RESNET
Residential Energy Services Network

Setting the STANDARD for QUALITY

What It Would Take:
A Building Performance Manhattan Project

RESNET Building Performance Conference

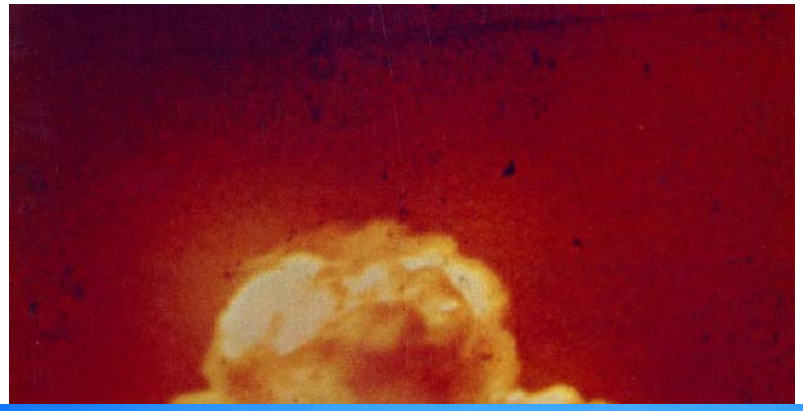
San Diego, CA

February 18, 2008

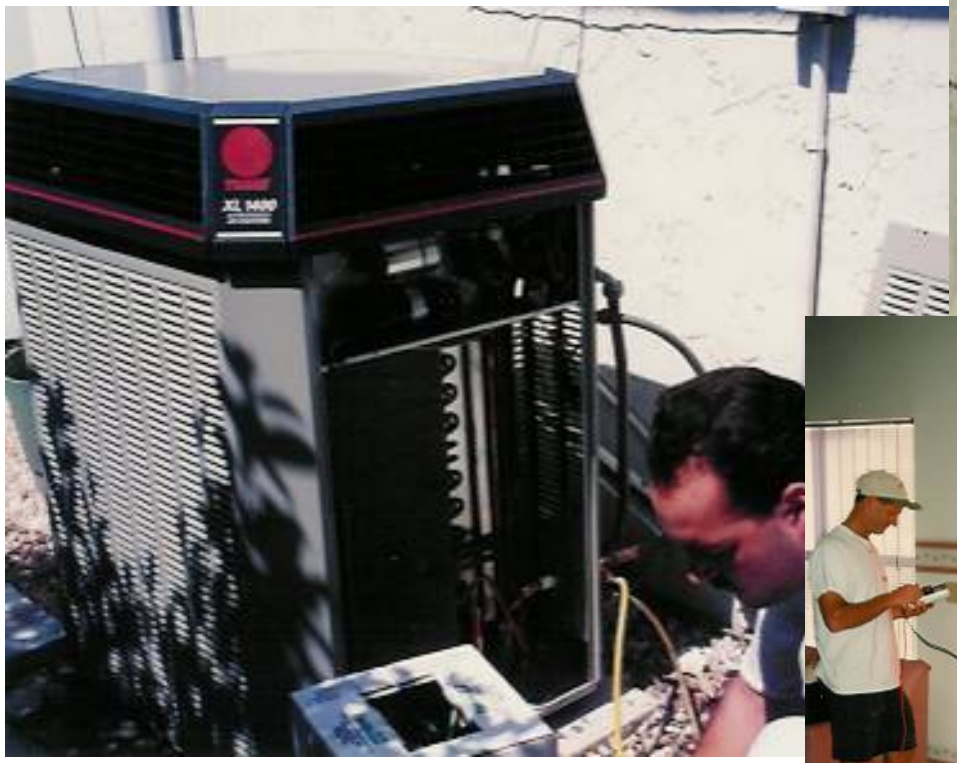
Philip Fairey & Danny Parker

Florida Solar Energy Center
Creating Energy Independence

Not this. . . Or this. . .



But this…



Large Federal Project

Federal Program (thru year)	**2006$ (G)**
Manhattan project (1945)	$26
Interstate highway system (1956)	$179
Apollo moon landing (1969)	$136
Afghanistan / Iraq War (2007)*	$1,200
Economic stimulus package (2008)	$152

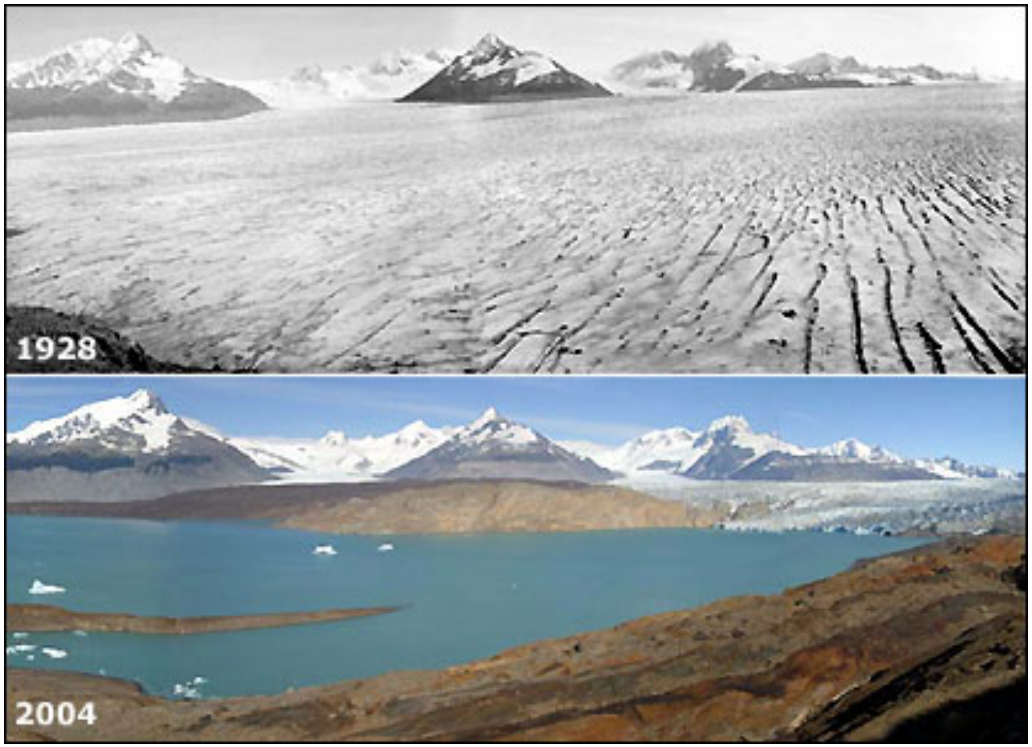
* Congressional Budget Office – over 6 year period equals about $400 billion per year or more than $1 billion per day.

Good Planets are Hard to Find

- "*Economists would conclude from an lifecycle perspective, that the earth is not worth saving*" *– Don Osborne, SMUD*
- Perspective from space:
  - Dead Mars once had an atmosphere and water…
  - Earth: High stakes atmospheric experiment
  - Taking care of our home is our fundamental responsibility.
- What is carrying capacity of our planet? 1 ton CO_2 per person/year?

Drastic Situations…

- Demand drastic medicine
- Global warming
- Energy Shortages
- Need to reduce carbon footprint
- Time is critical
- Glaciers in retreat
- May need crash program
- Good News/Bad News: Harold Orr—"*We have the knowledge. We lack the will*"



