

# **Net Zero Energy Homes**

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## **– Challenges, Barriers, Opportunities and Effects –**

**2008 Canadian Decentralized Energy Conference**  
**Exploring Alternatives to Traditional Generation**  
**Calgary**  
**2008 September 16**

**Gordon Howell**  
**Edmonton**

# What is a Net Zero Energy House?

- A house that generates all its own heat and electricity on an annual basis...
- Net zero energy is just the dividing line between
  - net deficit energy (which is where all our houses are), and
  - net surplus energy (where the house is a benefit to the environment because it exists)
- It has never been done before in Canada.



# CMHC EQUilibrium Housing Initiative

- CMHC national sustainable housing initiative
  - design-build-demonstration
  - 12 across Canada
  - 4 in Alberta (Edmonton, Red Deer (2), Calgary)
- Cooperative effort
  - with progressive builders & developers
- Phases:
  - Integrated design process, public demonstration, performance monitoring, and reporting



# *Net-Zero Energy Home Coalition*

## *Canada's Leading Industry Voice For NZEHs*



### Supporting Members

Canadian Solar Industries Association,  
Southern Alberta Institute of Technology (SAIT),  
Thomasfield Homes, Milton Hydro, Canadian Energy Efficiency Alliance

### Advisory Team

Howell-Mayhew Engineering, Solar Buildings Research Network



# *Net Zero Energy Home Coalition*

The catalyst for CMHC's EQUilibrium Initiative

Advancing community-scale NZE demonstration

NZEH Workshops and Forums, NZEH Strategy

Consultative body on NZEH initiatives  
– BC Government NZEH Demonstration Initiative

A new definition on the green building continuum

URGENT!

URGENT!

[www.netzeroenergyhome.ca](http://www.netzeroenergyhome.ca)



# Guiding Principles of EQUilibrium Housing

## ■ Health

- Indoor air quality
  - Emissions
  - Thermal comfort
  - Moisture
  - Particle control
  - Ventilation
- Daylighting
- Noise control
- Water quality

## ■ Energy

- Annual energy consumption
- Renewable energy strategy
- Peak electricity demand
- Embodied energy strategy

## ■ Resources

- Sustainable materials
- Durability
- Material efficiency
- Water conservation
- Adaptability / flexibility

## ■ Environment

- Land use planning
- Sediment and erosion control
- Storm water management
- Waste water management
- Solid waste management
- Air pollution emissions

## ■ Affordability

- Financing
- Marketability

# Discussions about EQUilibrium Housing

## ▪ Technology

- Products
- Performance simulation
- Design
- Installation
- Operation
- Monitoring

## ▪ Attributes of House

- Energy (house, food, transportation)
- Indoor environment (air, water)
- Outdoor environment (water, landscaping)
- Sustainability, materials, recycling
- Emissions (air, water, soil, land, waste)
- Costs, economics

