Eco-Sense

A Modern Story of Sustainability


Ann and Gord Baird
co-creators of Eco-Sense
Architect: NATURE

Our Story

TRAILER

LIFE

Three Generation Family of Six


Eco-Sense:
First completed and audited project for the Living Building Challenge

The Living Building Challenge

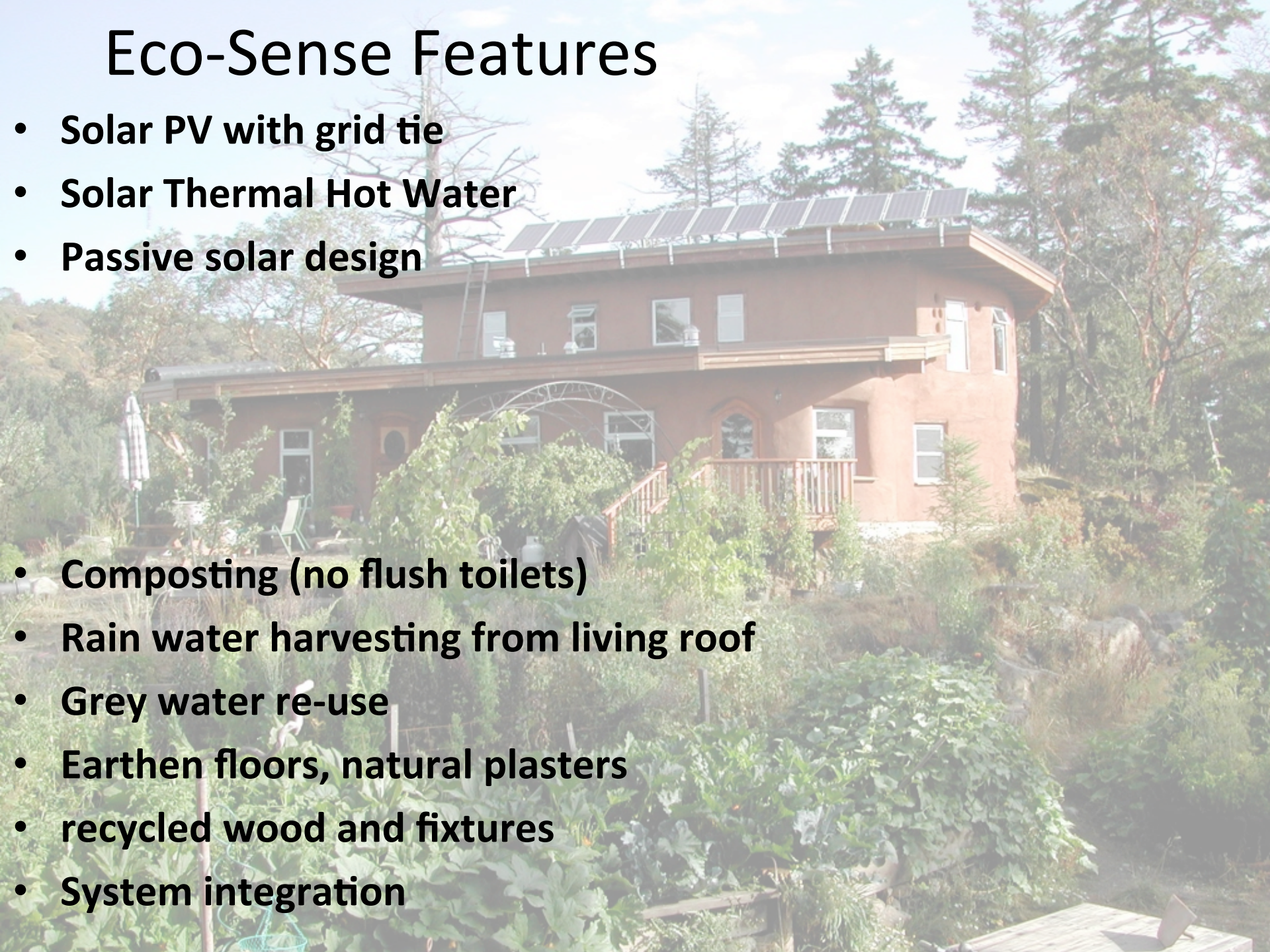
"The world's greenest modern house"

Jason F. McLennan

CEO Cascadia Green Building Council, CEO International Living Building Institute

Eco-Sense Features

- **Solar PV with grid tie**
- **Solar Thermal Hot Water**
- **Passive solar design**



- **Composting (no flush toilets)**
- **Rain water harvesting from living roof**
- **Grey water re-use**
- **Earthen floors, natural plasters**
- **recycled wood and fixtures**
- **System integration**

MUD – A Modern Utopian Dwelling

What
is
Cob?

Clay
Sand
Straw

Clay Properties

- Specific Heat Capacity 0.84 kJ/ kgC
- Water content 1%-6%
- Controls Humidity (absorbs-deabsorbs)
- Low embodied energy
- Electronically binds at the molecular level
- Requires water and MECHANICAL force to break the platelet bonds
- Porous


S220

What's it like to live in a sustainable Home?

- Using 90% less electricity
- Using 90% less water
- Home built with a zero Carbon Footprint
- Utilizing natural construction materials
- Utilizing natural finishing
- Utilizing recycled materials