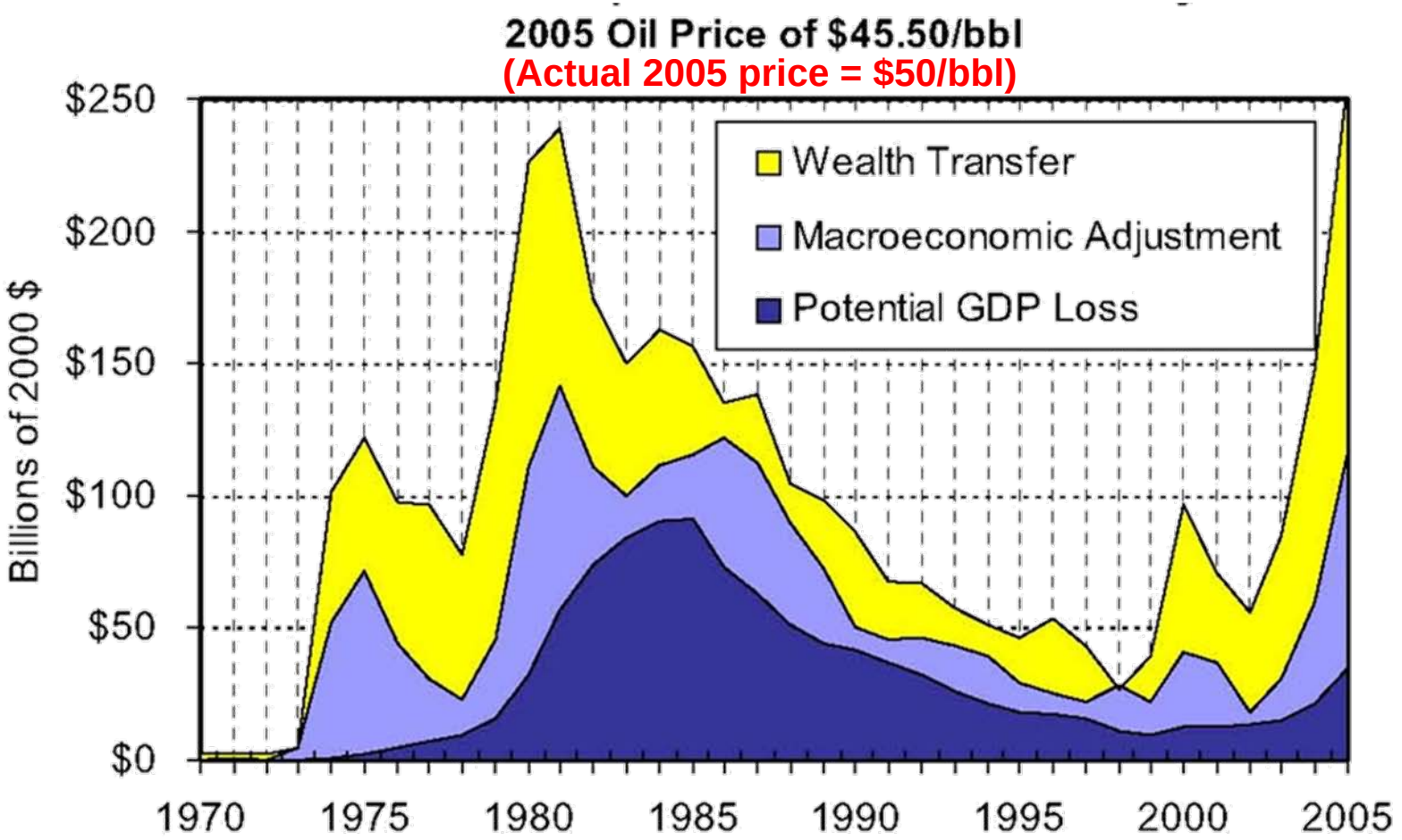
Upsala Glacier, Argentina

Smaller Carbon Footprint?

- Building energy is 27% of average per person's carbon emissions
- More than transportation!
- Five times as much as our own energy source (food!)