## ▪ Technology Transfer

- Communication
- Awareness
- Education
- Training
- Demonstration
- Marketing

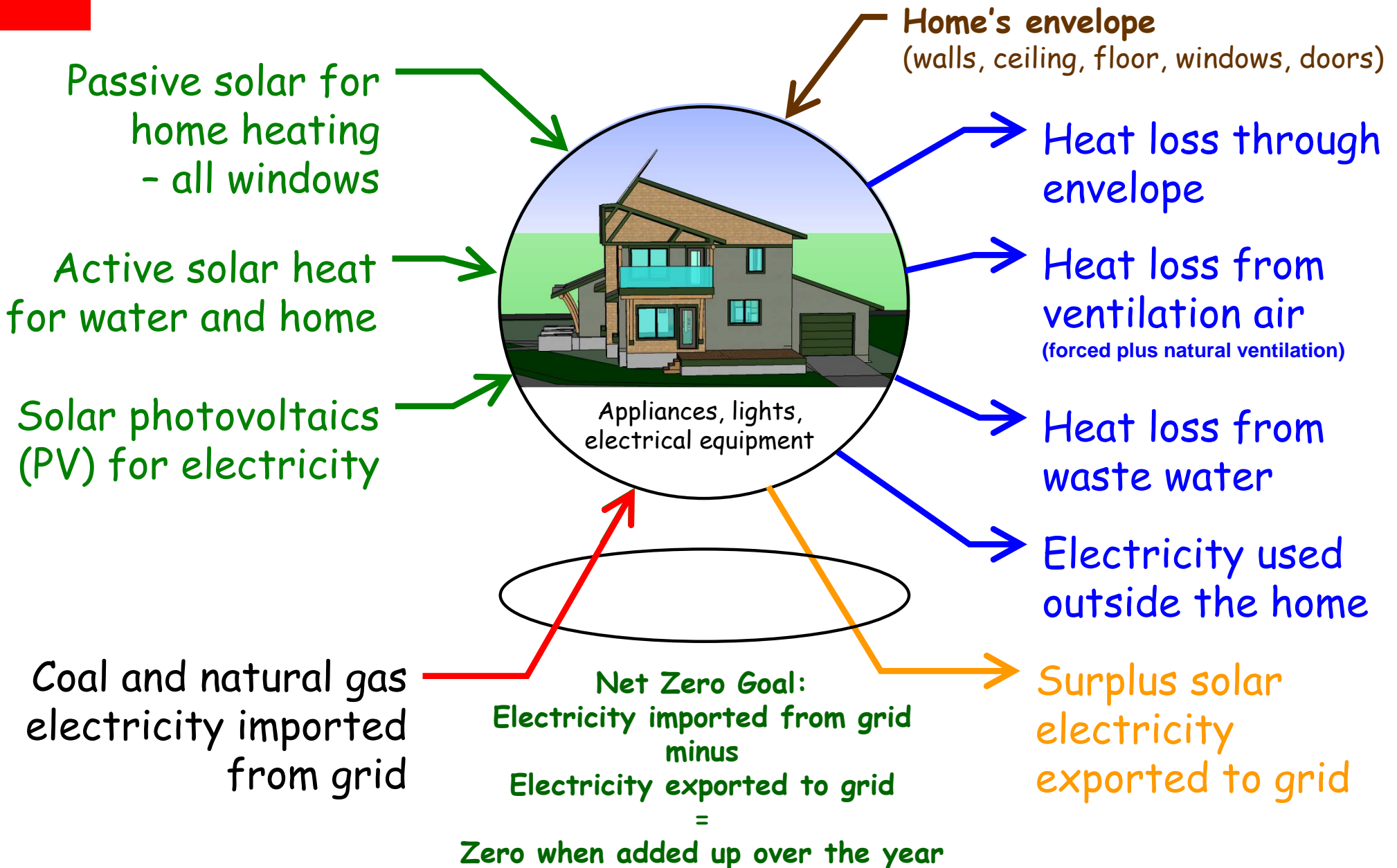
## ▪ Organisation of Society

- Policies and their goals and consequences
- Infrastructure (energy, housing, transport)
- Industrial capacity
- Incentives, barriers and standards
- Subsidies, green taxation
- Removing competing subsidies

# How does it Achieve the NZE Goal?

- First and most important:
  - **Reduce** heat and electrical energy consumption
  - by 65% through energy efficient and water efficient design, construction and appliances
- Second:
  - **Supply** 35% balance of heat and electrical energy
  - through on-site solar energy

