



# Energy Efficiency: A Capital Offense

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## Presentation to Eleventh Annual Conference on Energy in California

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## Presentation Summary

- To reduce California CO<sub>2</sub> emissions, focus on the main sources – generation of electricity and thermal energy
  - Combining heat and power doubles efficiency, cuts CO<sub>2</sub> in half while supplying same end use energy.
- All CHP uses energy (more precisely exergy) twice, but changing existing plants is a capital offense under the CAA.
- Environmental regulatory methodology, including Waxman Markey, ignores efficiency and makes old plants immortal
- To induce efficient CHP (like Denmark, Netherlands, Finland), reward clean generation (lower criteria pollutants and/or lower CO<sub>2</sub> per unit of output) and penalize dirty generation.
  - Expected benefits; 20% reduction of U.S. CO<sub>2</sub> and \$80 to \$100 billion per year savings.



## **The Energy/Carbon Story**

**The Generation Story**

**Recommendations**

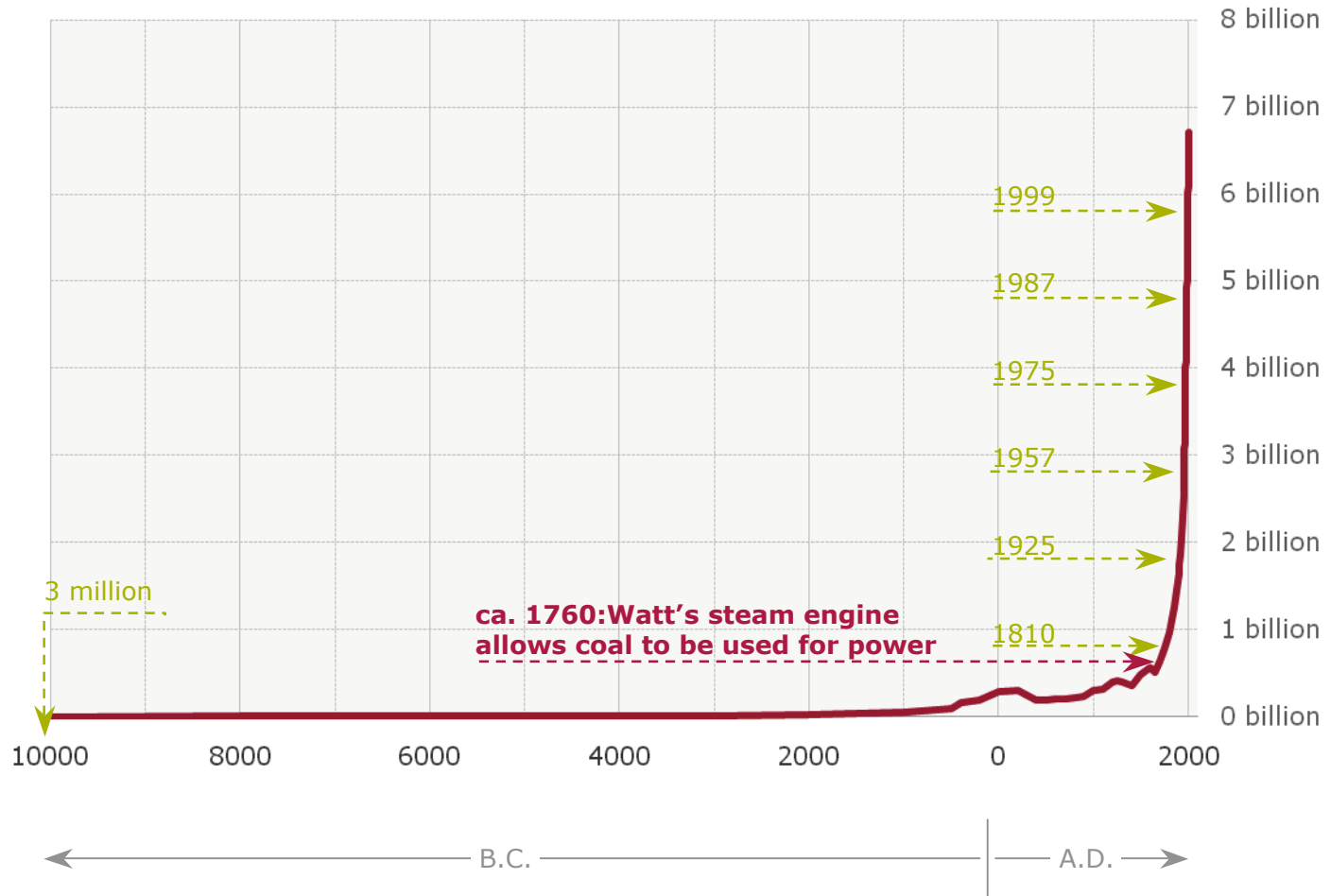


## The history of access to energy services

- Our standard of living depends on access to energy services:
  - Heat, power, mechanical energy
- Until recently, *homo sapiens* depended only on metabolic energy:
  - 100,000 years ago: Fire tamed
  - 10,000 years ago: Animals domesticated
  - 5,000 years ago: Power from wind
  - 2,000 years ago: Power from water
- Recent use of 'Ancient Sunlight' – fossil fuel:
  - 1760: First significant use of coal
  - 1859: Oil discovered
  - 1885: Natural gas first used
- Access to energy services allowed population to explode