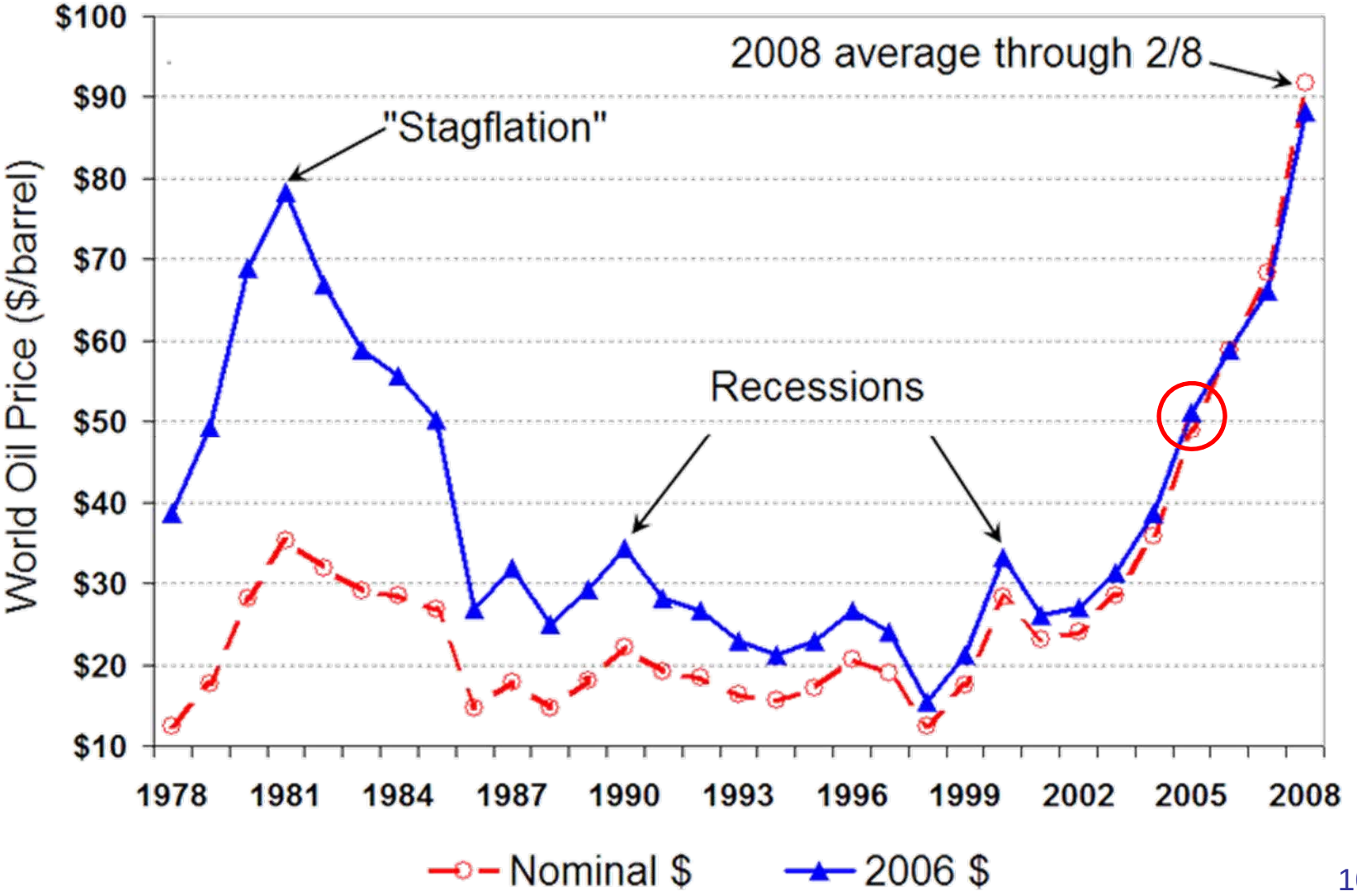
Into the Storm

The Cost of Oil Dependence

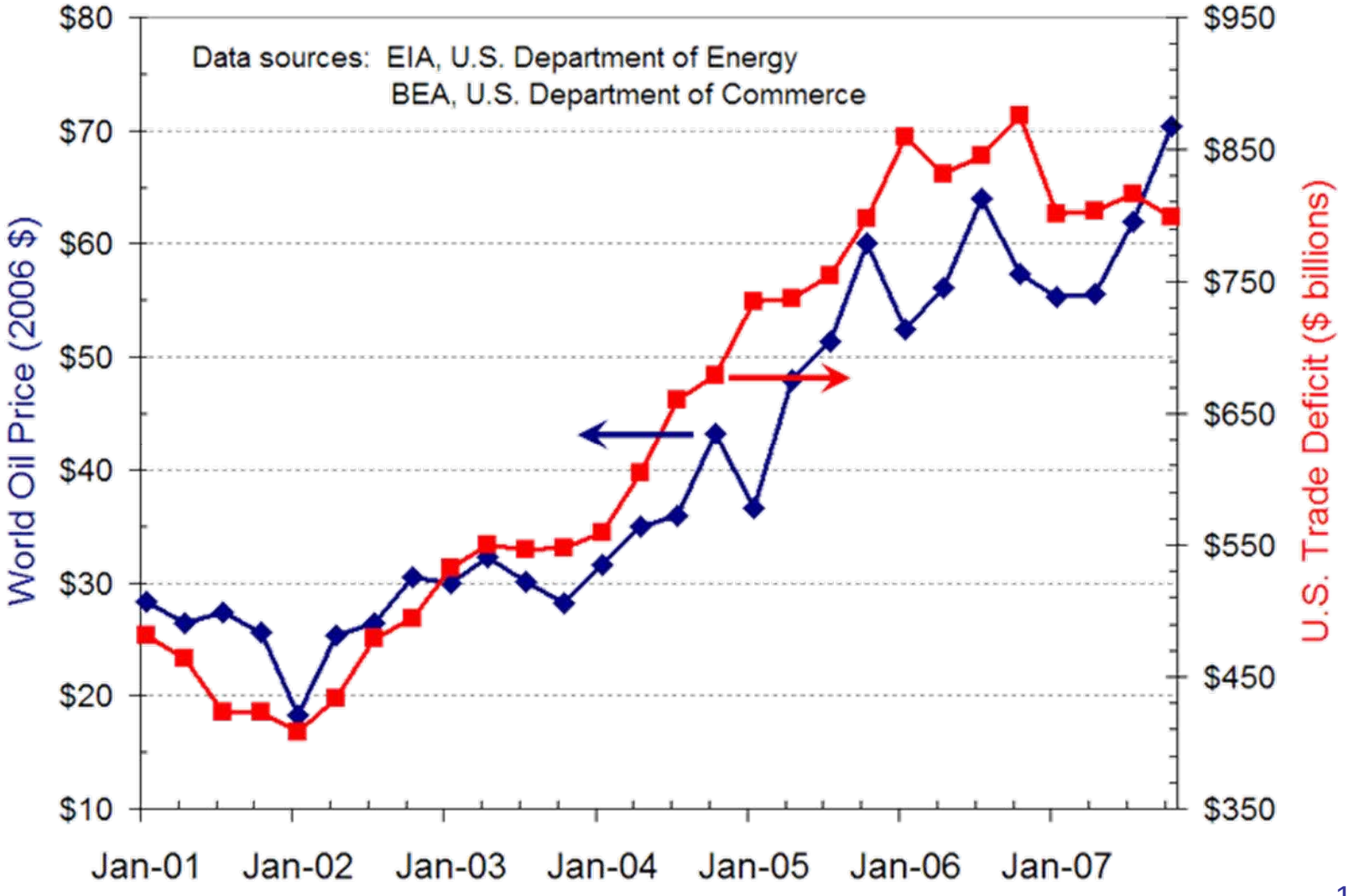


Source: Green, D. and S. Ahmed, "Cost of U.S. Oil Dependence: 2005 Update." Oak Ridge National Laboratory, Publication No. ORNL/TM-05/45, January 2005

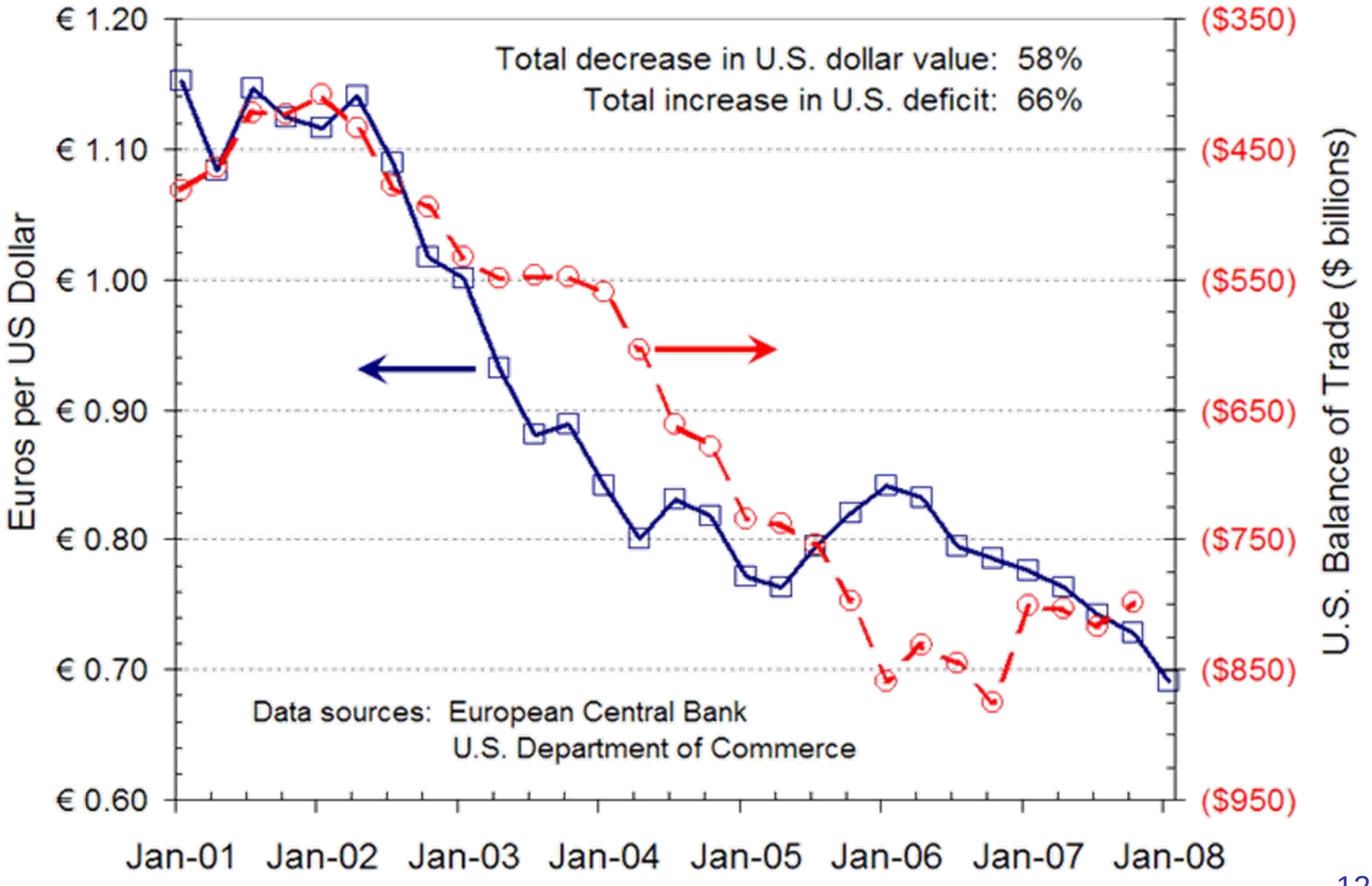
World Oil Prices Since 1978



U.S. Trade Deficit and Oil Price



Value of The U.S. Dollar



What Is This All About?

"It's the economy stupid!"

James Carville, 1992

And, the corollary is "*… the cheapest, easiest and fastest kilowatt we can generate is the one we save through efficiencies*."

Jeb Bush, 2000

In other words:

It's the efficiency stupid!

