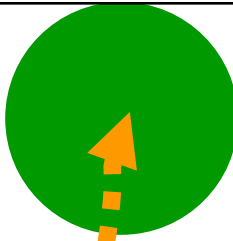


# The Path to Net Zero Energy Houses – Introduction

*Alaska Centre for  
Appropriate Technology*

Juneau, Fairbanks, Wasilla, Anchorage  
2011 April 11-15



Riverdale NZE



Mill Creek NZE



Belgravia NZE



South Windsor Park NZE

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**Habitat Studio  
& Workshop Ltd**

**Edmonton, Canada**

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# Workshop Outline

1. Introduction and Overview
2. Modelling
  - how do you determine how to achieve NZE?
3. Renewable Energy Options
  - the sizzle, but not the first thing to do...
4. Building Envelope
  - where the affordability happens
5. Mechanical Systems
  - what do you really need?
6. Renewable Materials
7. Marketing and Affordability
8. Logistics, Trades, Contractors
9. Verification – being real about net zero

# Intro: Us, Our Work...

- I am a professional engineer (electrical)
  - solar energy since 1977 and solar electricity since 1984
- Howell-Mayhew Engineering is a solar-electric system developer
- We design, supply and commission solar electric systems
- We participate on provincial, national and international committees to write solar-electric standards
- We have no vested interests in any one solar-electric technology
- Our interest is that you choose wisely:
  - with your eyes **wide open**
  - based on the facts and whether it is right for **you** ...or not.

**my house  
Edmonton  
20 m<sup>2</sup> (215 ft<sup>2</sup>)  
2.3 kW**

**12<sup>th</sup> one in Canada in 1995  
100% solar electricity**



# ...and others

- We also work with homebuilders who want solar-electric systems or who want to build net zero energy homes

- Edmonton's first 6:



- plus, under construction:

- Effect Homes
- Rosecrest Homes
- Kensington Master Builder
- and others...

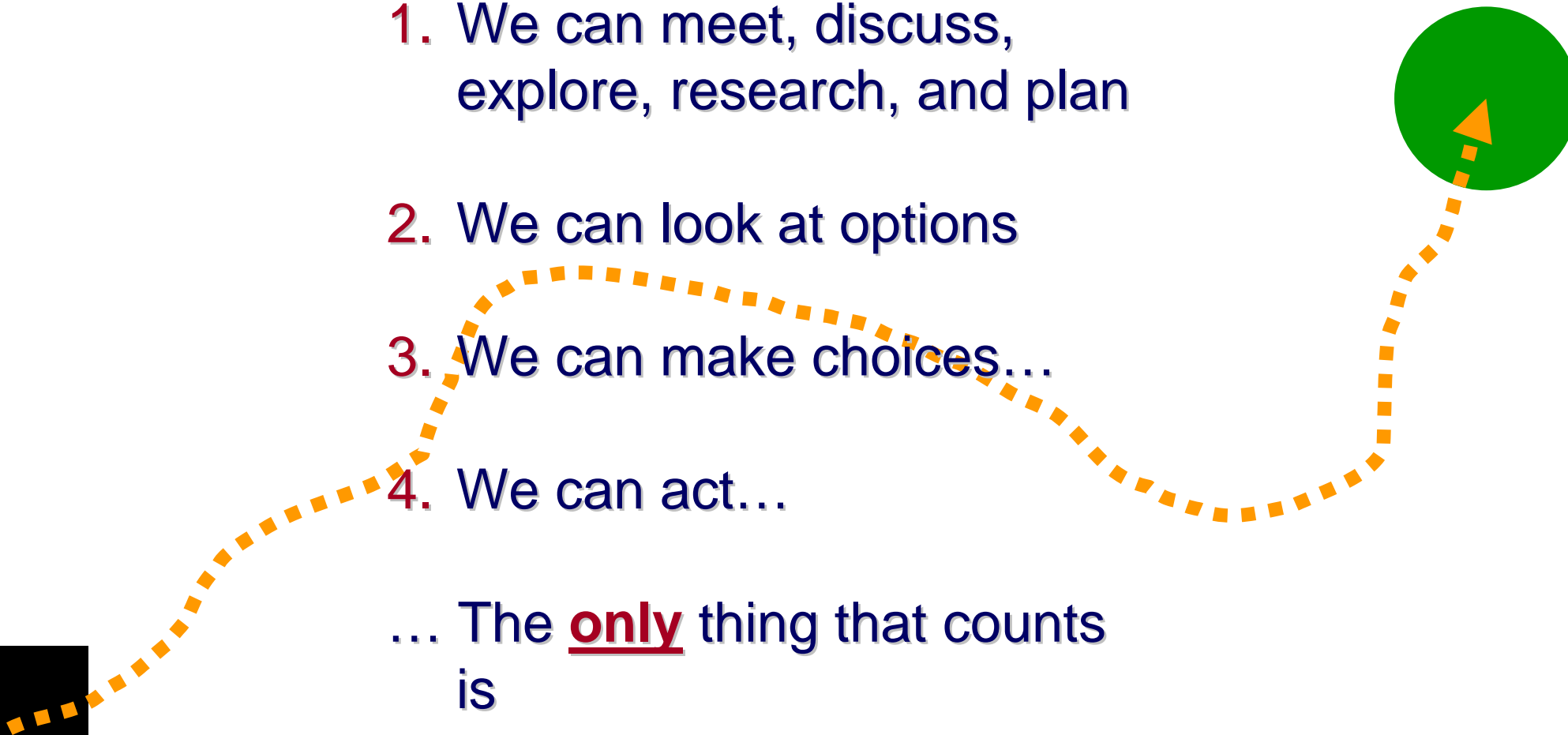
- total of around 12 houses now...