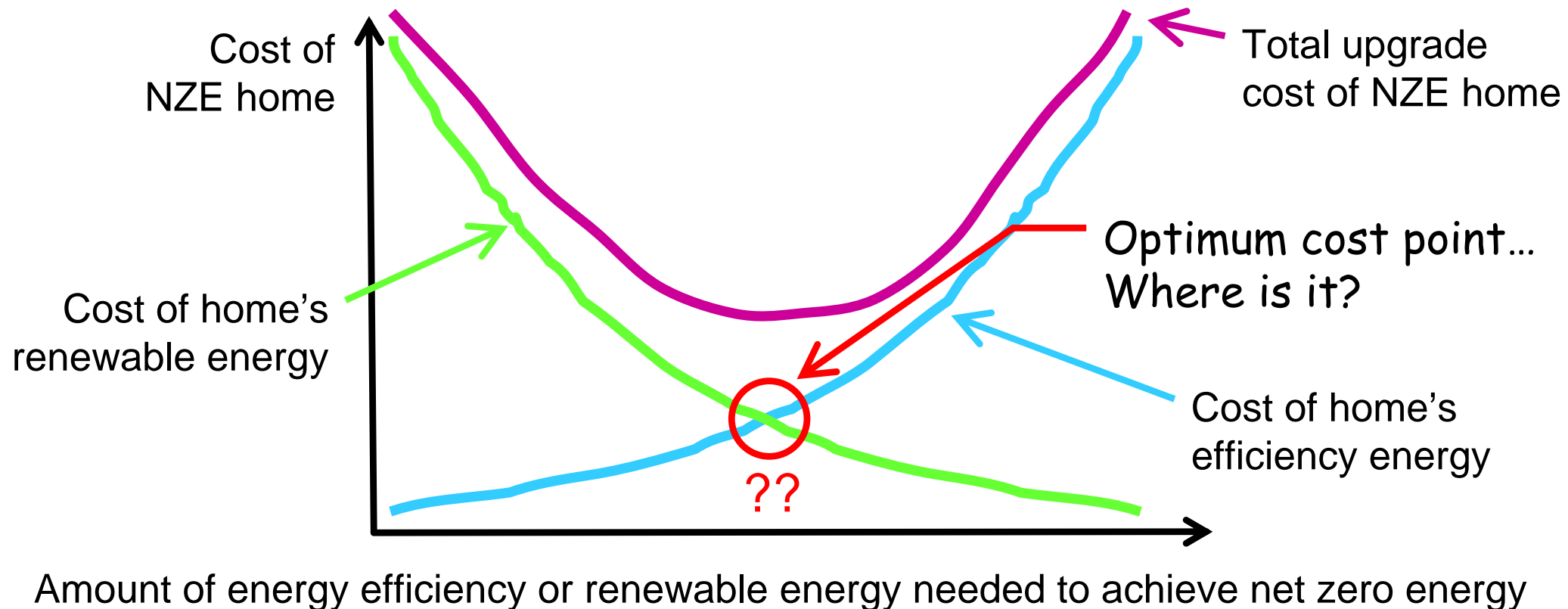
# Energy Flows – Riverdale NetZero Home



# Design-Economic Challenge

**Where do we find the minimum construction cost to achieve net zero?**

- We need large amounts of energy efficiency
- and large amounts of renewable energy



# Challenges – Technical and Organisational

## Challenges:

## With solutions that are:

- Environmental (long cold winters) ... Technical (energy efficiency)
  - Equipment Performance ... Technical (R&D, standards)
- 
- Training ... Organisational
  - Financial ... Organisational
  - Policy ... Organisational

# Riverdale NetZero Energy Home

– Edmonton  
2008

- duplex
- 1844 ft<sup>2</sup> per side
- 2519 ft<sup>2</sup> including basement
- 3 bedrooms

# Domestic Electricity

- Electricity consumption reduced by **50%** for an upgrade cost of **\$2000**
  - Energy efficient appliances, ECM ventilation motors
  - Energy efficient lighting (compact fluorescent, LEDs)
  - Task lighting (halogen)
  - Daylighting
  - Phantom load control
- Annual savings: \$500 (4600 kWh, 4000 kg of emissions)
- Return on Investment: 33% /year (=3 year payback)



Fridge



Clothes dryer



Dishwasher



LED lighting



CF lighting

# Domestic Water Heating

Drain water  
heat recovery

- Fuel consumption for water heating reduced **75%** for an upgrade cost of **\$1500**
  - Water efficient shower heads, faucets, dishwasher, clothes washer
  - Drain water heat recovery
- Annual savings: \$350 (6200 kWh, 46,000 litres, 1500 kg of emissions)
- Return on Investment: 25% /year



Shower heads and faucets



Dish washer



Clothes washer



# Building Envelope



Ceiling R-100  
cellulose



Double-stud  
2x4 walls with  
R-56 cellulose

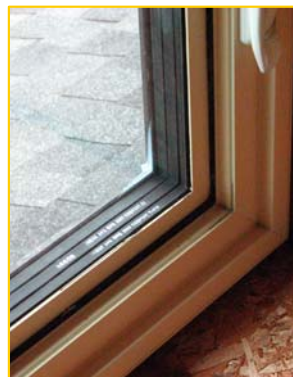


Basement walls R-54

- Fuel consumption for space heating reduced by **77%** for an upgrade cost of **\$22,000**
  - Ultra high insulation levels
  - High performance windows
  - Ultra low air leakage rate
  - High efficiency heat recovery ventilator
  - Internal house heat gains
- Annual savings: \$800 (27,000 kWh, 6300 kg)
- Return on Investment: 5.6% /year