McKinsey-Vattenfall Curve

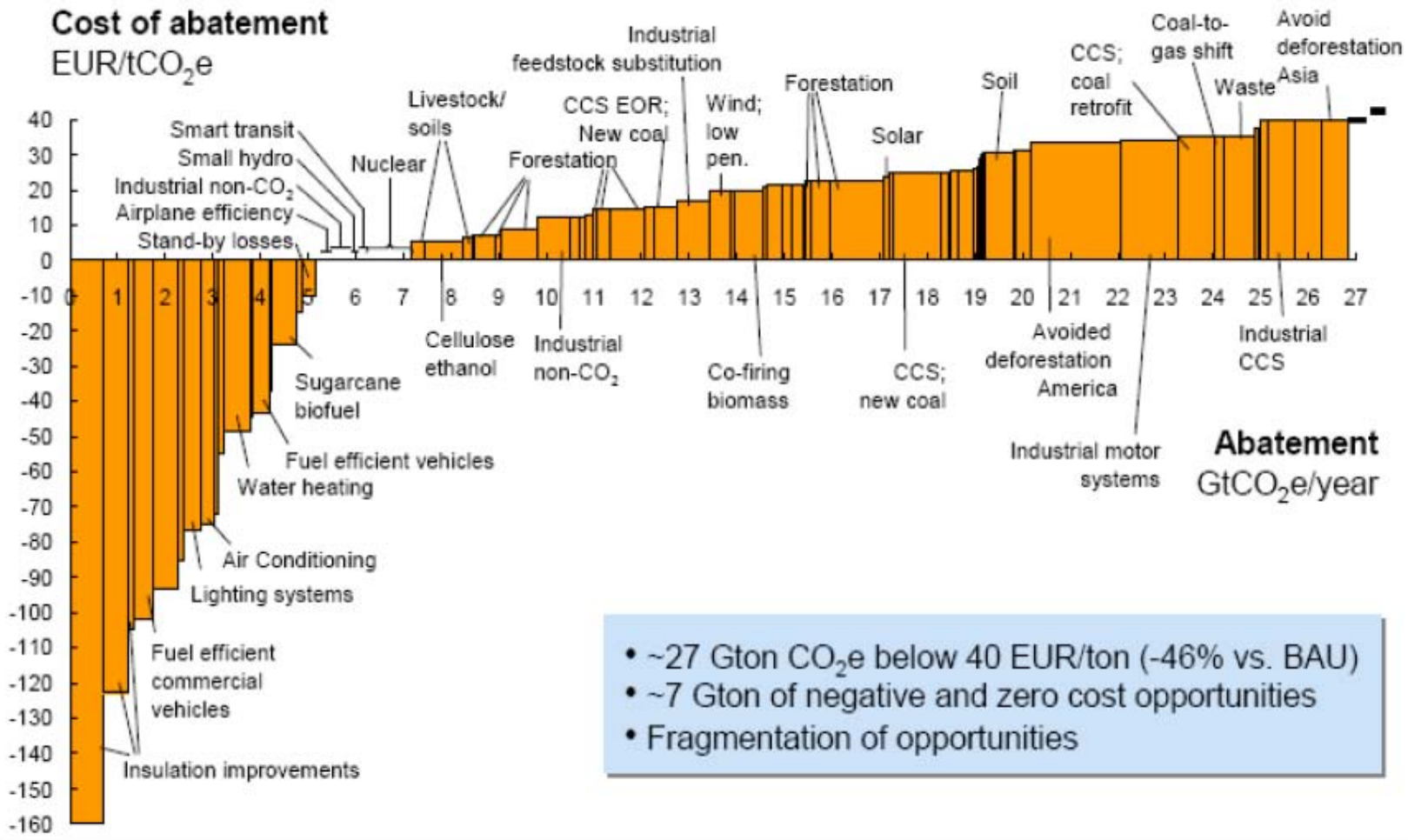
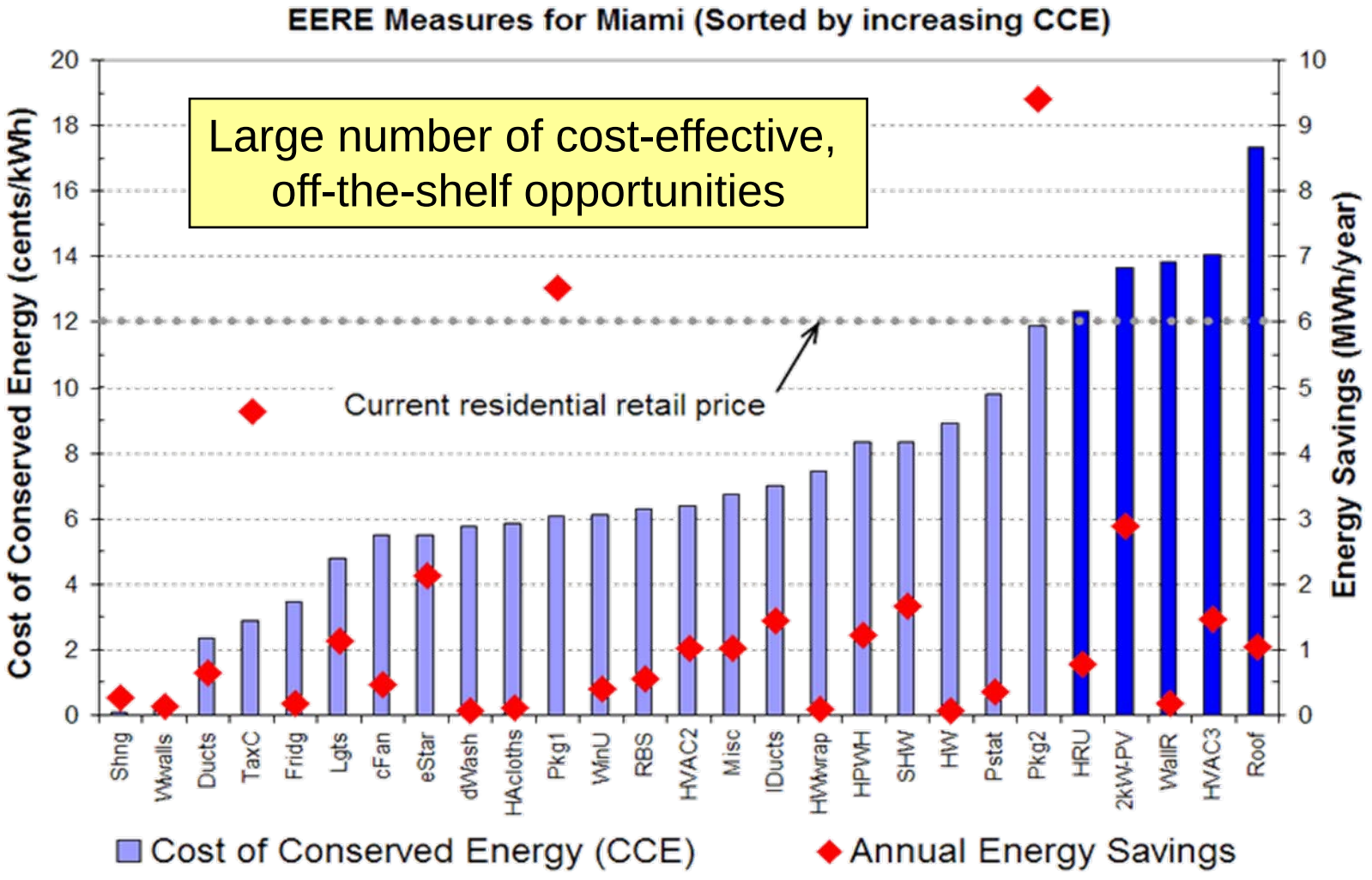


Figure 5. Financial cost-benefit analysis of CO_2 mitigation options prepared by Vattenfall, 2007.

Ranked Efficiency Measures



The Average American Home*

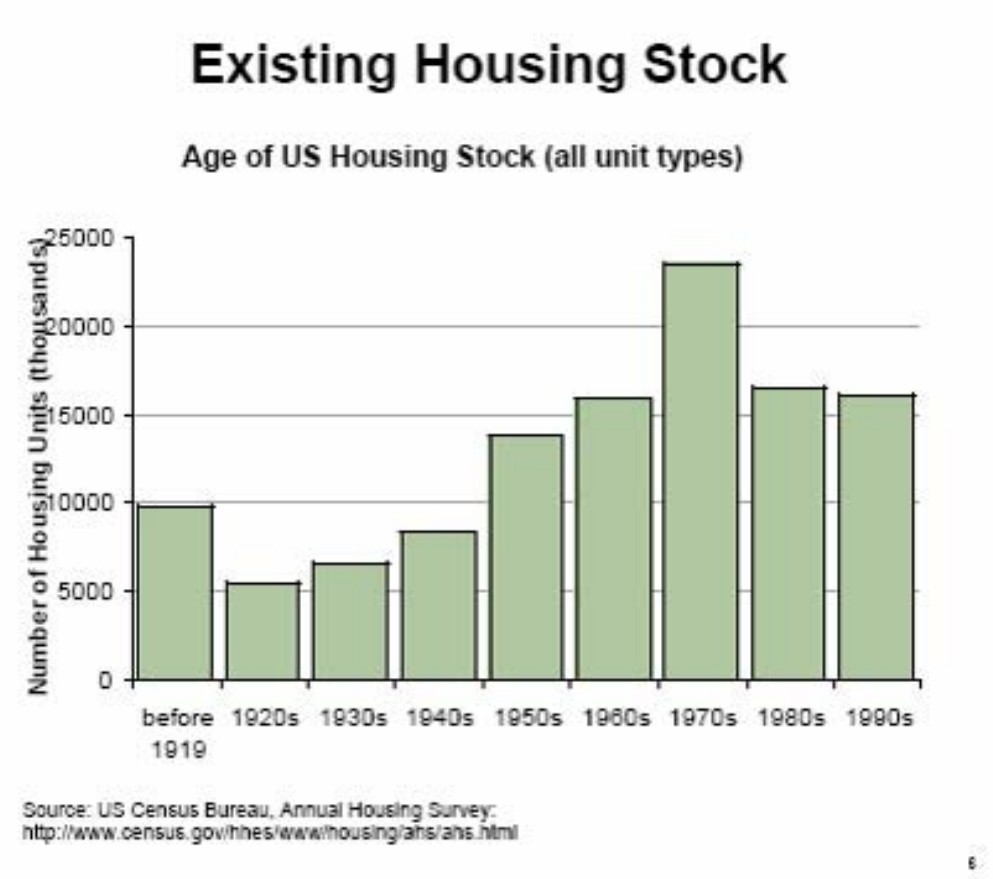
- 107 million residential units in 2001
- 10,700 kWh a year in electricity
- 700 Therms Natural gas
  - or 730 gallons Fuel oil
  - or 488 gallons LPG
- ~12.5 tons of CO_2
- About 8.3 tons from electricity

- Represents 21% of U.S. primary energy use
- **Most Important:** about two-thirds of all buildings that will be in use in 2050 are already built.