# Intent of Workshop

- To show you the path to take in order to achieve a net zero energy house
- With an actual example from Edmonton modelled for Juneau, Fairbanks, Wasilla and Anchorage
- This workshop shows the process and path
  - as real as we can make it in 1 day...
  - you will need to confirm various details (exact costs of equipment, prices of energy, incentives, politics) that are particular to your own city.

# Taking steps... the only thing to do

1. We can meet, discuss, explore, research, and plan
  2. We can look at options
  3. We can make choices...
  4. We can act...
- 

... The only thing that counts is

action (that's your part)

# Canada's Precedents



Saskatchewan Conservation House (1977)  
Regina, Saskatchewan  
76 kWh /year /m<sup>2</sup> (24 BTU /year /ft<sup>2</sup>)



Rob Dumont's House (1992)  
Saskatoon, Saskatchewan  
47 kWh /year /m<sup>2</sup> (15 BTU /year /ft<sup>2</sup>)

Factor 9 House (2007)  
Regina, Saskatchewan  
33 kWh /year /m<sup>2</sup> (10.5 BTU /year /ft<sup>2</sup>)



# Edmonton's Net Zero Energy Houses



■ Riverdale

- 2 net zero houses completed
  - 6 under construction
  - 2 being planned
- 6 builders



■ Mill Creek

**Peter Amerongen**



[www.habitat-studio.com](http://www.habitat-studio.com)



■ Parkland



■ Belgravia



■ South Windsor Park

# Status of NZE Housing Development

- Process of the development of any technology
  - prove the technical concept
  - increase its durability
  - – reduce its costs (evaluate different options)
  - marketing, promotion, codes, standards (simultaneous)
  
- All equipment and components are off-the-shelf
  - They are combined together in a way not done before.
  - No new technologies need to be developed...  
  
but many new ones will be developed  
in order to help reach the NZE goal more cheaply.

# Why is it called a Net Zero Energy House?

- A house that generates at least the same amount of energy as it uses on an annual basis...
- Net zero energy is just the dividing line between
  - net deficit energy (where you need to purchase energy because your house doesn't generate sufficient on its own)  
and
  - net surplus energy (where the house is a benefit to the environment because it is operating)
- It had never been done before in Canada until the government's Canada Mortgage and Housing Corporation (CMHC) developed their EQUilibrium Sustainable Housing Initiative.

# Key Concepts of Net Zero Energy

- only considers operating energy, not embodied energy
- is assessed over the year, not each day
- any off-site energy that is imported must be have an equivalent amount of on-site energy exported (other than wood heating, but only if it is sustainably harvested)
- is always connected to the electricity grid (so far)
  - doubtful that off-grid net-zero has yet been achieved on a practical house, though it is indeed technically possible
- typically is not connected to the natural gas grid (due to high cost of connecting to the natural gas grid)
- uses the electricity grid as an energy storage device
  - exports energy every second that generation > consumption if you have solar PV: any sunny second, more in the summer
  - imports energy every second that consumption > generation, more in the winter, less in summer



# Elements 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

# The Design Challenge: Is it possible to achieve NZ energy?

(after all, it's pretty cold and dark here in the winter...)

- In Edmonton, an average house uses:
  - Around 6 times more heating fuel energy than electricity!  
(ranging from 4 to 14 times)
  - Biggest challenge is not in supplying household electricity...
  - Instead ... it is in supplying home heating!  
(likely the same as in all of Alaska)