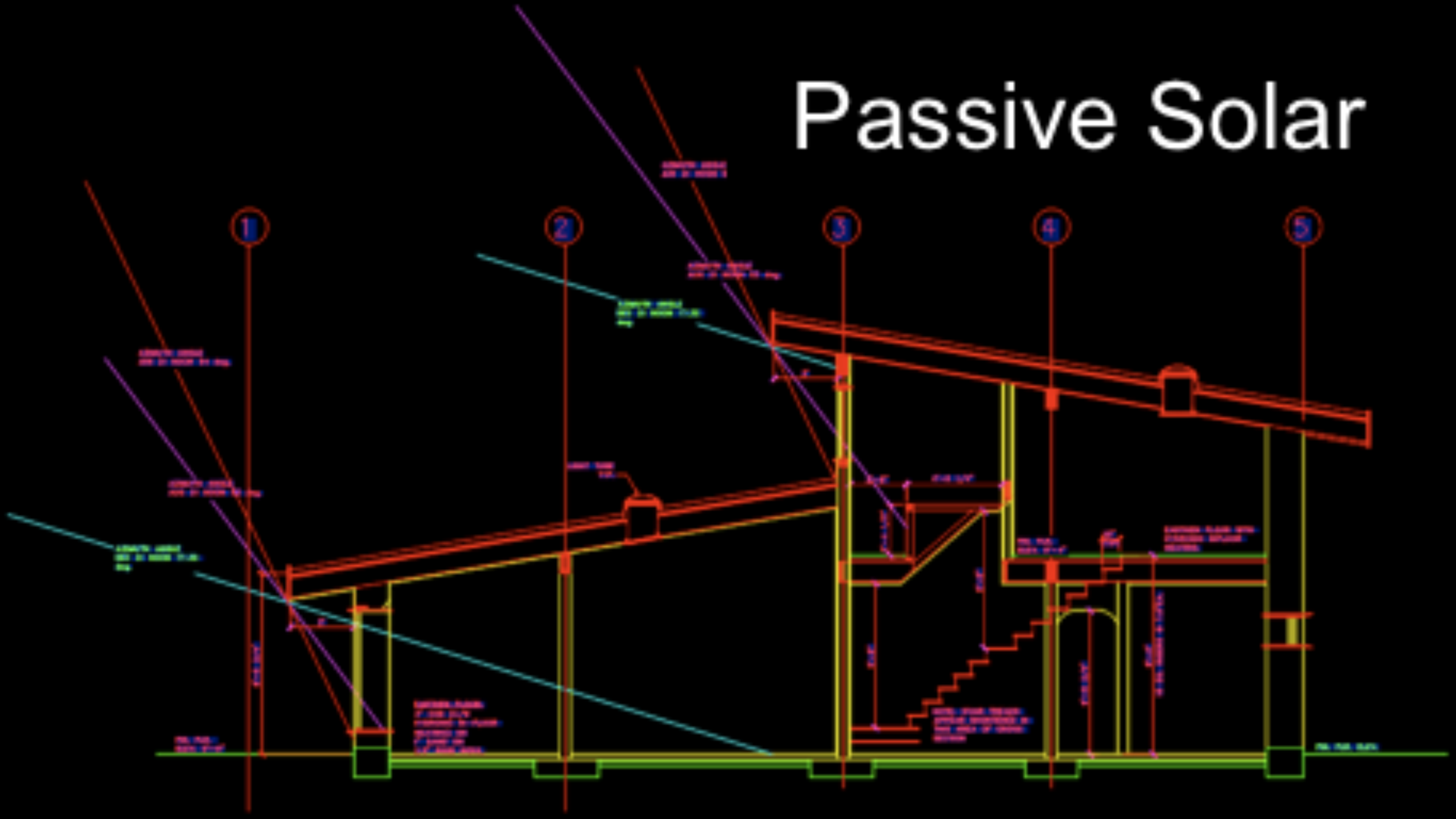
Mom and Dad's Kitchen

Solar Energy

Two types of Solar

- Active Solar
  - Solar PV to produce electricity
  - Solar thermal for hot water
- Passive Solar
  - design of the house
  - grow our food and our wood
  - Use solar produced organics to make compost

Passive Solar



South Exposure. Overhangs to block summer sun. Mass walls/floors to absorb winter sun. Upper opening windows to allow air flow (create chimney). Slopes floors to shed cool air to exits. Light tubes and multiple small windows to create many small light sources. Storage and mechanical place in coldest darkest areas (north wall).

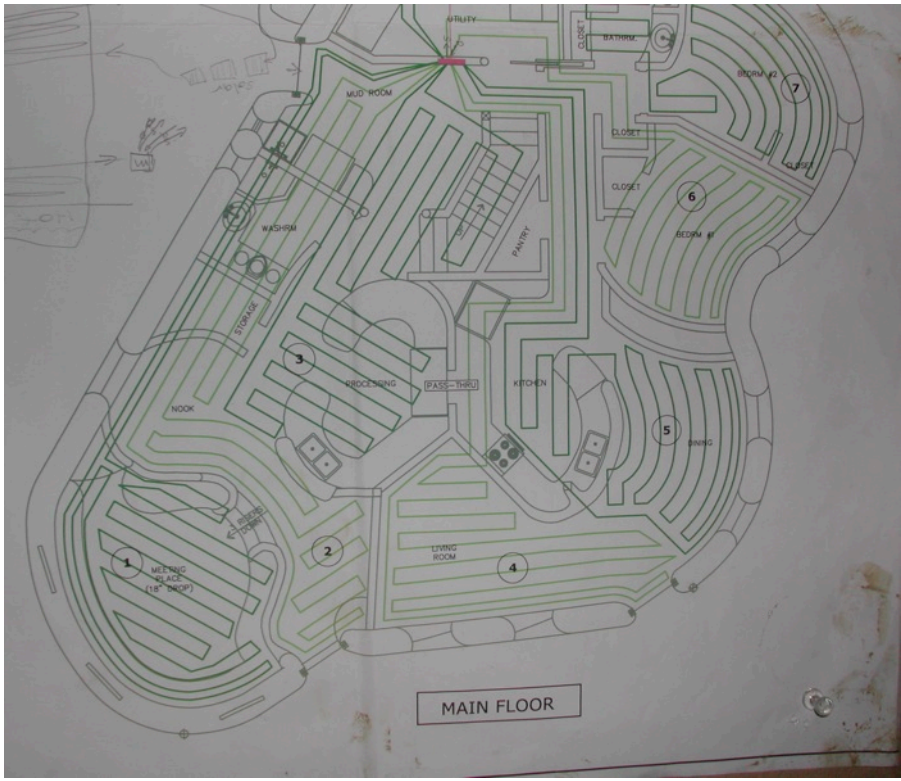
Deciduous trees on western exposure, regular windows on south, low-E on west, triple glaze on North. Reflection pond for additional winter solar gain.

Shading on western exposure.