**RECS 2001: http://www.eia.doe.gov/emeu/recs/*

New vs. Existing Buildings

- We love to work on new buildings
- So much more flexibility
- And not so much messiness– no difficult occupants with fickle preferences
- **But…here is the work!**

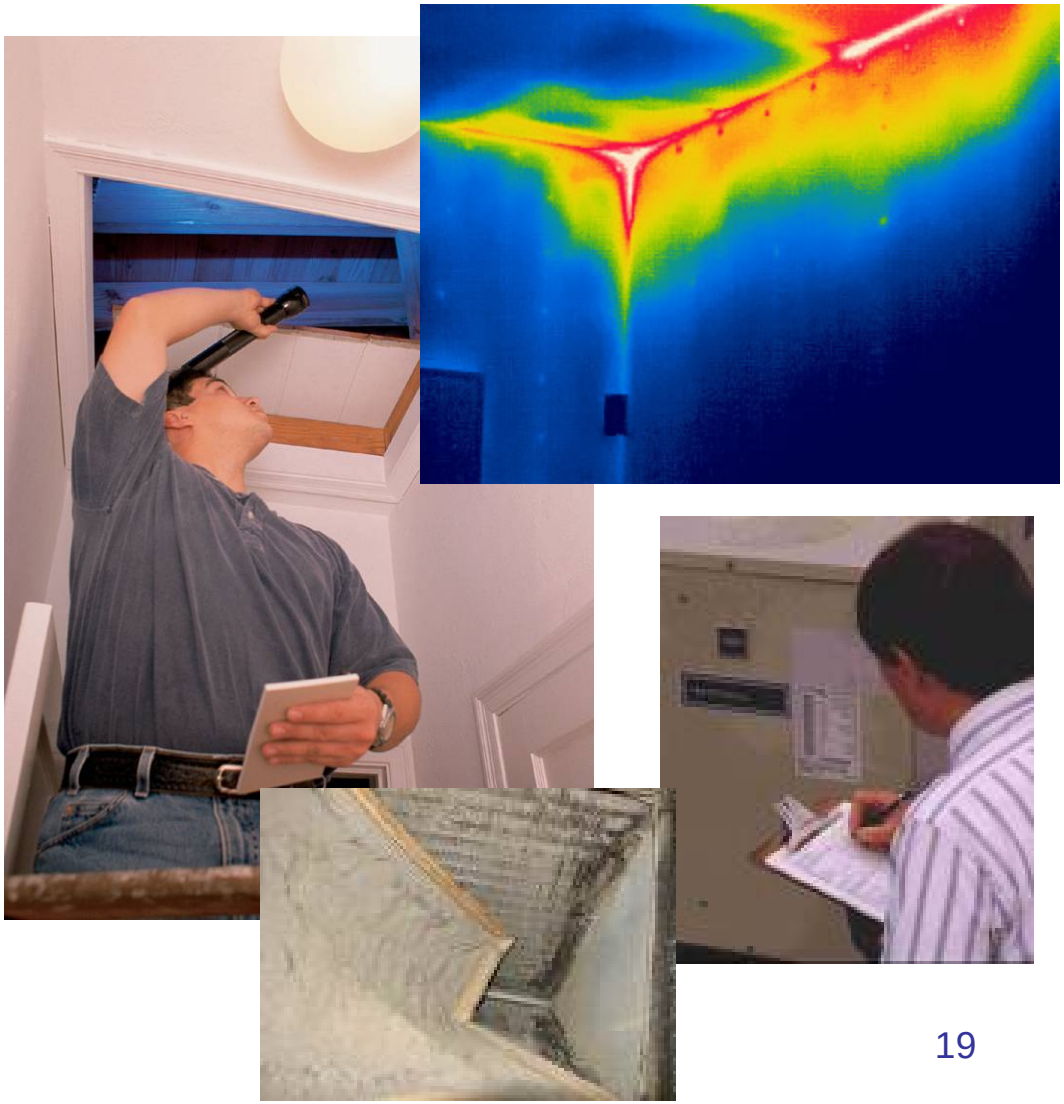


Imagine Several levels

- Why? Appetites are so large; mouths are so finite…
  - Immediate success= more political traction for next phases
  - Characterize housing stock
  - Chewable chunks
  - Maturation of technologies; create demand
- What are the levels?
  - I. Immediate survey: audit and mass measures (non-tailor made, but huge implementation).
  - II. Tailored implementation: Evaluation for specific home and occupants; home owner & computer driven evaluation
  - III. Factor Ten Implementation: May include measures not currently feasible or economically attractive
- Hazard: Drive by audit and medium level retrofits may miss big opportunities– challenging issue

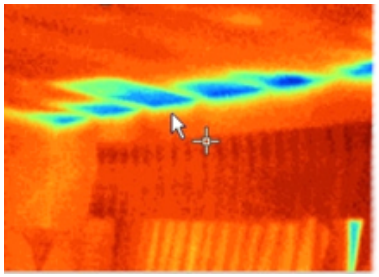
Oh, the Complications!

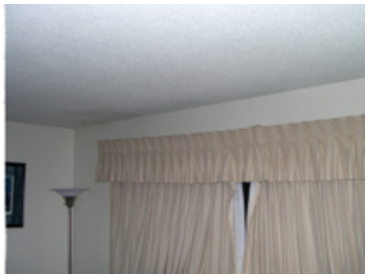
- Non-homogenous
- Terribly different
- With different occupants of different levels of cooperation
- Regional differences (lots)
- Each one potentially a cases study in what will work



With Huge Variability

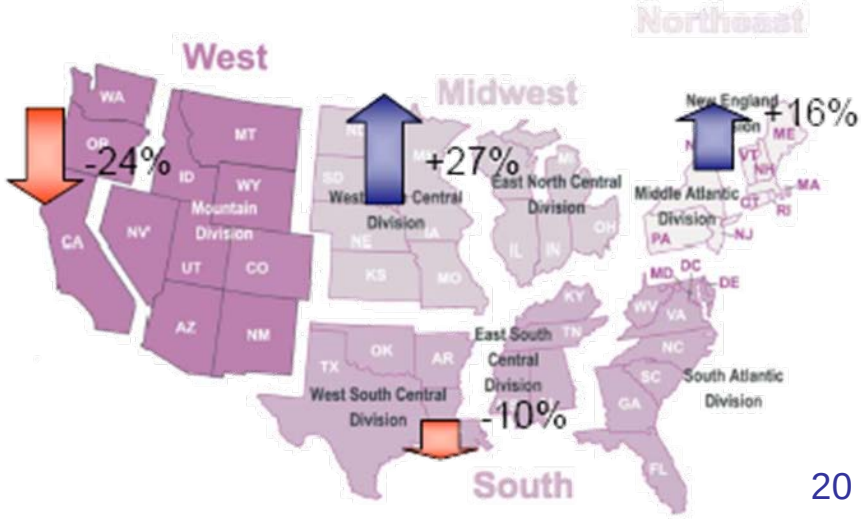
- Regional differences
- Different vintages
- Different maintenance
- Different equipment
- Different installed appliances
- Plugs loads and amenities
- “No size fits all”





Location affects consumption!

Regional energy use vs. US average

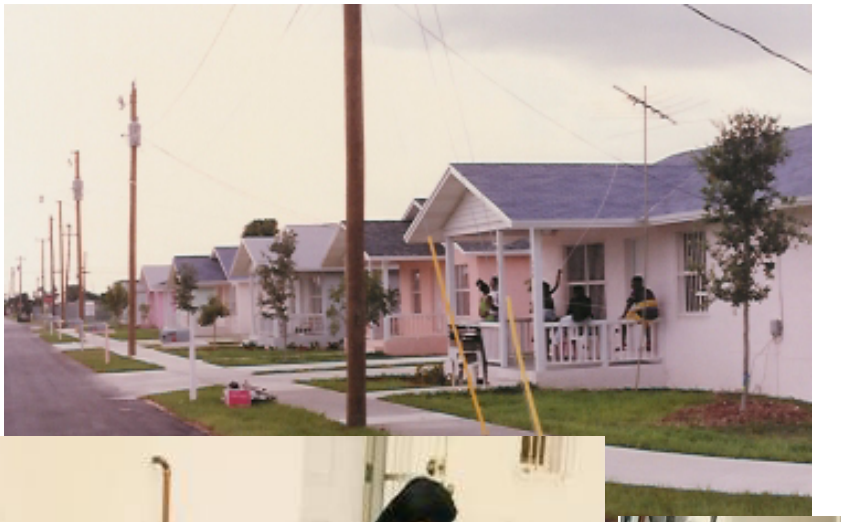


Attack of the Monster Homes

- Contradiction: Banks will never finance spending $150K on efficiency
- Wrong: Banks are financing 5,000 sqft homes
- Consider: Max 2,500 sqft
- Cost per sqft is > $150-200
- Save $150-200K
- Spend half on super efficiency & solar features
- Greater appreciation potential
- Saves energy and PV cost/ responsible social signal
- Find your family without a household intercom!