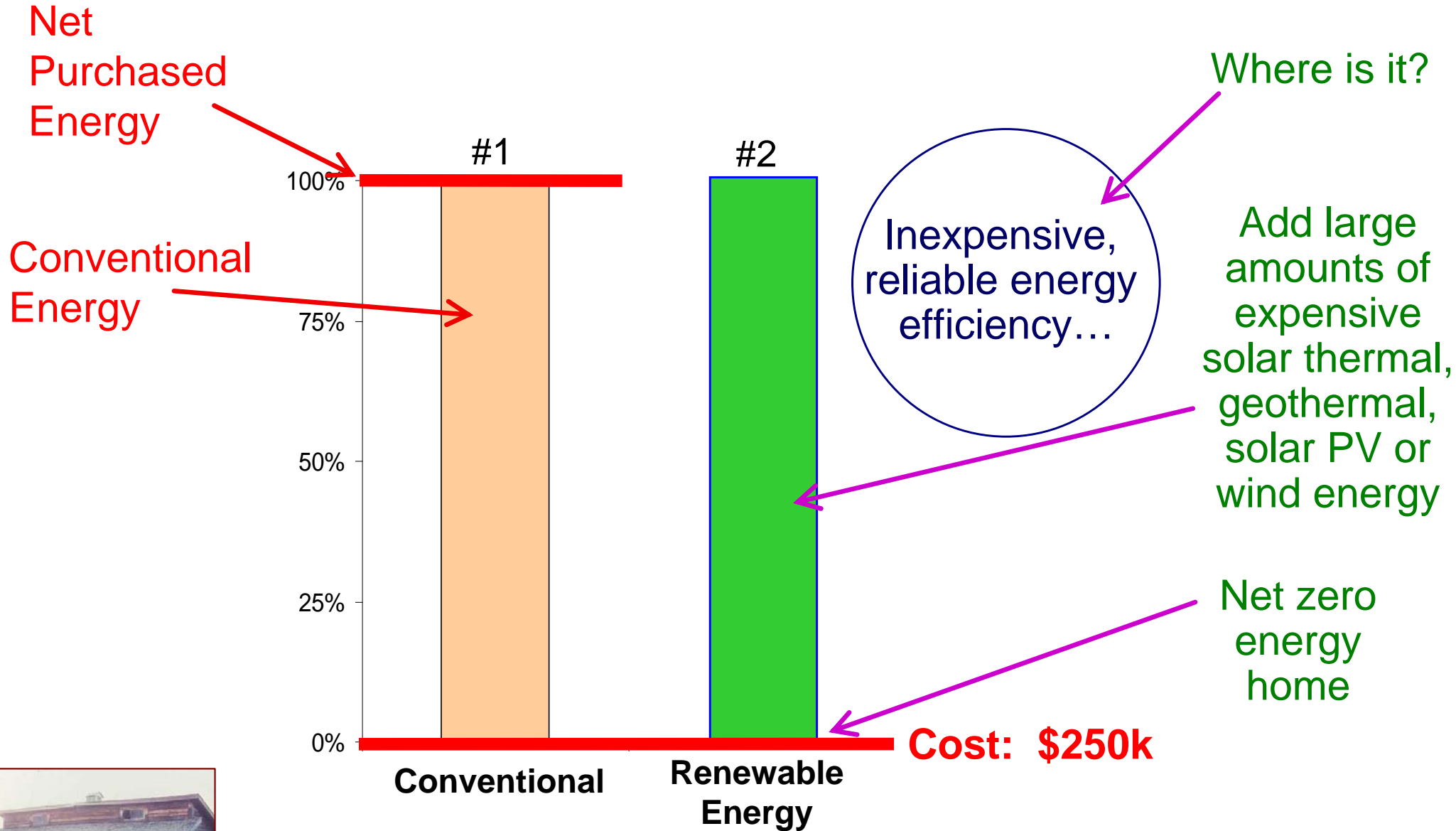
**Beautiful home... as seen in visible light**



**Same home... as seen by its energy use**



# The most expensive way to achieve NZE...



# Every House Can Achieve the NZE Goal...

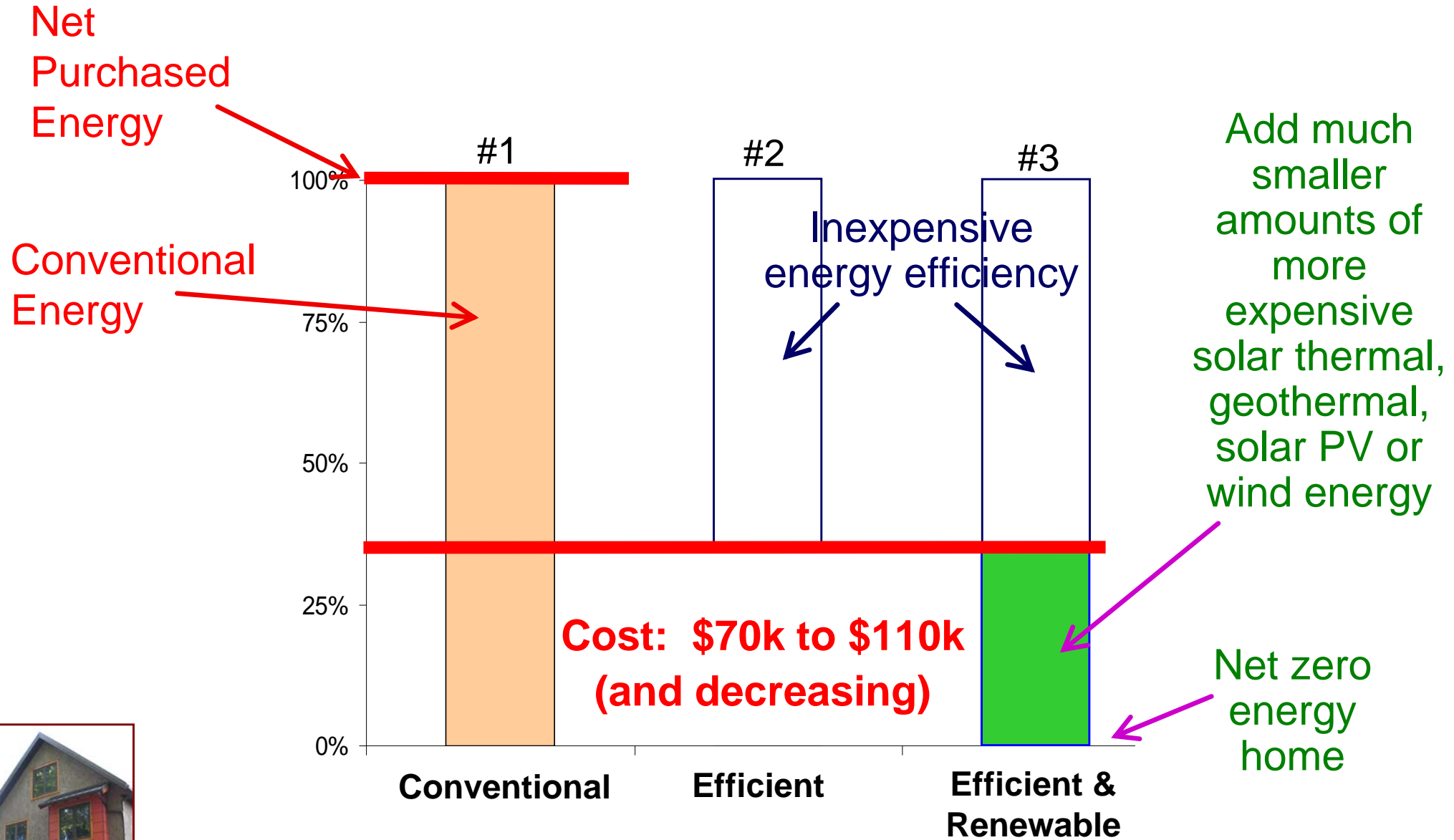
- ...if you have a large enough solar PV system on it.