Grow food or other deciduous plants

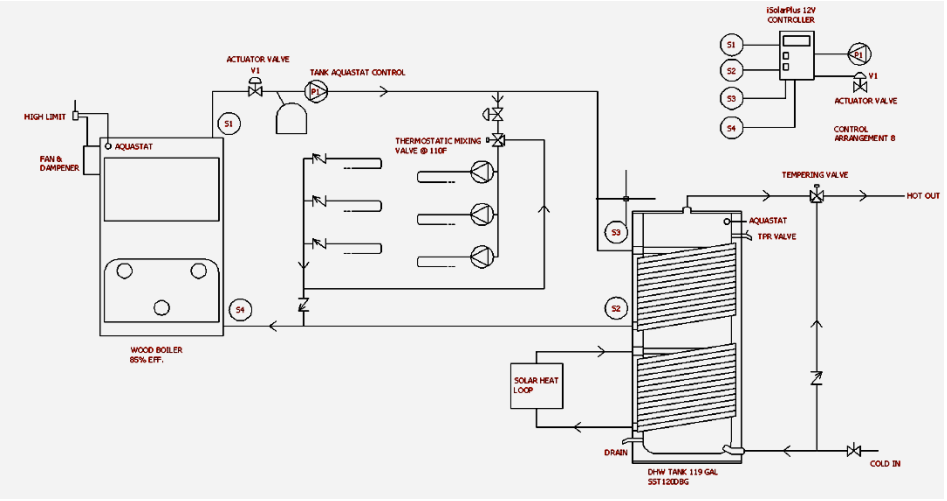
Solar Thermal Hot Water

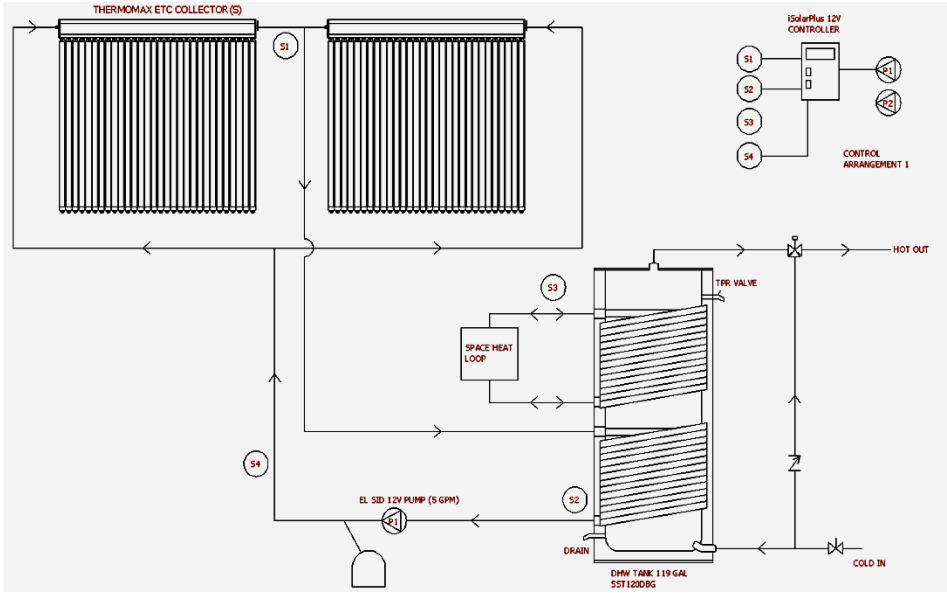
Solar PV - runs all mechanical systems



Hydronic in-floor heating

Eco-Sense
Solar Hot Water System

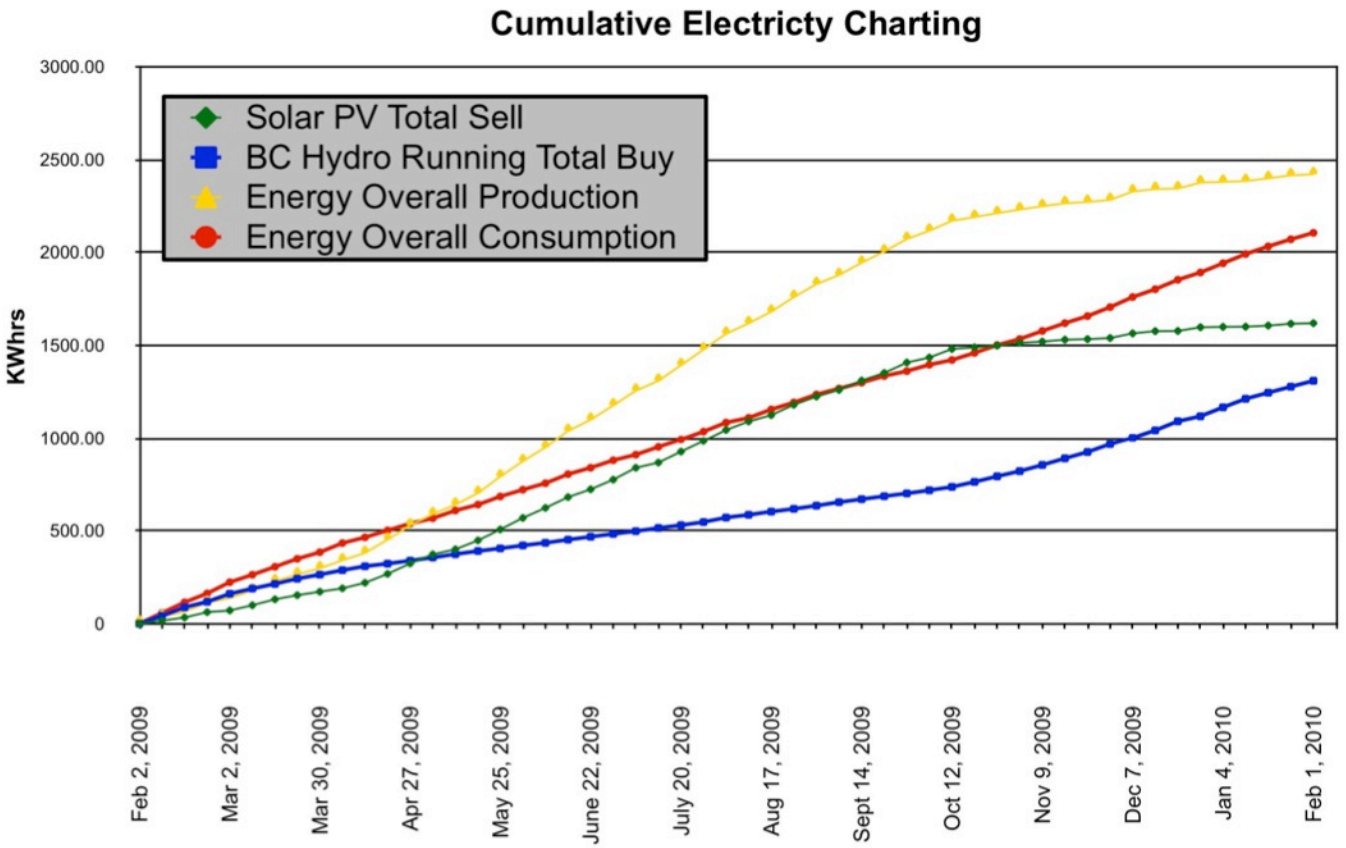




Solar Photo Voltaic – Grid tie

Eco-Sense Energy Strategy

#1 - Conservation – Lifestyle choices and efficiency
#2 - Design for passive solar
#3 - Use Sustainable Energy



Conversation on Conservation
Needs & Wants

Wants:
- Stuff
- Gadgets
- Processed foods
- More Stuff
- Vacations
- Expensive stuff
- Bigger Stuff
- Better Stuff
- Faster Stuff

Needs:
- Love
- Shelter
- Healthy food
- Clean water
- Clothes
- Healthy body
- Family
- Community
- Purpose

Solar Kids

Water

Strategies:

- **CONSERVATION!**
  - We use 17,000 gal/year or 46.5 gal/day or 9.3 gal/pp/day (avg. 107 g/p/d)
- Use **simplest technology** possible to achieve objectives

Rain water Harvesting

- **Rain Water Harvesting for garden irrigation**

- **10,000 gallons in 4 cisterns**
- **Well water for indoor use**

Living Roofs

Living Roof

Rain Water filtration

Garden irrigation

Increase PV Output

Fire Resistant

Bee Food

Quiet

Beauty

Examples of integrated systems

- Living Roof
  - Rain water filtration
  - Storm water control
  - Bees/birds habitat
  - Solar PV output
- Solar Thermal Combination system
  - DHW
  - Space heating
  - Solar dehydrator
  - Thermal mass storage
- Earthen Walls
  - Temperature moderation
  - Humidity control w/o mechanical sys.
  - Structural/insulation/air barrier
- Grey Water
  - Dedicated irrigation
  - Nutrient cycling
  - Water conservation
  - Decreased energy for pumping
- Composting Toilets
  - Nutrient cycling
  - Soil building
  - Food generation
  - Decreased embodied energy
  - Decreased external energy inputs (conservation)

Reasons to stress “simple design/ simple systems”

- Less to break
- Easy to repair

} = RESILIENCY

- Limited reliance on a centralized/specialized industrial system
- Owner/builder can participate
- Less embodied energy
- Less expensive thus more accessible

NATURE IS REDUNDANT, RESILIENT, DIVERSE, LOCAL

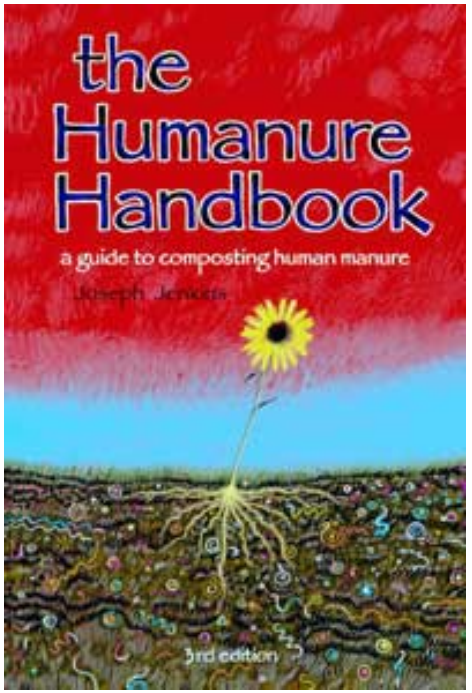
NATURE IS NOT efficient, centralized, or IMPORTED

Grey Water Features

- **Greywater for irrigation of fruit and nut trees**
- **Branched drain to mulch basin system. System developed by Art Ludwig.**
- **Four different grey water systems utilized**

Composting toilets

- **Composting WATERLESS toilets**
- **Based on the book called "The Humanure Handbook" by Joseph Jenkins.**
- **30% of indoor water use is "FLUSHED" away.**
- **Zero Waste – Resource recovery**
- **How does NATURE do it? Compost it.**



What do Rain water, Grey water, and Composting toilets have in common?