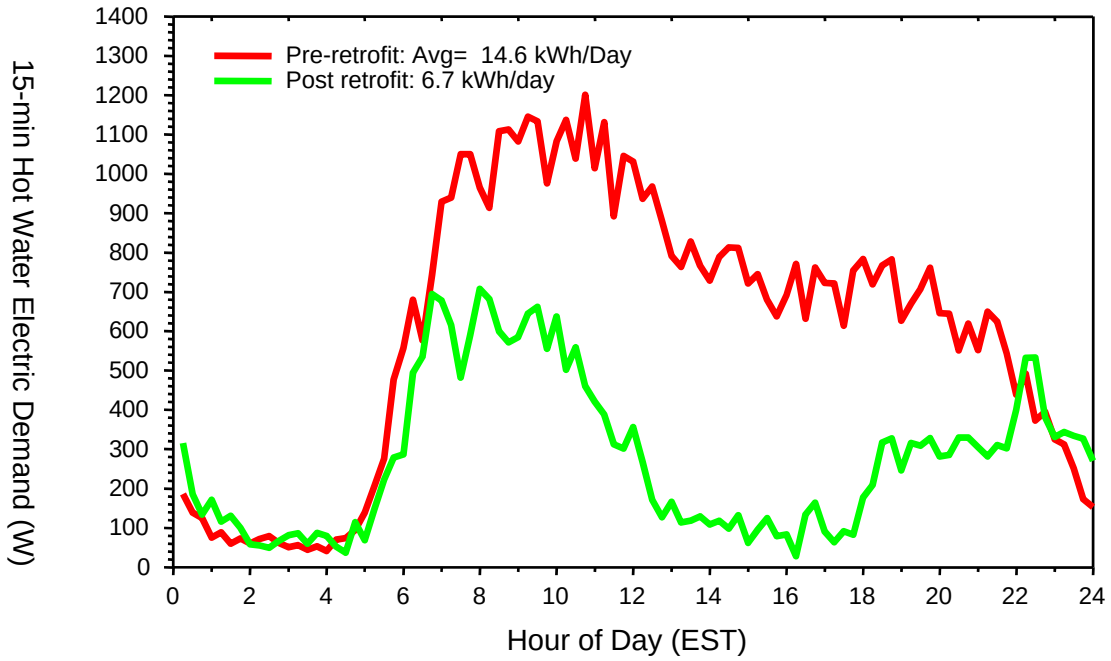
Case Study: 10 Habitat Homes

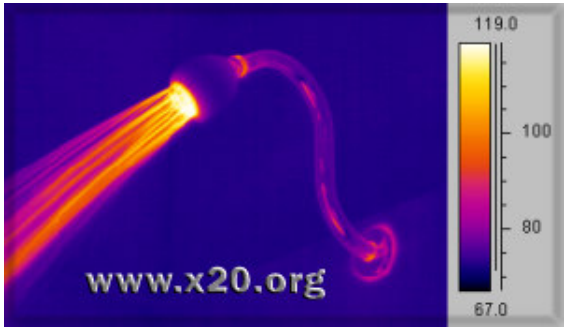
- Homestead, FL
- 1000 - 1100 sqft ft
- Repair duct leakage
- Adjust refrigerators
- Low flow showerheads & solar hot retrofit
- CFL lighting
- 2,100 kWh savings
- 14% of total use



Solar Water Heater & New Showerheads

54% Saved !



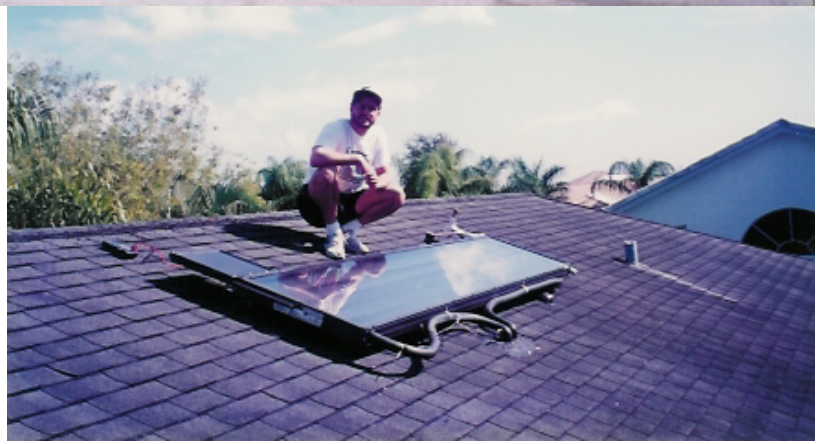


Case: Comprehensive Retrofit

- Extensive retrofit without structural modifications
- Radiant barrier with better ventilation
- Hi-Efficiency AC with Variable Speed AH
- Smaller pool pump
- CFL lighting
- Efficient refrigerator
- Solar water heater

Comprehensive Retrofit

- $9000 cost over one year period as retrofits were installed
- 45% reduction in measured electricity use (12,000 kWh)
- $1450 saved per year
- CCE = 6 cents per kWh
- Improved comfort reported
- Greater potentials; Example of Hazards, Missed opportunities
  - Tile floor
  - Attic to R49
  - Ductless mini-split AC
  - Low-e window replacement
  - Tight house with ventilation



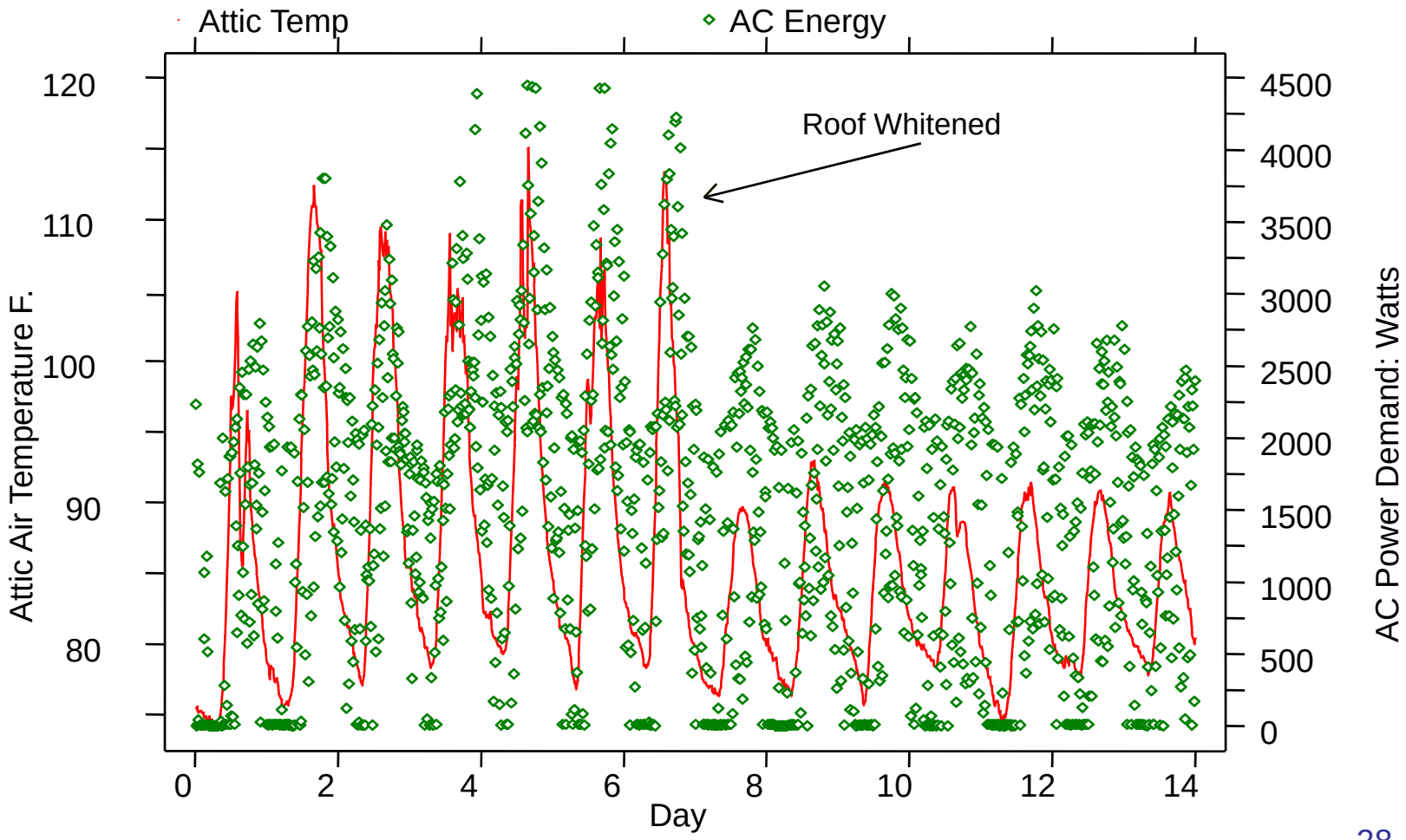
Chinese menu approach

- Improve each household element from top to bottom
- But include flexibility
- Choose from a list: (e.g. for hot climate roof/attic)
  - Radiant barrier with attic ventilation
  - More insulation
  - Reflective surfaces with sealed attic & deck insulation
- Best opportunity to make major changes

Deep Retrofit: Deep South

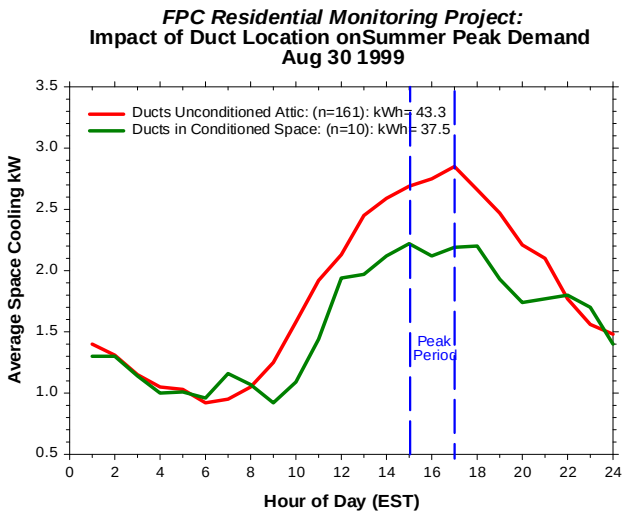
- New roof
- Interior ducts
- Insulated walls
- Floor treatment
- New windows
- BIG remodel
- Expensive, but offers savings beyond 50%
- Lost opportunities: Will attic ducts, R30 ceilings and R11 walls be acceptable in 2030?