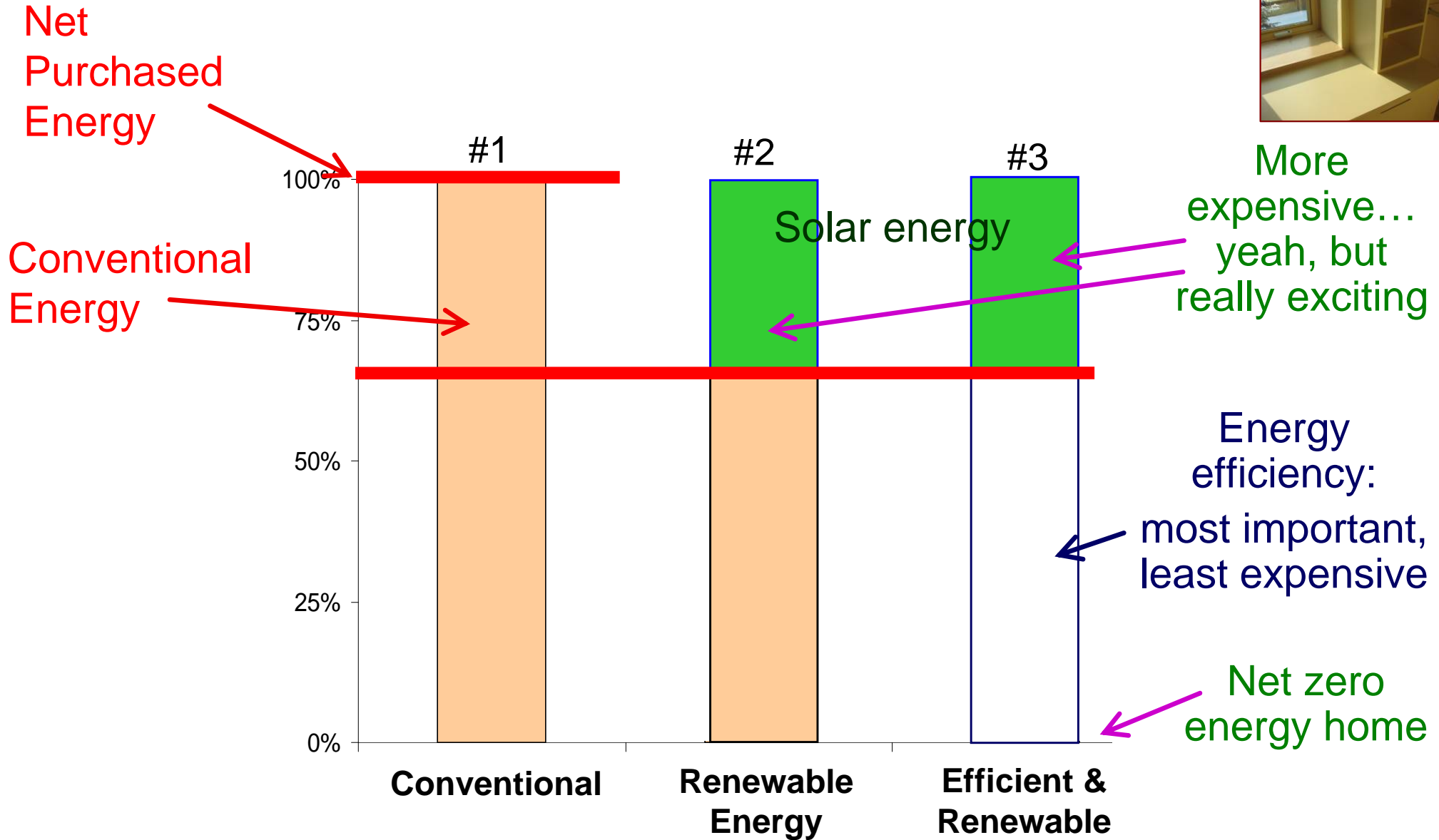
Drawing credit: Peter Amerongen

- But this will be the most expensive way to go...
- Making the house energy efficient is far cheaper than solar thermal, geothermal, solar PV, wind **and** energy from the grid.