FOOD

Carbon Neutral Patio

Earthen Bread Oven

Earth Sheltered Greenhouse

Research on the Eco-Sense home

We gratefully acknowledge the support of our sponsors:

Vancity

real estate foundation BRITISH COLUMBIA

Contributors:

Ann and Gord Baird
Christine Goodvin

Eco-Sense
Goodvin Designs

CASCADIA GREEN BUILDING COUNCIL

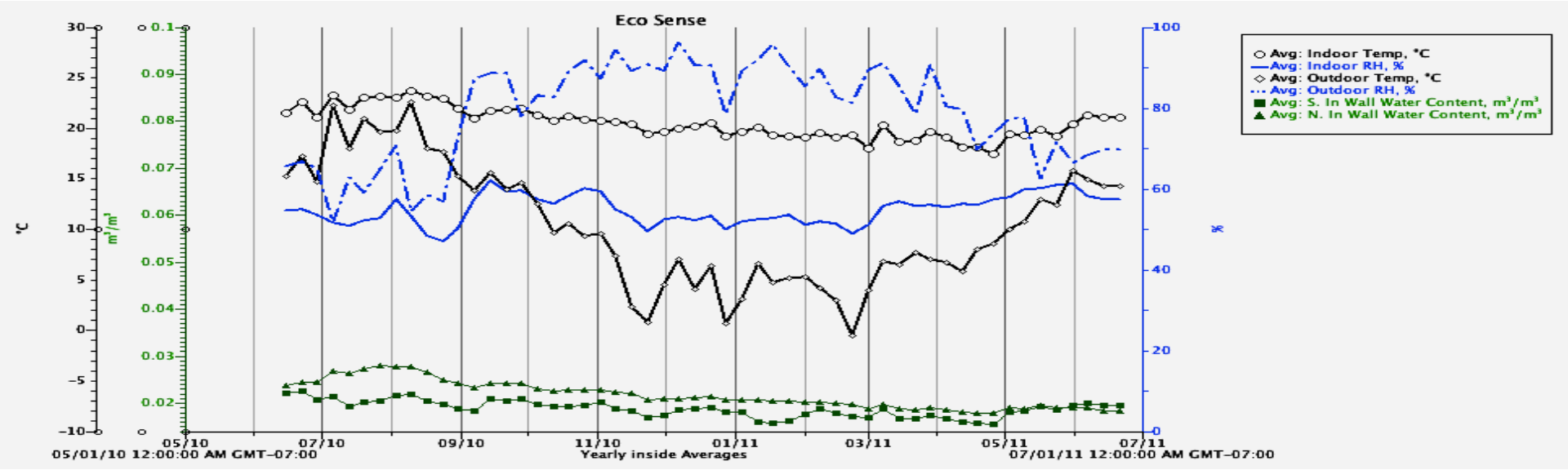
Hobo Link Data Monitor
S-TMB Soil Temp Sensors
S-THB Temp/RH Sensors
S-SMC Soil Water Content
KD2 Pro Thermal Property
iSolar DL2 data logger
iSolar Plus controller
Internet connection
Water meters

Overview of the Research

- Building code
- Wall performance in relation to the code
  - Thermal properties – R/U value, Specific Heat Capacity
  - Vapour diffusion and humidity moderation
  - Moisture
- Carbon Footprint Analysis
- Energy systems
  - All energy inputs
  - Energy profile and consumption patterns

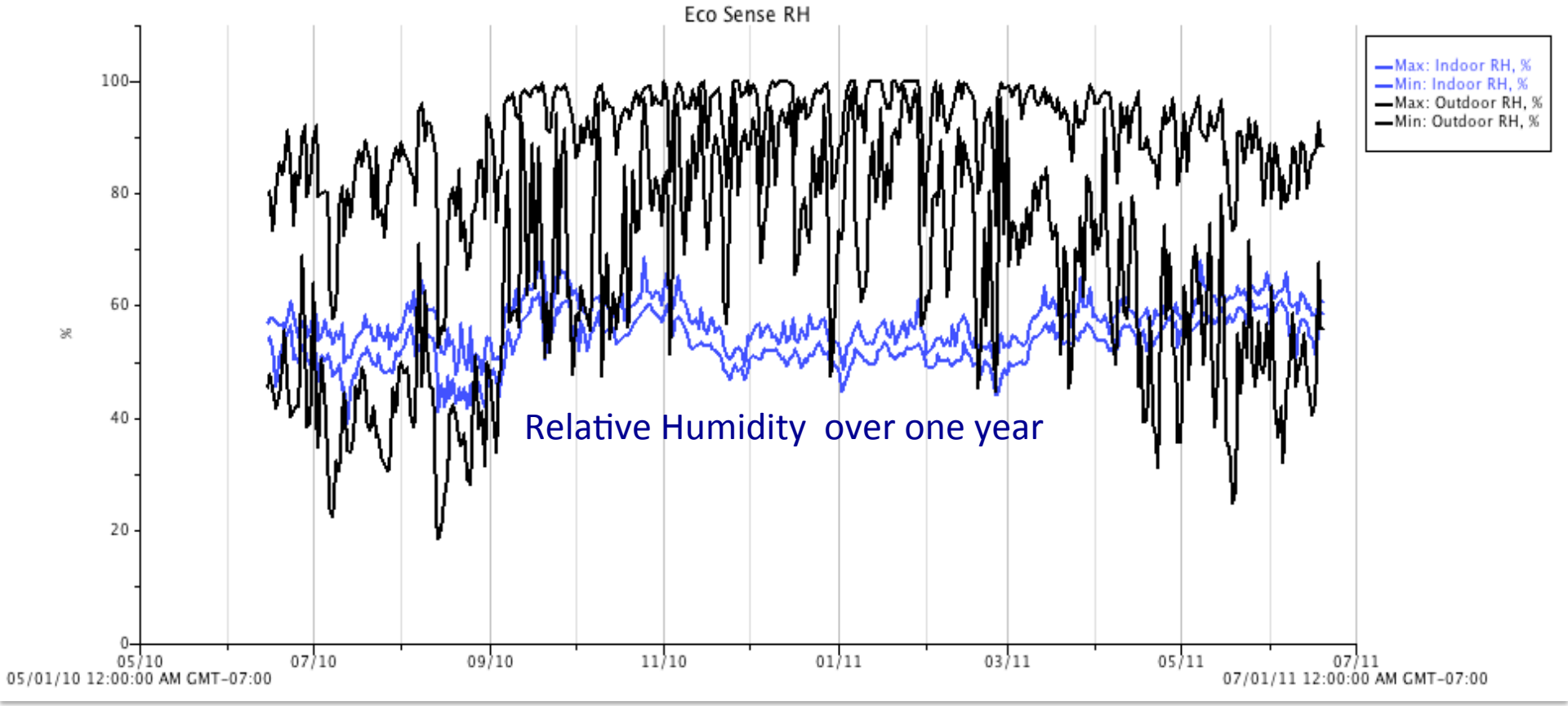
Affordable, Sustainable Homes: Eco-Sense and the Future of Green building