South  
windows  
R-7.3  
R-8.3



North  
windows  
R-10



Heat recovery  
ventilator  
80% efficient

Air tight  
envelope  
0.59 AC/h



Passive solar for space heating  
- all south windows

Provides  
40% of our space heating



Upgrade cost: ~\$6,000 for concrete mass

Annual value of heat: \$150 (4400 kWh, 1000 kg)

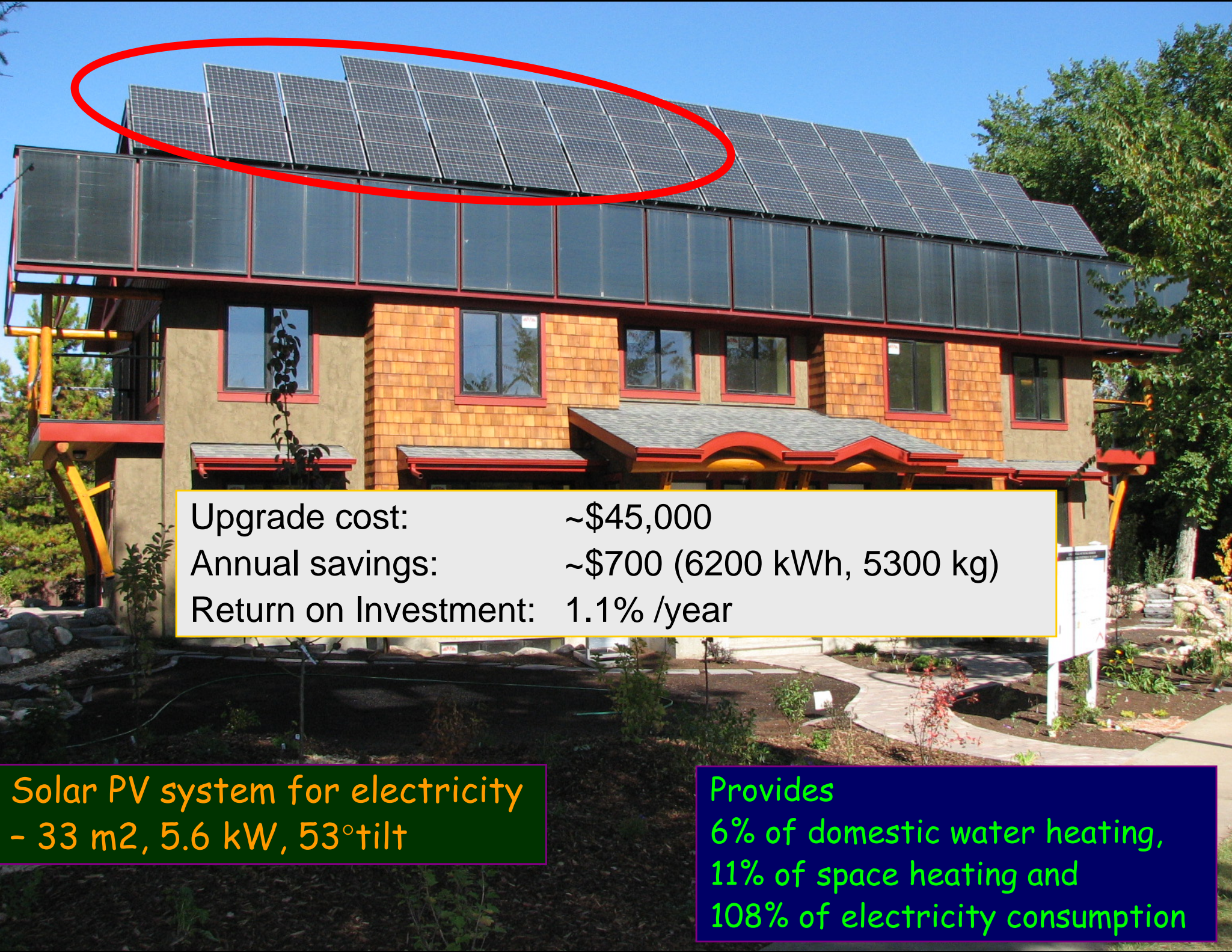
Economics are integrated with building envelope, not easy to determine yet...