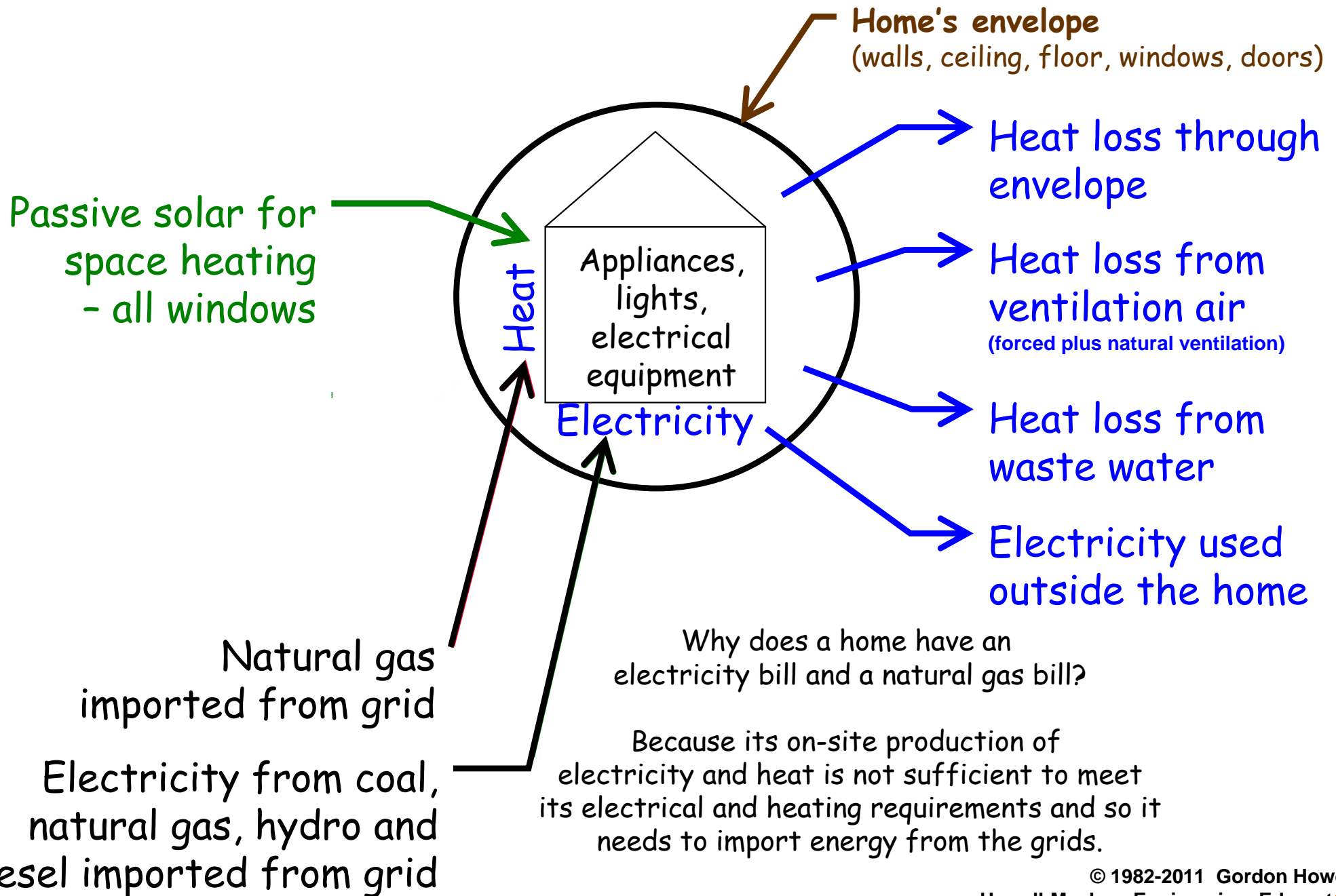
# The least expensive way to achieve NZE...