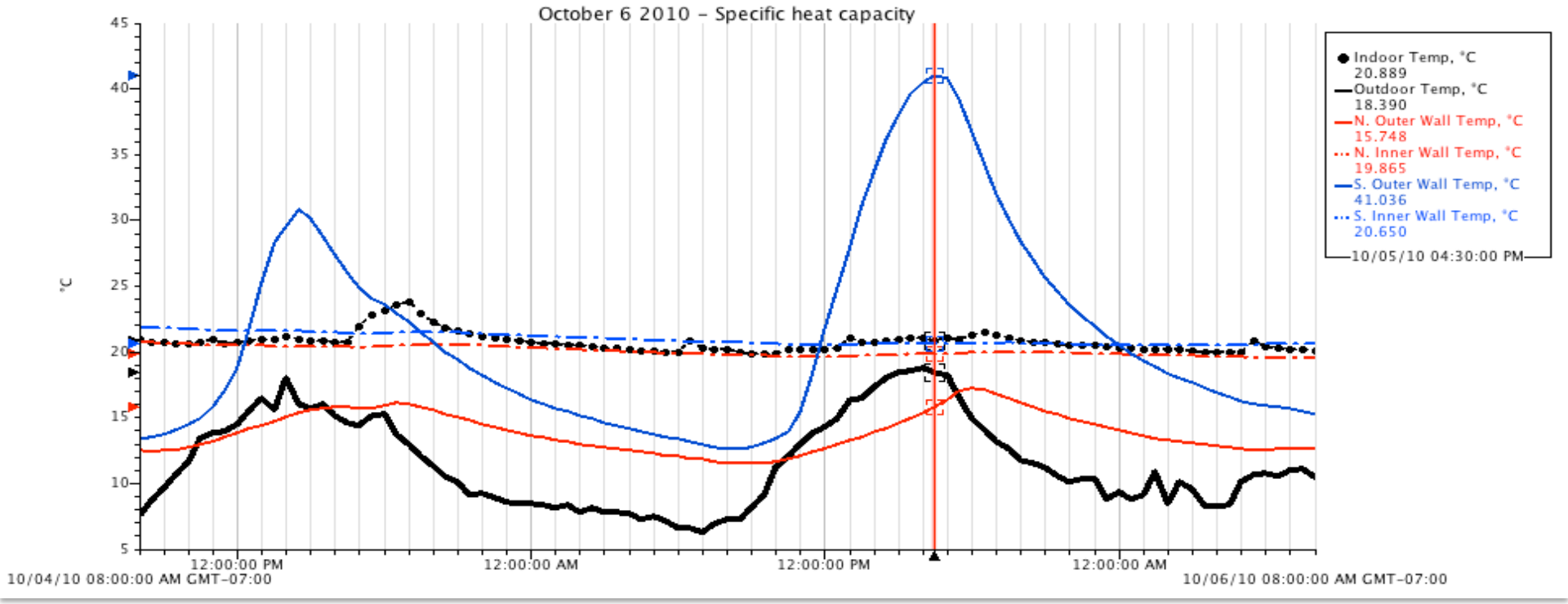
Wall Water Content



	Max & Min Moisture content	Average Annual Moisture Content	Daily Avg moisture content (m^3/m^3) fluctuation	Daily Moisture content range
S. Inner Wall	2.35%	1.88%	0.0012 or 0.12%	1.82%-1.94%
	1.41%			
N. Inner Wall	2.93%	2.18%	0.0010 or 0.10%	2.13%-2.23%
	1.70%			
S. Outer Wall	7.73%	5.21%	0.0079 or 0.79%	4.82%-5.6%
	3.81%			
N. Outer Wall	5.55%	3.20%	0.0045 or 0.45%	2.98%-3.42%
	2.21%			

		Average Annual RH %	Daily Avg RH % Fluctuation	Daily RH% Range
Indoor Max RH	68.6%	54.81%	4.7%	57.16%-52.46%
Indoor Min RH	39 %			
Outdoor Max RH	100%	78.95%	24.7%	91.30%-66.60%
Outdoor Min RH	18.4%			