Does it Make a Difference?



Interior Ducts

- Not this…
- Ducts inside insulated envelope
- Tested 3% leakage or lower to outside



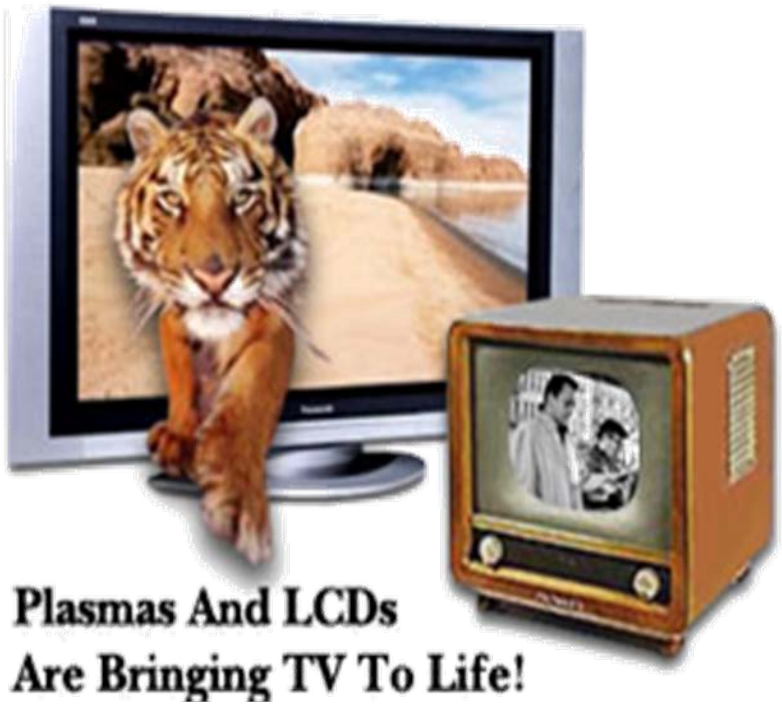
Retrofit for Next 100 Years

bsc **Four Square Renovation**

- R60 Roof
- R41Walls
- R28 Basement Walls
- R10 Basement Floor
- U=0.33 Windows
- 92% AFUE boiler
- 80% EF water heater
- Ventilation
- 3.6 kW PV
- Savings:
  - 67%

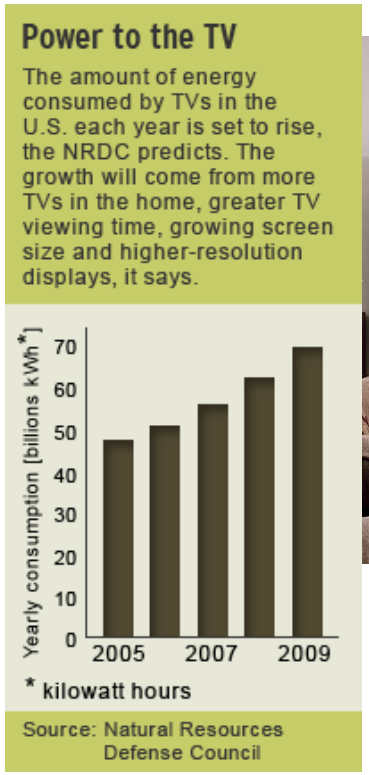
Find the Gaps!

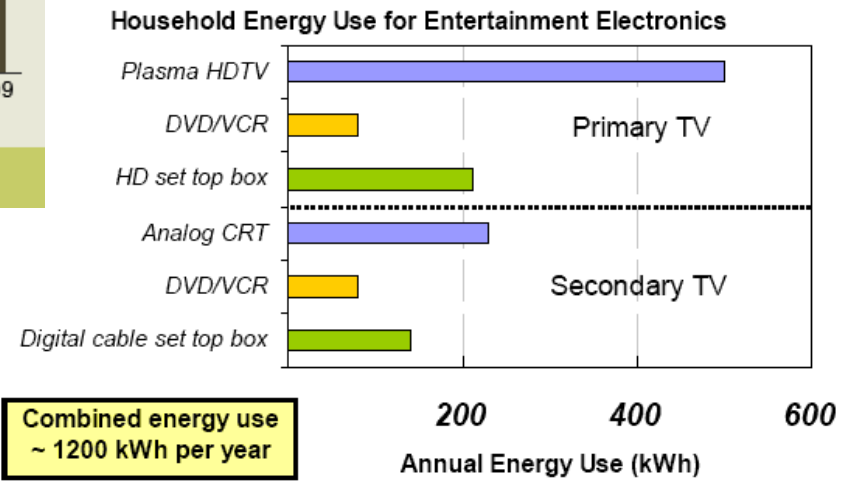
- Stuff seldom considered
- Often big payoff
- Miscellaneous electricity use is big
- Occupant behavior leads to big variation in energy use
- Let's use both!



Home Entertainment Center

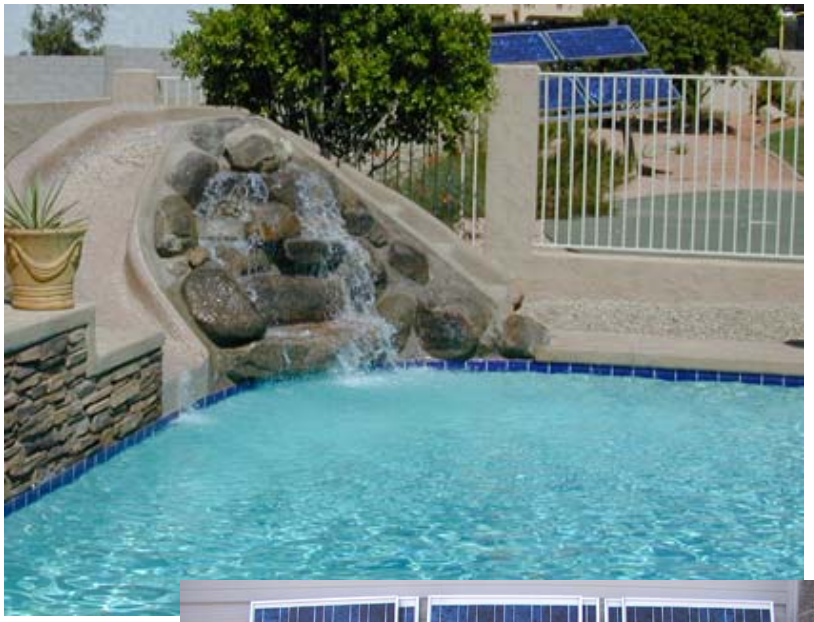
- Average Energy Use
  - Television: 520 kWh/yr
  - VCR/DVD: 58 kWh
  - Cable box: 220 kWh
  - TiVO: 265 kWh
  - Rack Audio: 81 kWh
  - Satellite stn: 131 kWh
- Avg 2.5 TVs/household
- 5-10% of energy
- Home entertainment energy use to grow by 50% by 2009
- Provide switching circuit for entire entertainment center (often 50 W of standby power!)





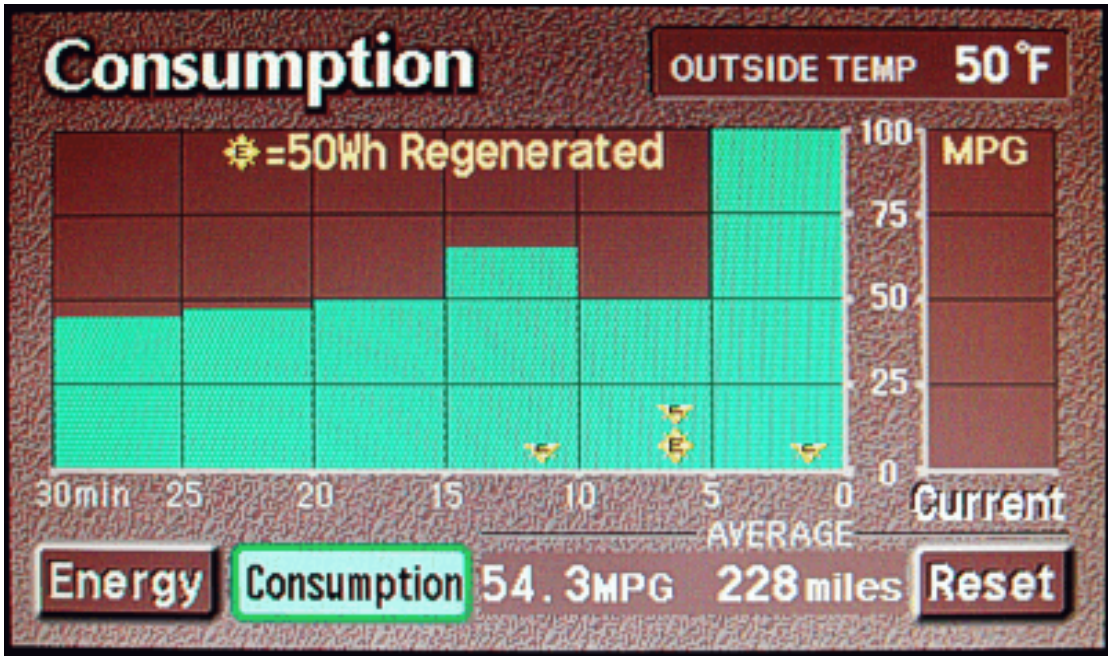
Pools are Big!