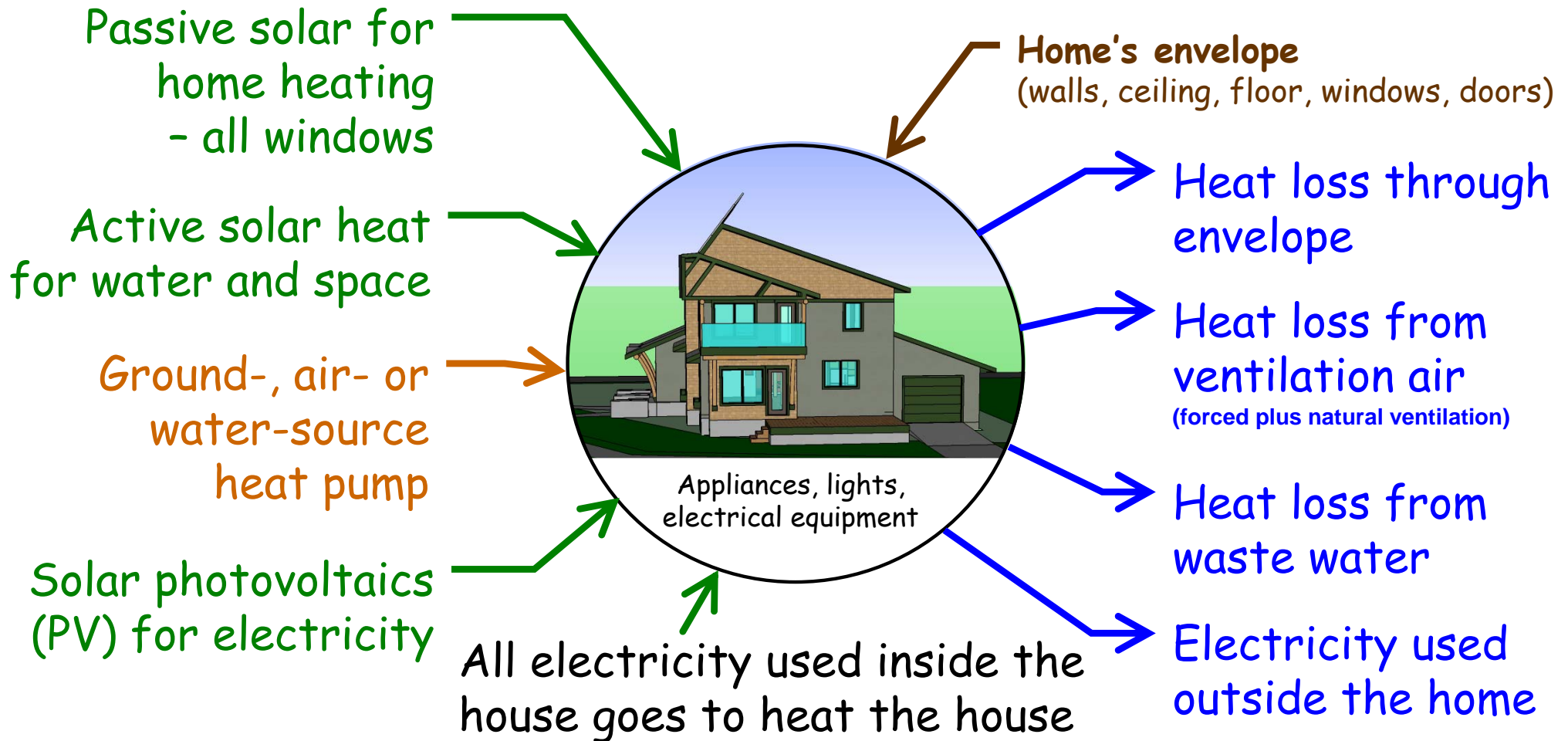
# The most exciting way to achieve NZE...