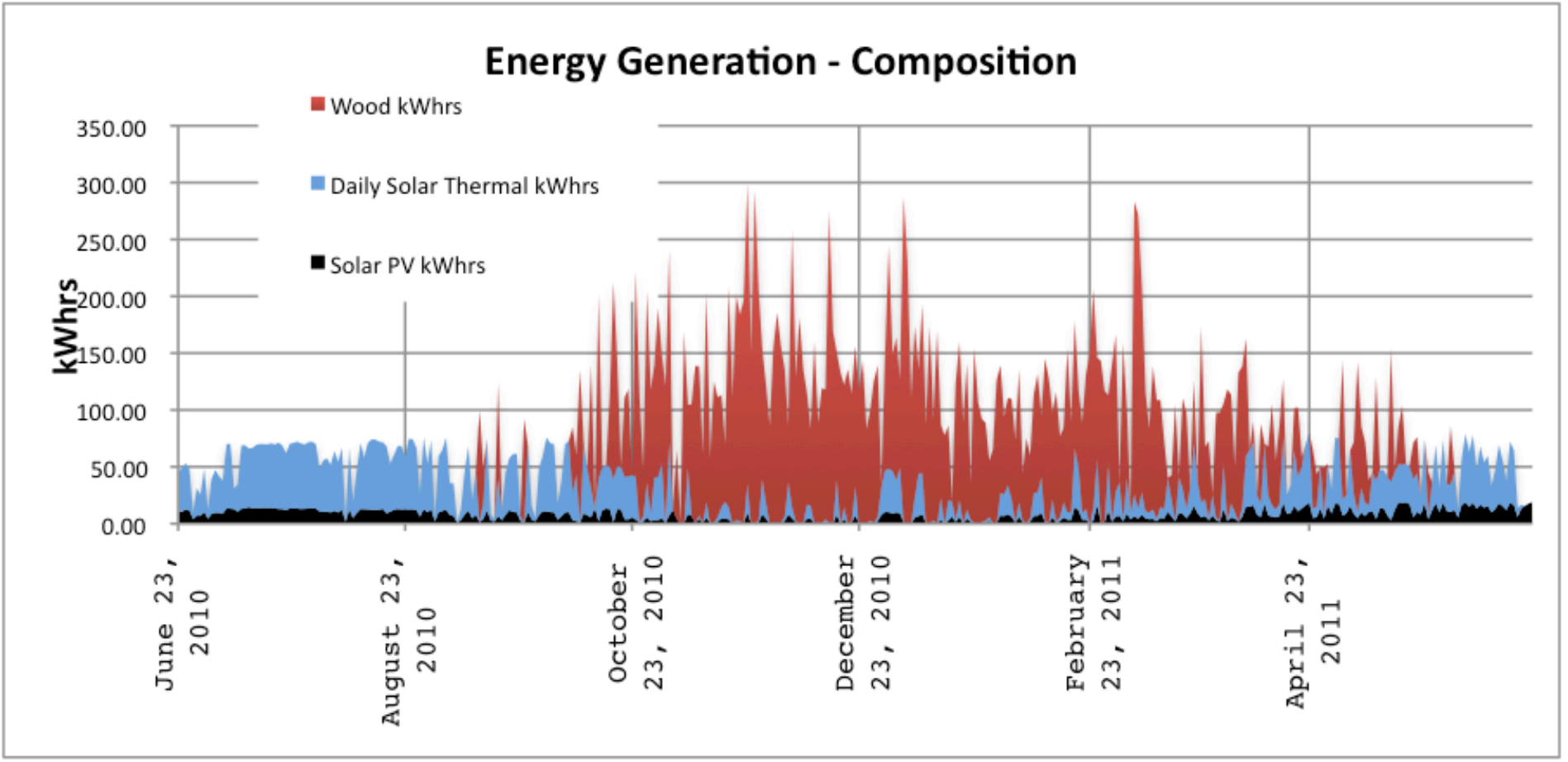




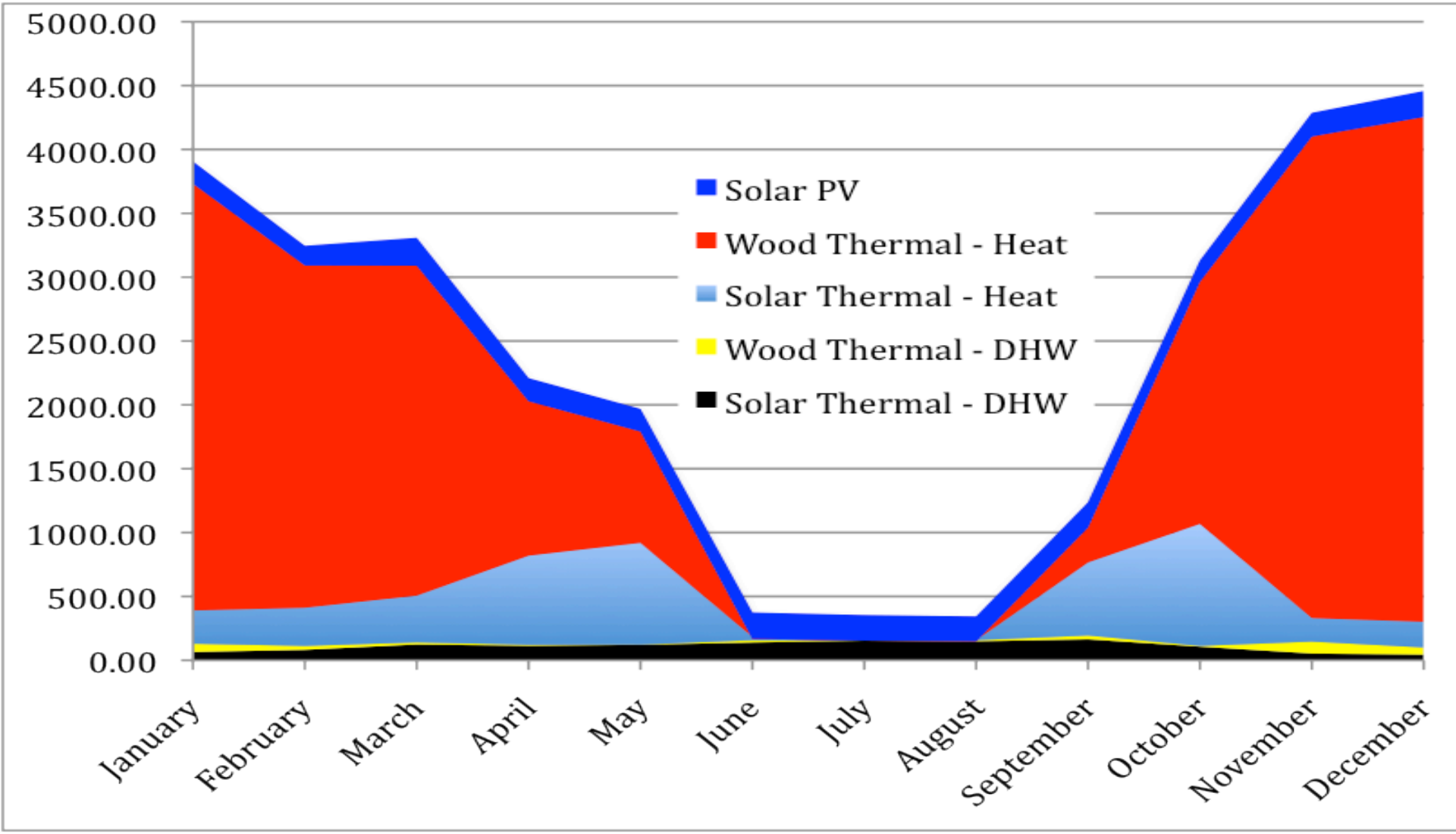
The walls act as a solar battery

Storing and releasing heat energy later

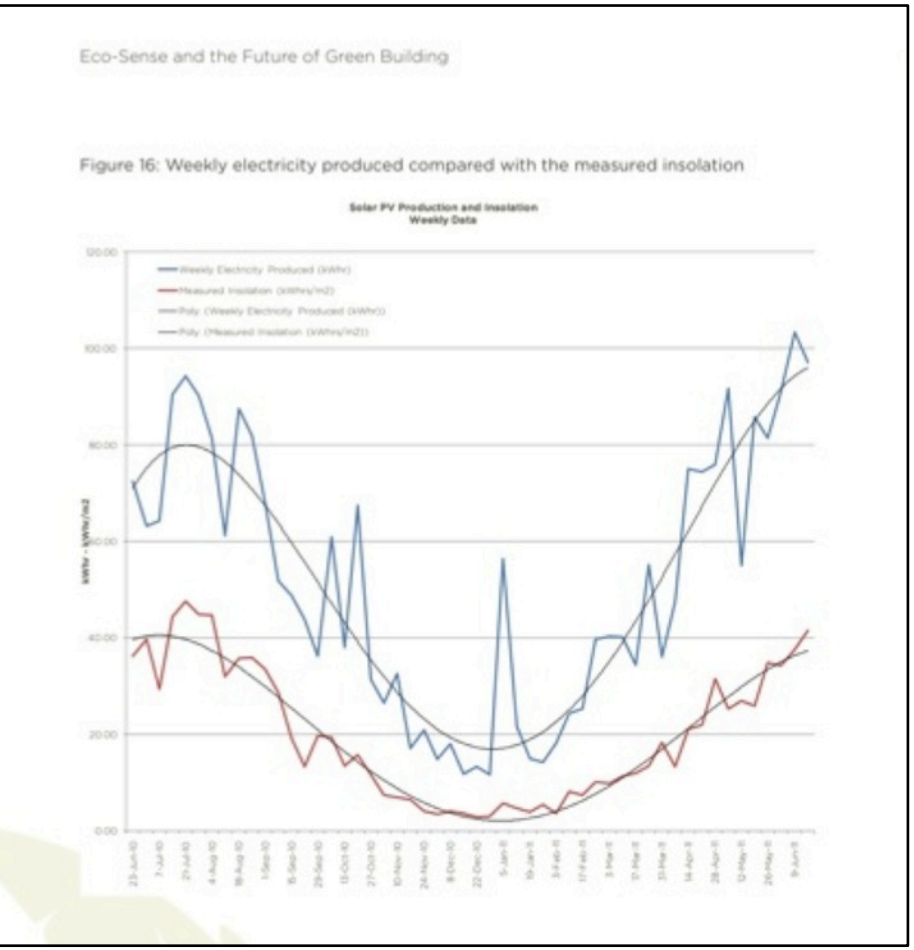
Energy Profile