Upgrade cost: ~\$35,000 (including \$7k of “learning” we made)  
Annual savings: \$500 (including eliminating gas connection fees, 4100 kWh, 1000 kg)  
Return on Investment: 2.3% /year

Active solar heating system: 21 m<sup>2</sup>, vertical  
Domestic water heat storage: 300 litres  
Space heat storage: 17,000 litres

Provides  
83% of domestic water heating and  
21% of space heating



Upgrade cost: ~\$45,000  
Annual savings: ~\$700 (6200 kWh, 5300 kg)  
Return on Investment: 1.1% /year

Solar PV system for electricity  
- 33 m<sup>2</sup>, 5.6 kW, 53° tilt

Provides  
6% of domestic water heating,  
11% of space heating and  
108% of electricity consumption

# Riverdale NetZero Energy Home

– Edmonton  
2008



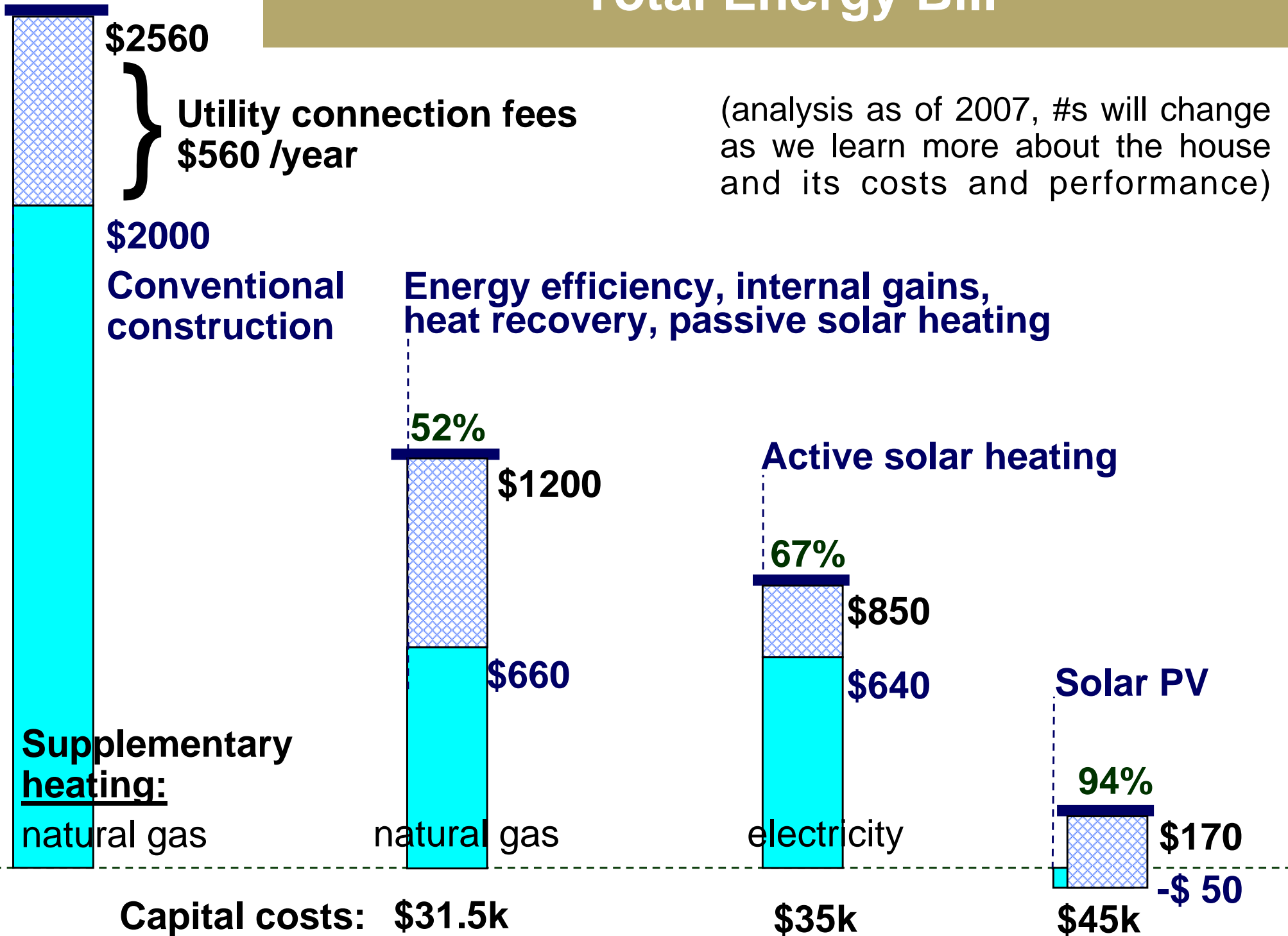
Upgrade cost:	~\$111,500
Annual savings:	~\$2600 (40,000 kWh, 16,000 kg)
Return on Investment:	3 to 12% /year depending on government policies on fossil-fuel subsidies, environmental emissions and finance