# Energy Flows – Standard Home



# Energy Flows – Any NetZero Home

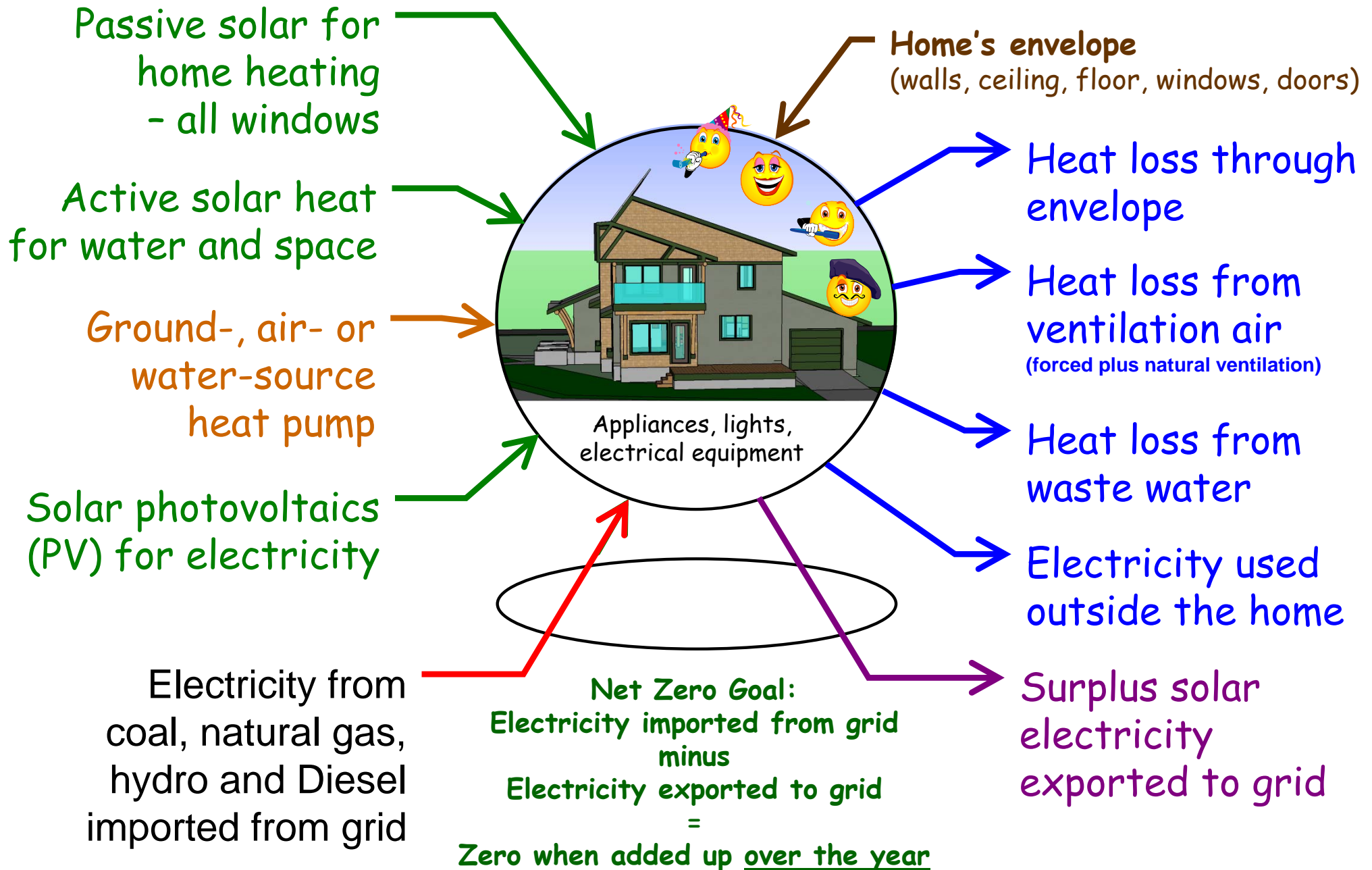


**#3.** The third key to a net zero energy house is to **maximise** and **control** the energy gains...

**#1.** The first key to a net zero energy house is to **minimise** and **control** the electricity usage...

**#2.** The second key to a net zero energy house is to **minimise** and **control** the house heat loss...

# Energy Flows – Any NetZero Home



# Net Zero Energy – a bunch of math

- The net zero energy goal is a simple bit of math
  - not a number of brownie points like LEED or Built Green
  - You either reach the NZE goal or you don't.
- 1. **Add** up the annual **consumption** of heat and electrical energy.
- 2. **Subtract** the annual **production** of heat energy and **generation** of electrical energy
- 3. If you **reach** 0 you are at net **zero** energy
- 4. If your net consumption is **> 0** you still have a **net energy deficit**
- 5. If your net consumption is **< 0** you have a **net energy surplus**

# Net Zero Energy – almost...?

- Net zero energy is only a target...
  - It is not a be-all and end-all concept
- Net zero **ready**
  - You have designed the house so that heat and electricity generators could be easily added in the future without any design changes to the house
- **Near** net zero
  - You still have a net energy deficit, but are “close” to net zero
  - What does “close” mean? 10% away??? not defined yet...

# The Journey to Net Zero Energy



– cheapest to most expensive

- **Electrical fixtures and appliances – electrical**
  - **Water fixtures and appliances – water**
  - **Building envelope – heating**
- } **Ultra-high efficiency technologies**
- **Passive solar space heating...???**
  - **Active solar liquid for domestic water heating...???**
  - **Active solar liquid for space heating...???**
  - **Active solar air for space heating...???**
  - **Wood heating...???**
  - **Heat pump: ground, air, water, solar...???**
  - **Solar-electric heating: air circulation, electricity...???**
- } **Heating technologies**
- **Solar photovoltaics...???**
  - **Microwind...???** (likely not in urban settings)
  - **Microhydro...???** (likely in rural settings)
- } **Electricity technologies**

# Many Energy Options

<u>Energy Technology</u>	<u>Consumes</u>	<u>Supplies</u>
■ Electrical fixtures and appliances	++	0
■ Water fixtures and appliances	++	0
■ Building envelope	+++++	0
■ Passive solar space heating	+++	+++++
■ Active solar liquid domestic water heating	+	+++++
■ Active solar liquid space heating	+	+++++
■ Active solar air space heating	+	+++++
■ Wood heating	++	+++++
■ Heat pump: ground, air, water, solar	+++	+++++
■ Solar photovoltaic heating from air circulation	+	++???
■ Solar photovoltaic heating using its electricity	0	+++++
■ Solar photovoltaics	+	+++++
■ Microwind	+	+++++
■ Microhydro	+	+++++

# How do you plan for a net zero energy house?

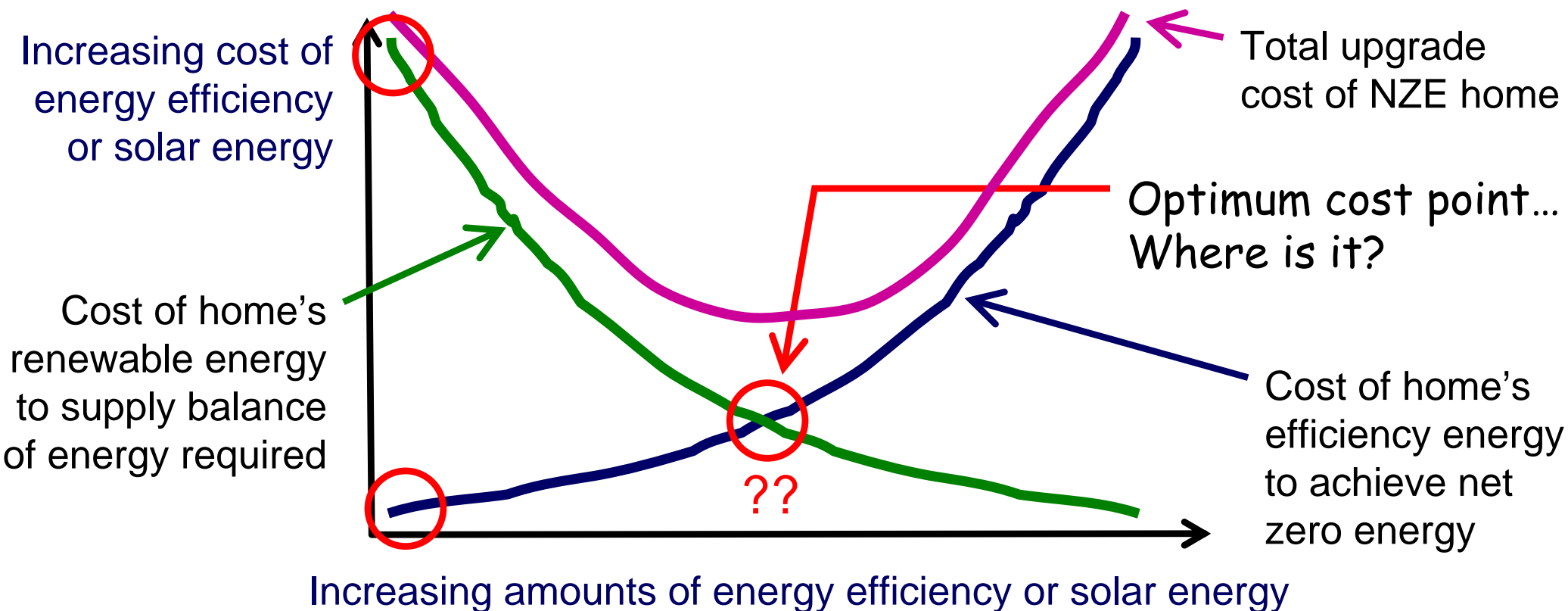
- First and most important:
  - Minimise heat and electrical energy consumption
  - Reduce by 65%+ through energy efficient and water efficient design, construction and appliances
  - This is the cheapest-cost option
  - Cost range: \$15,000 to \$25,000
- Second:
  - Maximise and control the contribution of energy sources
  - Supply 35%- balance of heat and electrical energy
  - Cost range: \$50,000 to \$90,000  
and dropping in cost...