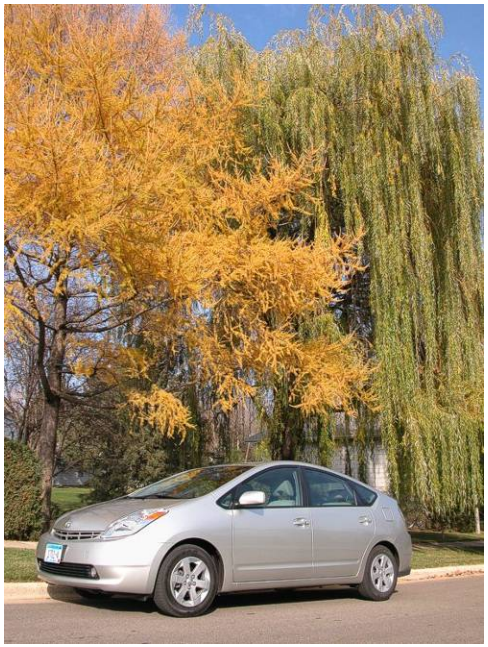
- Second largest end-use in homes that have them (4000 kWh/yr)
- No relationship!
  - Pool size/pump size
- Ready design solutions
  - Larger piping/low friction filters
  - Two-speed pumps
- Potential to cut by 70%
- Solar pumping eliminates energy end-use!
- ***ETAEngineering.com***



If a House Drove Like a Prius?

One important reason why hybrid cars result in better mileage is that drivers suddenly have an indication of how various aspects of their driving habits shape mileage. Hybrid mailing lists are filled with people taking about "driver break-in periods" as new drivers, given immediate feedback from the car, learn how to drive in a mileage-optimal fashion.Most hybrid drivers see a steady improvement in mileage over the first year because of this. -Jamais Cascio, WorldChanging.



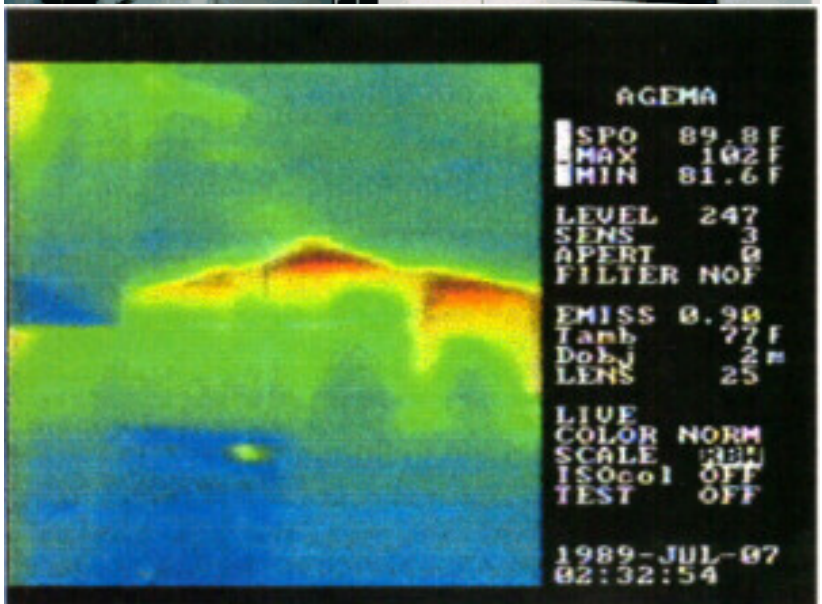


How Effective?

- ***Hydro One***
- **Installation of 500 *PowerCost Monitors* in the summer of 2004.**
- **Participants monitored for 2.5 years.**
- **Avg. reduction in electrical consumption of 6.5%. (7-10% with targeted tips)**
- **Income and demographic factors had no impact on the homeowner responsiveness.**

How Many Homes?

- Millions of Homes 2001*
  - 73.7 Single Family Homes
  - 28.5 Apartments & Multifamily
  - 6.8 Manufactured Homes
  - 107 Million total



*2001 EIA RECS data & Annual Review of Energy www.EIA.com/recs

How Much Can We Spend?

- 108 million homes
- Low hanging fruit:
  - $1500 per home
  - Saves 1,000 kWh/yr
  - Saves 100 therms/yr
- Extensive Retrofit:
  - $10,000 per home
  - Saves 4,000 kWh/yr
  - Saves 400 therms/yr
- Deep Retrofit:
  - $50,000 per home
  - Saves 7,000 kWh/yr
  - Saves 600 therms/yr
- Above + 3 kW PV:
  - $75,000 per home
  - produces 4,300 kWh/yr

Note the pools in Kansas!

It’s BIG Spending

- Low hanging fruit
  - $168 Billion
- Big intervention
  - $1,123 Billion
- Deep Retrofit
  - $5,616 Billion
- Above + 3 kW PV for everyone
  - $8,424 Billion
- A lot of money, right?

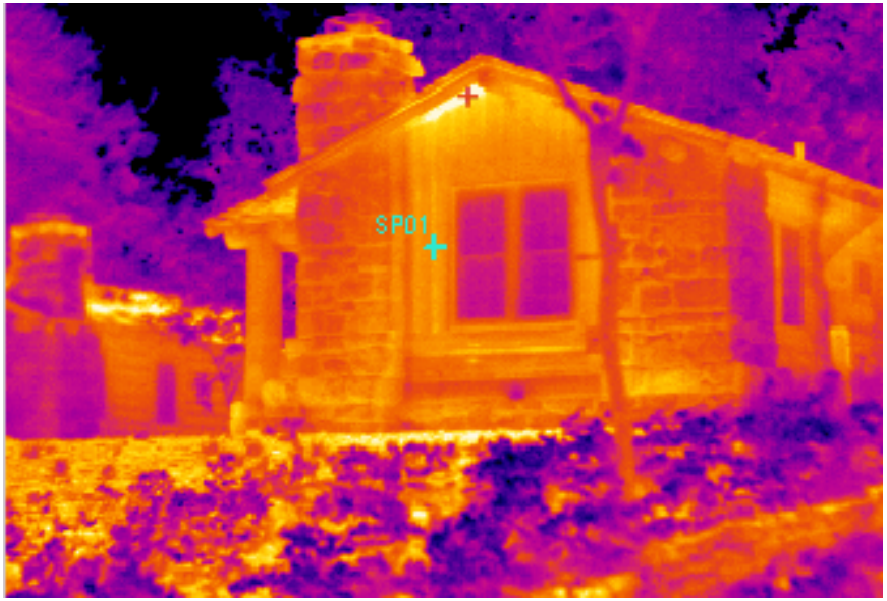
Compared to What?

- *Iraq War* now costs $200 Billion/year*
- ***Iraq War Equivalent*** = $200 Billion/year
- Our costs are small: 10 months of war cost to intervene in all homes!
- Major retrofits: 5.6 yrs
- 42 years – ***WE*** to do massive retrofit to all homes in the U.S. with 3 kW of PV on all eligible

* Linda Bilmes (Harvard) and Joseph Stiglez (Columbia University, "The Economic Costs of the Iraq War," presentation at the Allied Social Sciences Associations, Boston, January 2006. Also, "What 1.2 Trillion Can Buy," David Leonhardt, New York Times,17 January 2007.

What's the Payback?

- Low level audit pays for itself in 7 years
  - 120 Million Tons of CO_2 reduction
- Even most extreme case with PV pays for itself in less than 35 years
  - Over a billion tons lower annual CO_2 = 20% reduction for U.S.



Other Benefits

- Millions of new jobs
- Largest public works program since WPA
- Billions of dollars in annual savings to the public
- Large multiplier impact to U.S. economy
- Improved Homes! Lower operating cost, better durability, safety and IAQ!
- Genuine world leadership