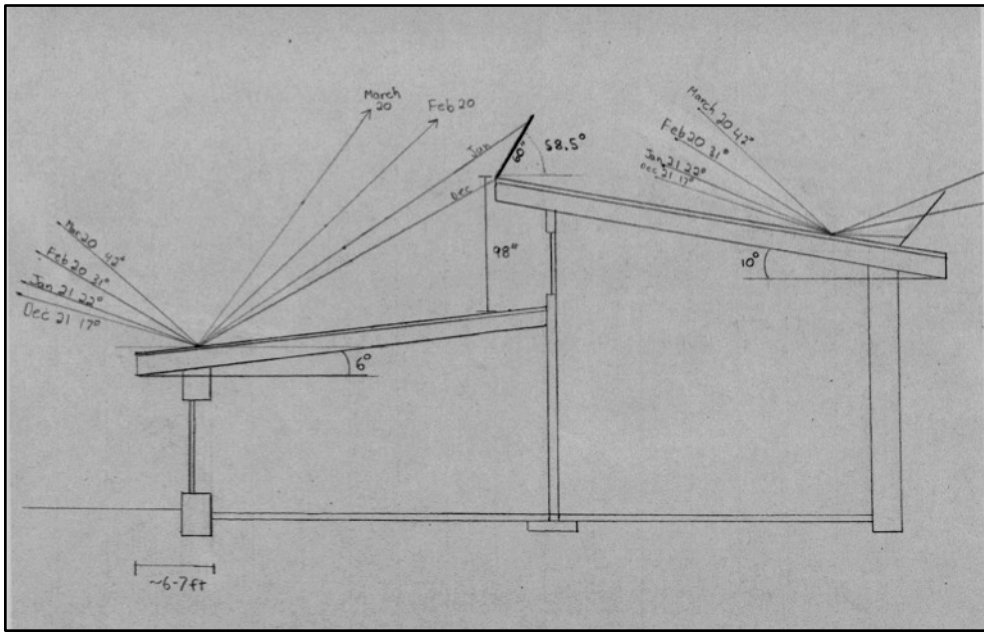
Energy profile by season



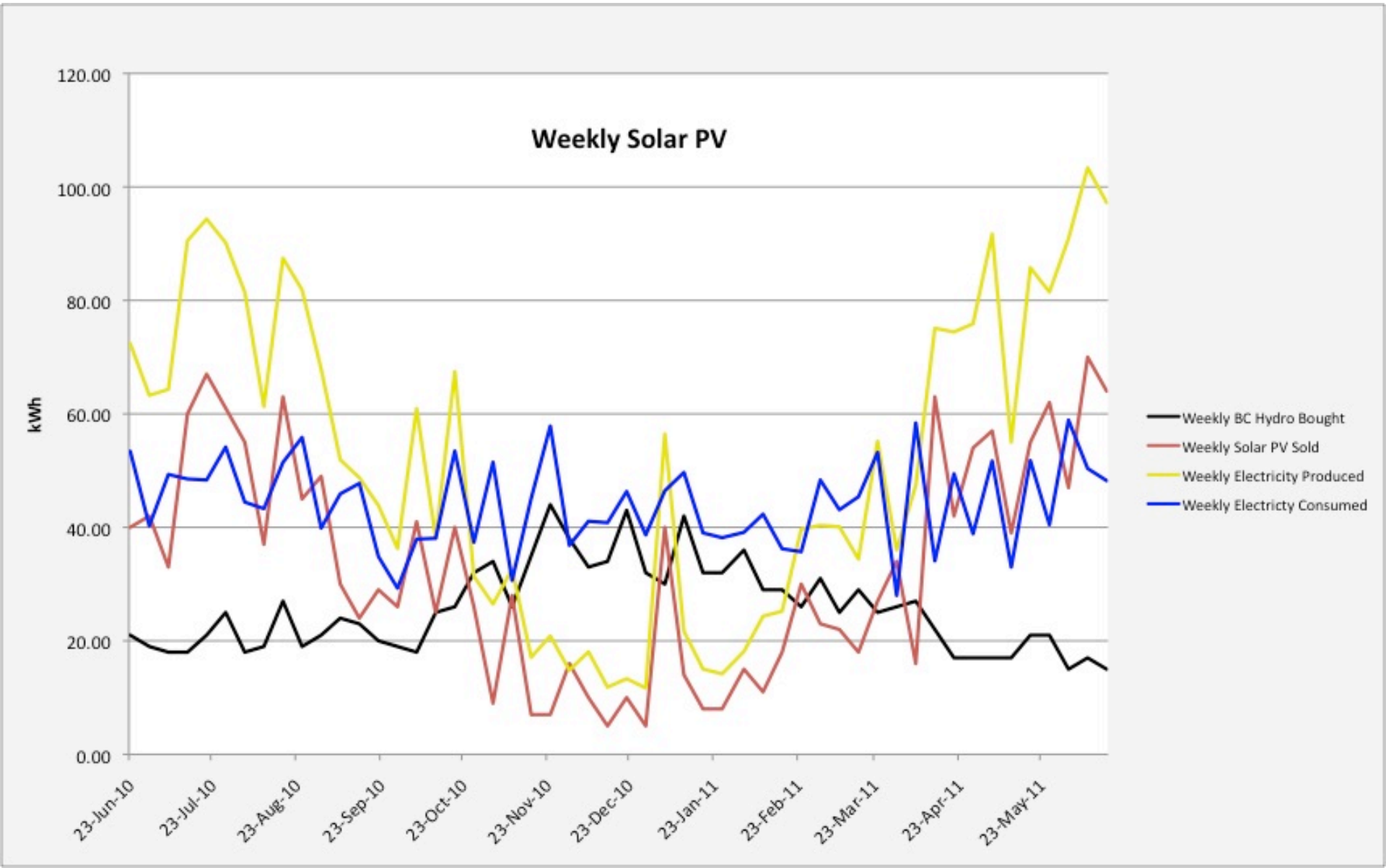
Maximizing Solar in the North



Look what happened to the solar PV output when there was snow on our roof.



