMHC chose to do simple, monthly monitoring in the EQ houses
  - Lower cost to install and analyze
  - Lower burden on homeowner (less equipment in view)
  - Low to no energy usage by monitoring system to affect the energy balance
  - Fewer electronic glitches

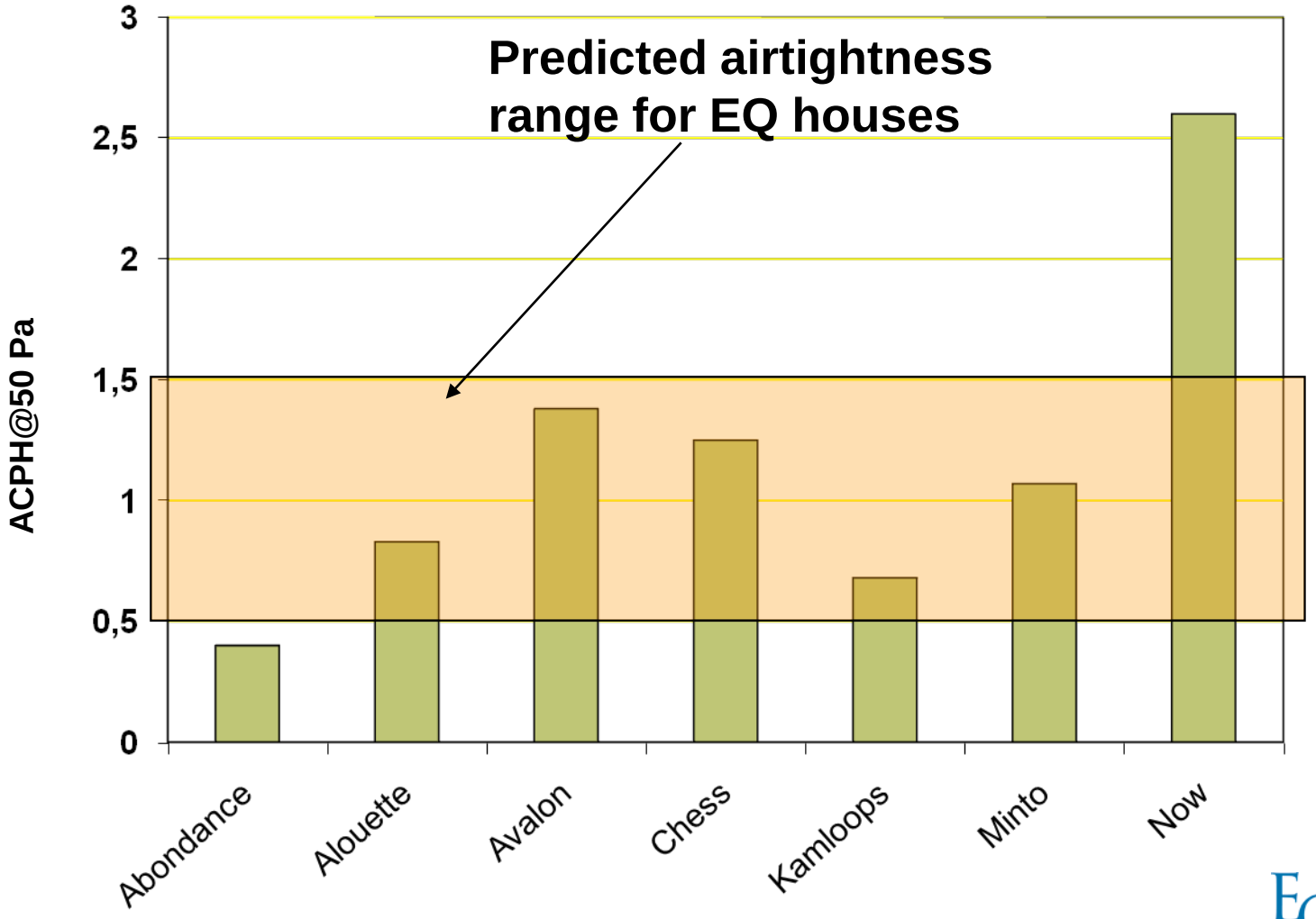
Simple monitoring (cont.)

- This simplicity has its drawbacks
  - Consultant visiting the site may miss a month here or there
  - Harder to account for performance deviations in complicated equipment
  - Lacks instantaneity of electronically-dispatched data

Airtightness targets

- All EQ houses were predicted to be very airtight
  - E.g. in a range that runs from Passivhaus (0.6 ACPH @50 Pa) to R-2000 (1.5 ACPH @50 Pa)
- Actual tests show that some have met targets and some houses have more air leakage than anticipated
- All those tested so far are quite airtight

Airtightness test data



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What's Next

- Air quality testing results.
- More detailed energy monitoring results/conclusions
- EQuilibrium insights into specific aspects of the homes.
- EQuilibrium Communities

Thank You