# Design Challenge



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

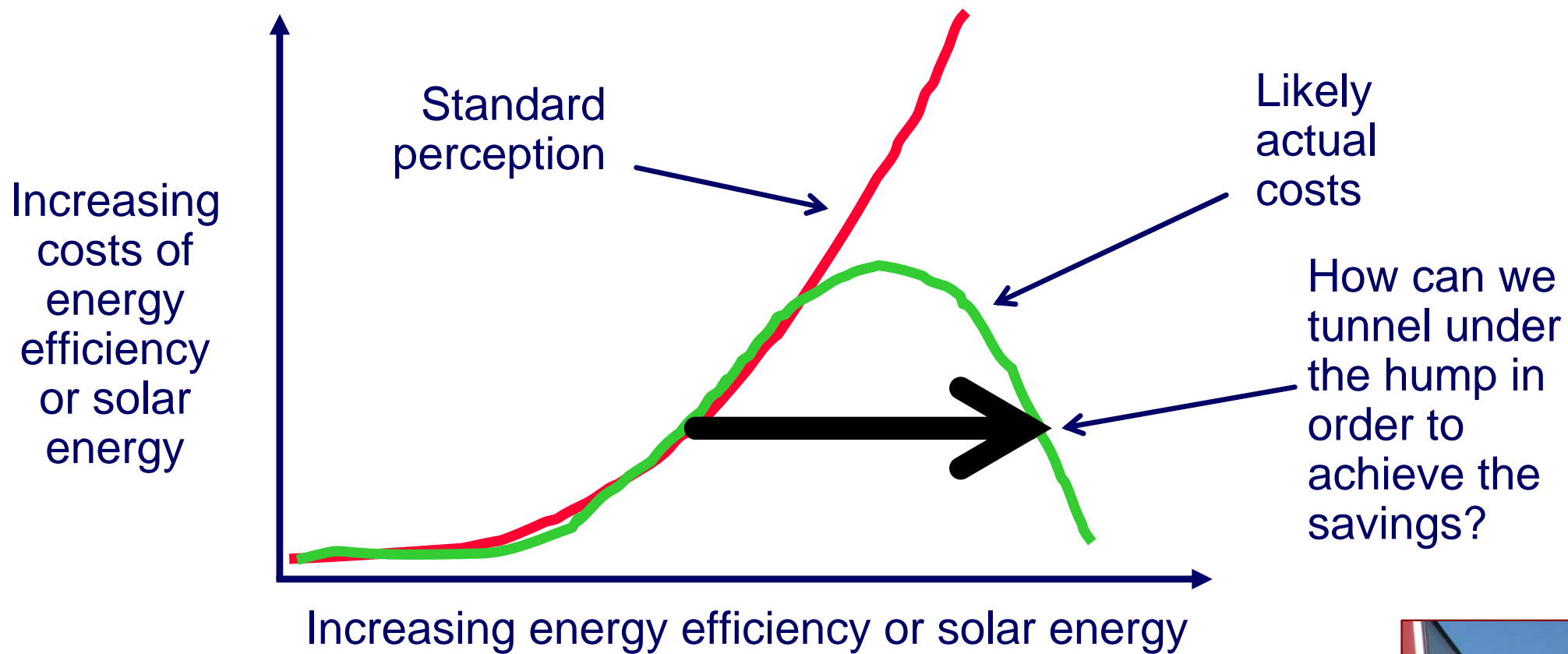
- We need large amounts of energy efficiency and large amounts of solar energy



# Economic Challenge

## – “Tunnelling Through the Threshold”...

- Diminishing returns... yes,  
but... there are cost reduction opportunities too...



Concept courtesy of Amory Lovins



# Net Zero Energy Housing

... can we really afford anything less?

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We welcome any feedback, questions, suggestions, comments and challenges to anything we present.