Produced Consumed Purchased Sold



Net Zero Electricity

Primary Strategy

ENERGY CONSERVATION

- Lifestyle Choices
- Efficiency

Less Life STUFF; More Life STYLE

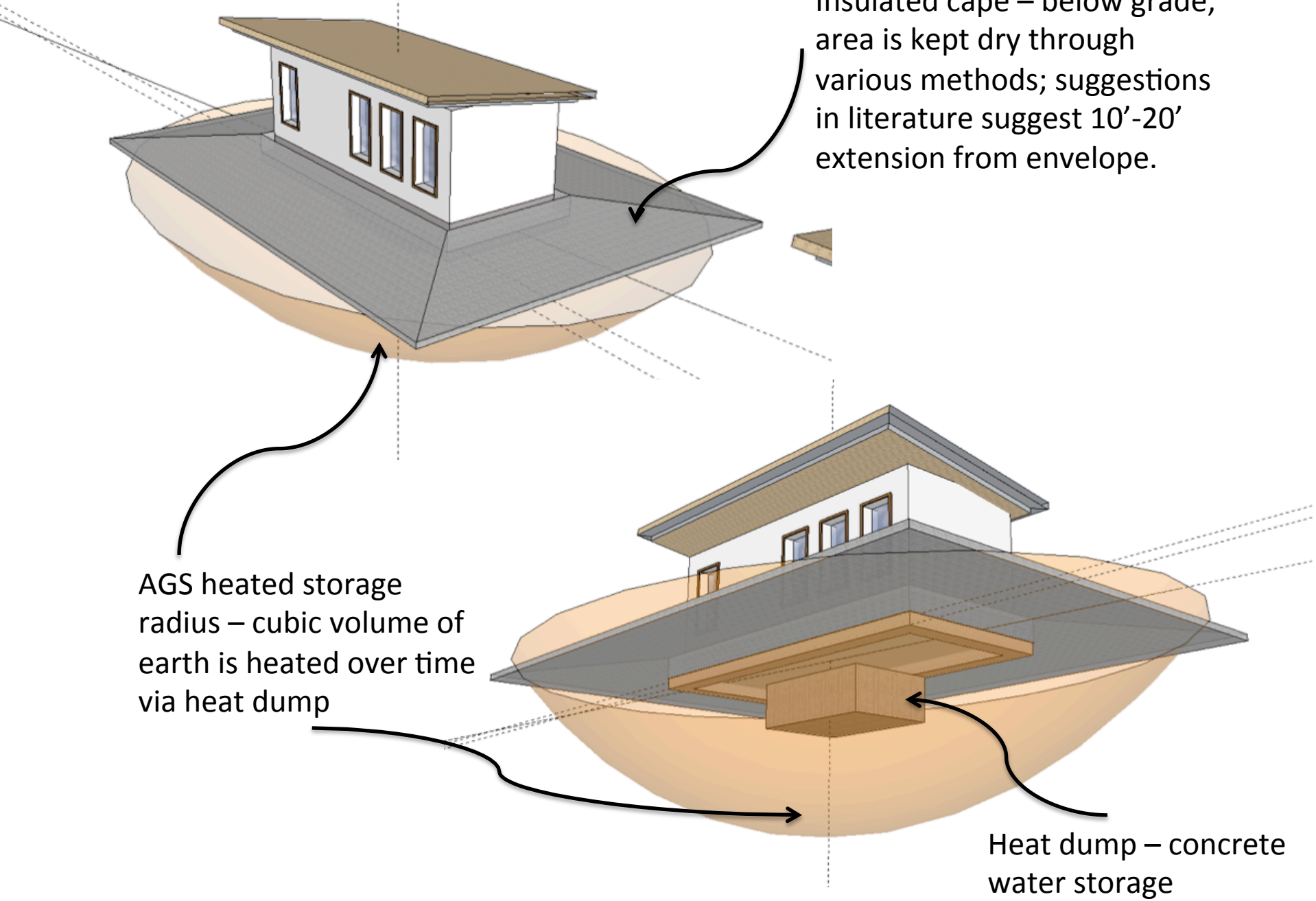
3 Thirds Lifestyle

- Working for $$$
- Volunteer
- Personal passions

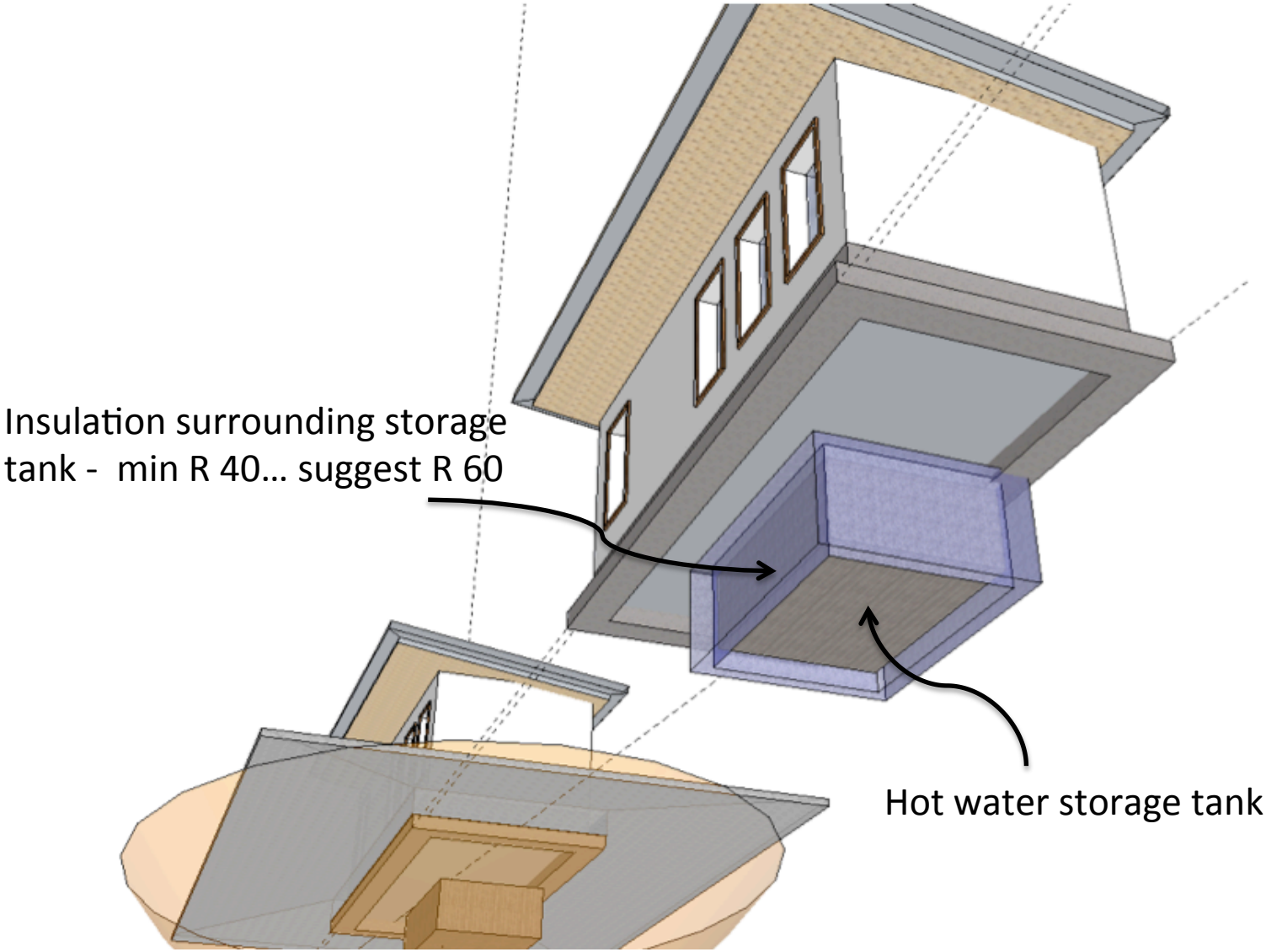
Personal Passions

- Growing food
- Working on home projects
- New Project…

AGS - Annualized Geo Solar



Solar Hot Water Storage



AGS vs SHW

AGS

- Pros
  - It is a passive form of heat
  - Less reliance on mechanical systems
  - Huge storage capacity at low cost per volume
- Cons
  - Can use a lot more insulation
  - More diligent site prep required
  - More variables – virtually impossible to study
  - Question as to heat control

SHW

- Pros
  - Less infrastructure
  - Less variables in design and sizing
  - Able to use to supply HW to hydronics using conventional technology
  - Storage of higher temp differential
- Cons
  - Reliant on pumps, power, temp sensors

Thermal Storage

- dQ = m c dt

  Where:

  dQ = heat supplied (kJ, Btu)

  m = unit mass (kg, lb)

  c = specific heat (kJ/kg oC, kJ/kg oK, Btu/lb oF)

  dt = temperature change (K, oC, oF)

- Eg Heat storage of 1m3 water vs earth vs polystyrene insulation

Foam 10.5 kg	x	1.3 kJ/kgC	x 1 C	= 13.65 kJ	= 0.0038 kW
Water 1000 kg	x	4.186 kJ/kgC	x 1 C	= 4186 kJ	= 1.1628 kW
Cob 1685 kg	x	0.975 kJ/kgC	x 1 C	= 1643 kJ	= 0.4564 kW

- Consider this as the Amp Hours of thermal storage

$$$ Total costs for Eco-Sense Home $$$

Affordability - Cob House Expenses: 2500ft2 outside 2150ft2 inside
Includes suite for parents – total 5 bedroom, 2 bath, 2 kitchen

Section	Total	Notes	$/ft2	% of total
Infrastructure	6,572	not including septic system completion	2.63	1.8%
Foundation	7,277		2.91	2.0%
house wiring	19,576	ac and dc	7.83	5.3%
house plumbing	9,011		3.6	2.4%
structure	51,762	includes $3729 for 42 yards of pumice	20.7	14.0%
finishing	44,584	includes $14,932 for appliances	17.83	12.0%
living roof	12,994	a bit more to come	5.2	3.5%
Communications	1,464	running wires for phone/internet/ etc	0.59	0.4%
Solar Electrical	45,016	Includes grid intertie	18.01	12.1%
Heating and hot	34,778	Hydronic heating, tubes, boiler, etc	13.91	9.4%
Water system	11,714	storage tanks, pumps, irrigation, etc	4.69	3.2%
Professional	9,712	Engineer, CAD plans, permits, HPO	3.88	2.6%
Hired Labour	14,575		5.83	3.9%
Our Labour	101,600	20 months	40.64	27.4%
TOTALS	370,635		148.25	100.0%

VISION

eco sense

Resources

- Tours
- Presentations
- Consulting
- System Design
  - Heating, building, energy
- Email support

Free:

Research Reports

How to booklets

Utube Videos

Blog

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