# Results: Annual Home Energy Bills

- Natural gas bill: \$0 no gas line needed, saves \$400 per year in connection fees (in 2008)
- Electricity costs: surplus ~\$50 ranging from \$150 surplus to \$100 deficit per year depending on homeowner electricity consumption choices
- plus normal electricity grid connection fees \$220 (in Edmonton)

# Total Energy Bill

(analysis as of 2007, #s will change as we learn more about the house and its costs and performance)



\$2560



Utility connection fees  
\$560 /year

\$2000

Conventional construction

Energy efficiency, internal gains, heat recovery, passive solar heating

52%

\$1200

\$660

natural gas

Active solar heating

67%

\$850

\$640

electricity

Solar PV

94%

\$170

-\$ 50

Supplementary heating:

natural gas

Capital costs: \$31.5k

\$35k

\$45k

# Economic Challenges

## ■ Return on Investment

- Simple ROI perceived to be 2.2% per year (46 year payback)
- Actual ROI is 3% per year when increases in electricity and natural gas prices are considered

## ■ Government regulatory polices

- Feeding electricity into the grid
- Value of a clean environment
- Implicit and explicit subsidies on coal- and natural gas-electricity and heating fuel
- Loan financing
- These policies
  - Increase the operating costs for the house
  - Reduce the savings and benefits of energy efficiency and solar energy

# Organisational Challenges

- **Policies ...are answers to the questions:**
  - “How do we want to organise ourselves?”
  - “What goals do we want to achieve?”
- **Present government policies**  
(energy regulatory, fiscal, economic development and environmental)
  - Strongly value economic growth to the effective exclusion of the value of a clean environment
  - Appear that reducing energy consumption is a threat to the economy
  - Effectively subsidise fossil fuel prices
  - Effectively increase the consumption and production of fossil fuels

Socialism collapsed because it did not allow the market to tell the economic truth.  
Capitalism is heading towards collapse...  
...because it does not allow the market to tell the ecological truth.

Øystein Dahle  
VP Exxon Norway

# Policy Solutions

- If government regulatory polices
  - **Valued** the environment
  - **Allowed** full cost recovery of all electricity fed into the grid
  - **Valued** increasing Canada's solar industrial capacity
  - **Removed** fossil fuel subsidies
  - **Required** fossil fuels to pay for their environmental damage
  - **Provided** ultra-low interest green loans
- The energy operating cost of the house would be zero
- The benefits of energy efficiency and solar energy would be fully valued
- The house would have a 12.5% per year ROI (8 year payback).

The changes to achieve this relate to how we want to organise ourselves, they are not technical – they are mostly territorial barriers.

# Organisational Challenges

## ■ Training and Awareness

- design professionals
  - integrated design, new products
- performance modelling
  - need better software
- building trades
  - energy efficiency, solar installation
- plumbing codes and inspectors
  - grey water recycling, solar water heating
- performance standards
  - drain water heat recovery, solar space heating, insulation systems
- utility companies, regulators, inspectors
  - micropower grid-connection
- real estate agents
  - marketing

## ■ Community Design Standards

- land-use bylaws
  - for selling PV electricity, installing microwind
- solar access
  - minimise obstructions
- subdivision design
  - maximise solar gains

# Policy Recommendations

...organising government policies to facilitate net zero energy housing.

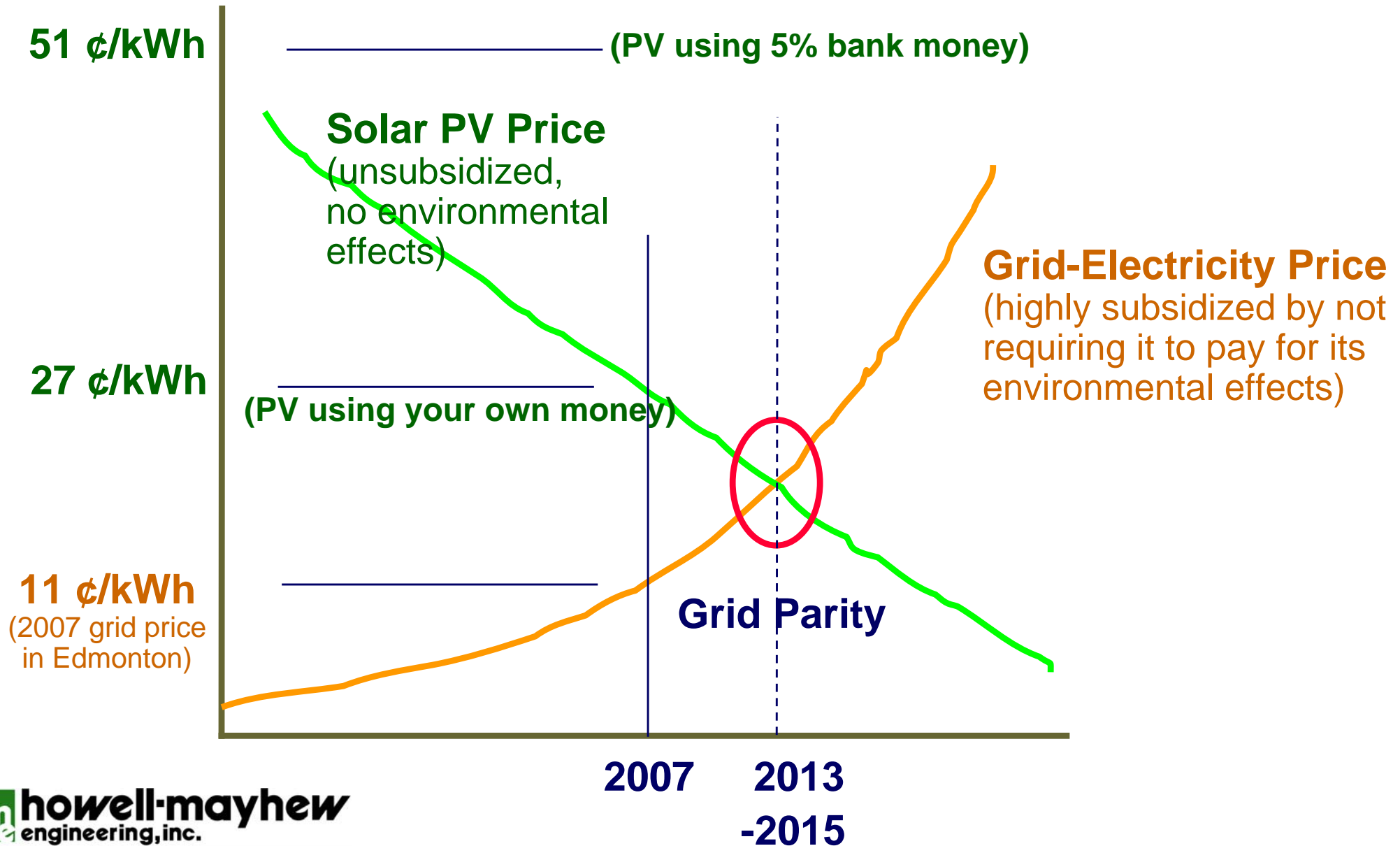
1. **Eliminate** barriers to net zero energy housing and to micropower grid access
2. **Develop** ultra low-interest “green” loans
3. **Develop** and **demonstrate** net zero energy housing
4. **Have** a common micropower grid-connection **approvals process**
5. **Use utility energy pricing policy** to provide realistic economic returns for the reduction in emissions, use of energy efficiency and renewable energy
6. **Provide** ways for **utility companies to profit** from energy efficiency and renewable energy
7. **Revise** land-use bylaws, solar access laws, building codes, energy codes and product standards to reflect the full costs of all energy use

# Interest from the General Public

- We are seeing that people are increasing their personal value on being environmentally responsible;
- People increasingly want these technologies regardless of price... which are eliminating economic barriers for them;
- We have **toured 4200** people through the Riverdale NetZero house during construction;
- We have given **36 presentations** on the net zero house to **2600 people**;
- We have not done any marketing to date though have received 20 expressions of interest to purchase;
- We are building our next NZE home ([www.greenedmonton.ca](http://www.greenedmonton.ca)) for clients and have another one planned for 2009.

# Need to Work Stridently to Remove Barriers...

Solar PV's progress to parity with fossil fuels...



# The future is in our hands...



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