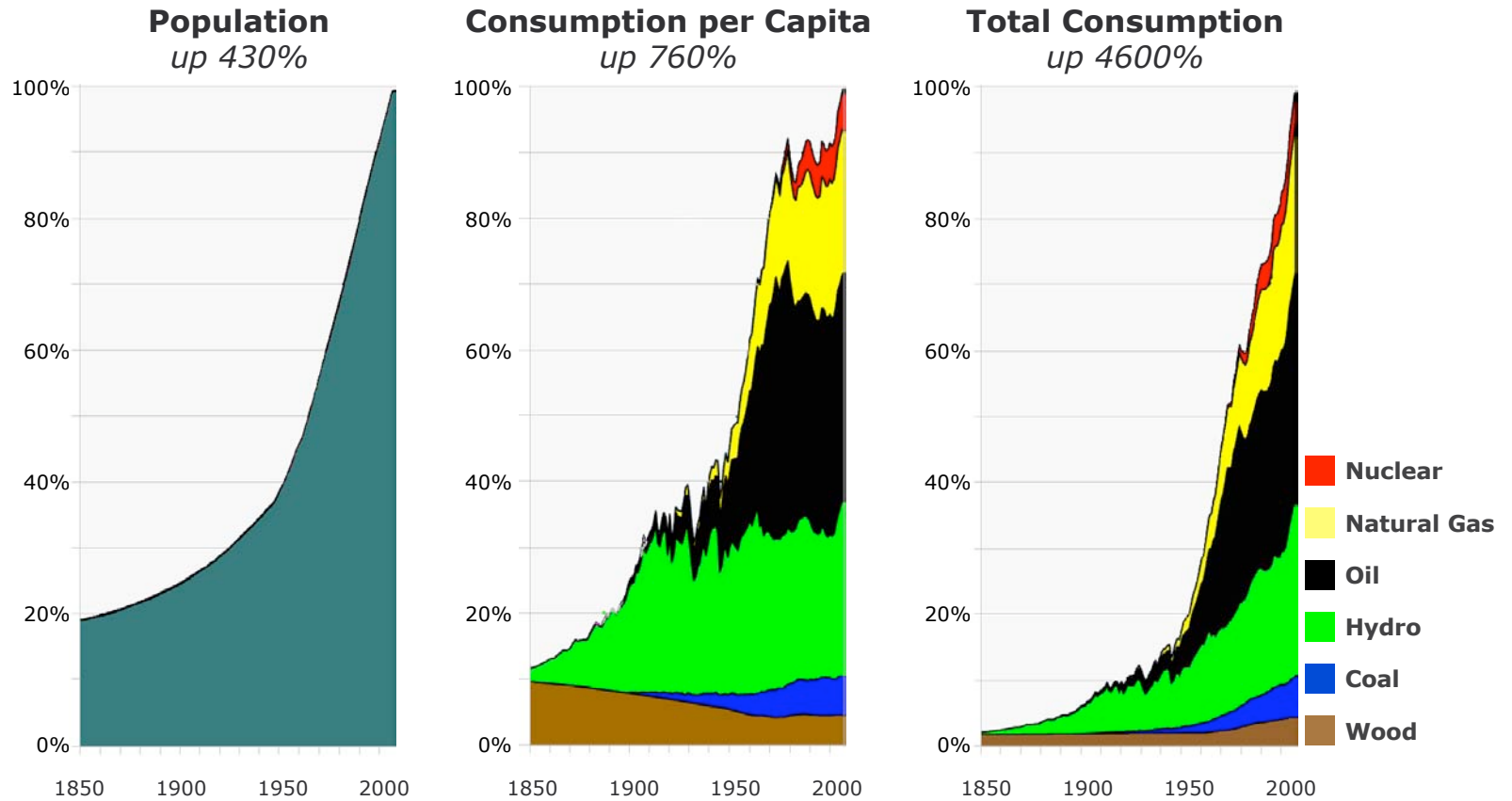


# World population has grown dramatically



Source: various authors cited by the U.S. Bureau of Census

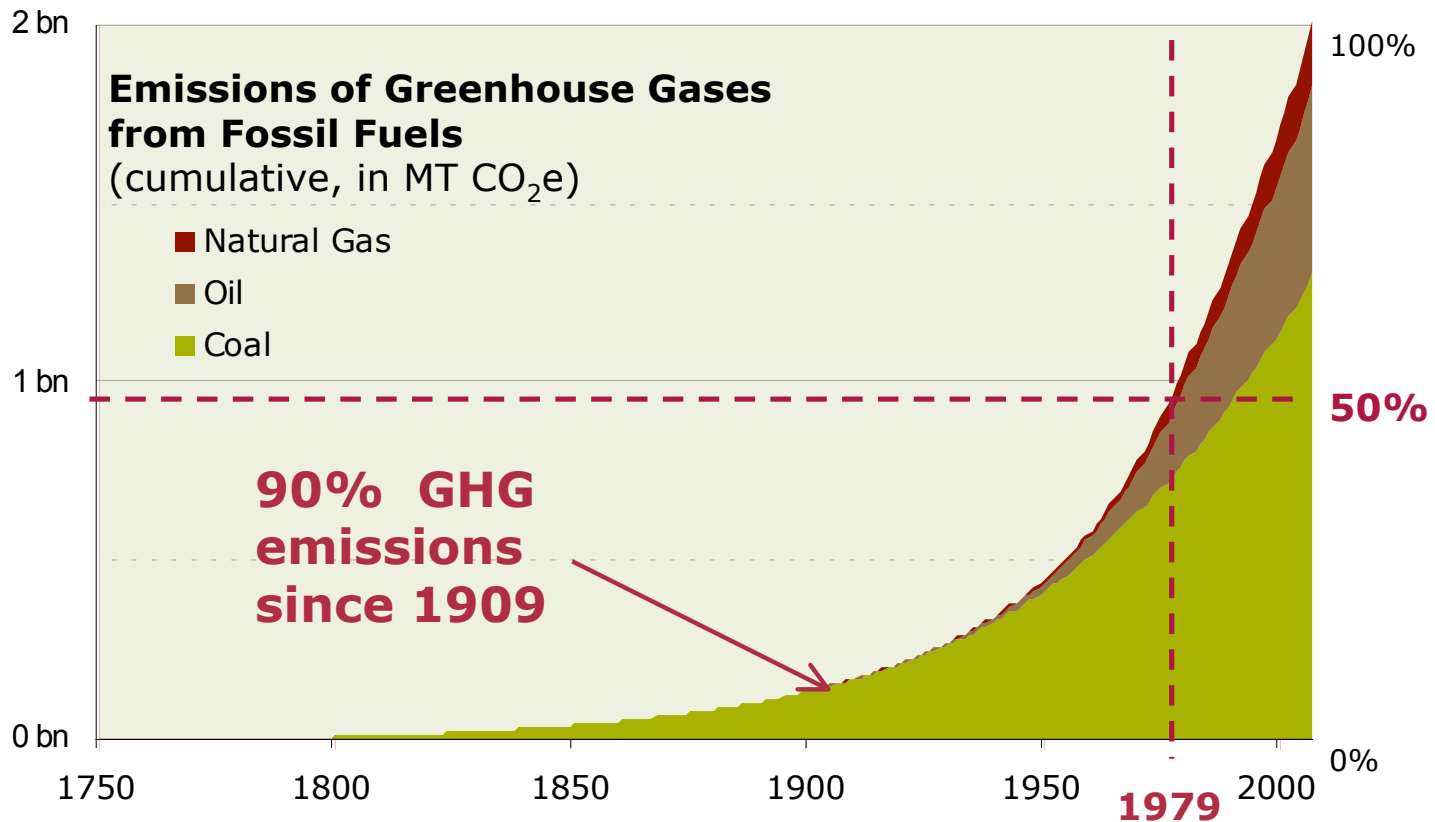
# Increases in world population and energy consumption 1850-2007



Source: Arulf Grubler (1998), BP Statistical Review of World Energy (2008), US Bureau of Census (2008)



# Ninety percent of human greenhouse gas emissions during the past century



Source: RED calculations based on data from BP Statistical Review and J. David Hughes, Geological Survey of Canada (ret.)



**The Energy/Carbon Story**

**The Generation Story**

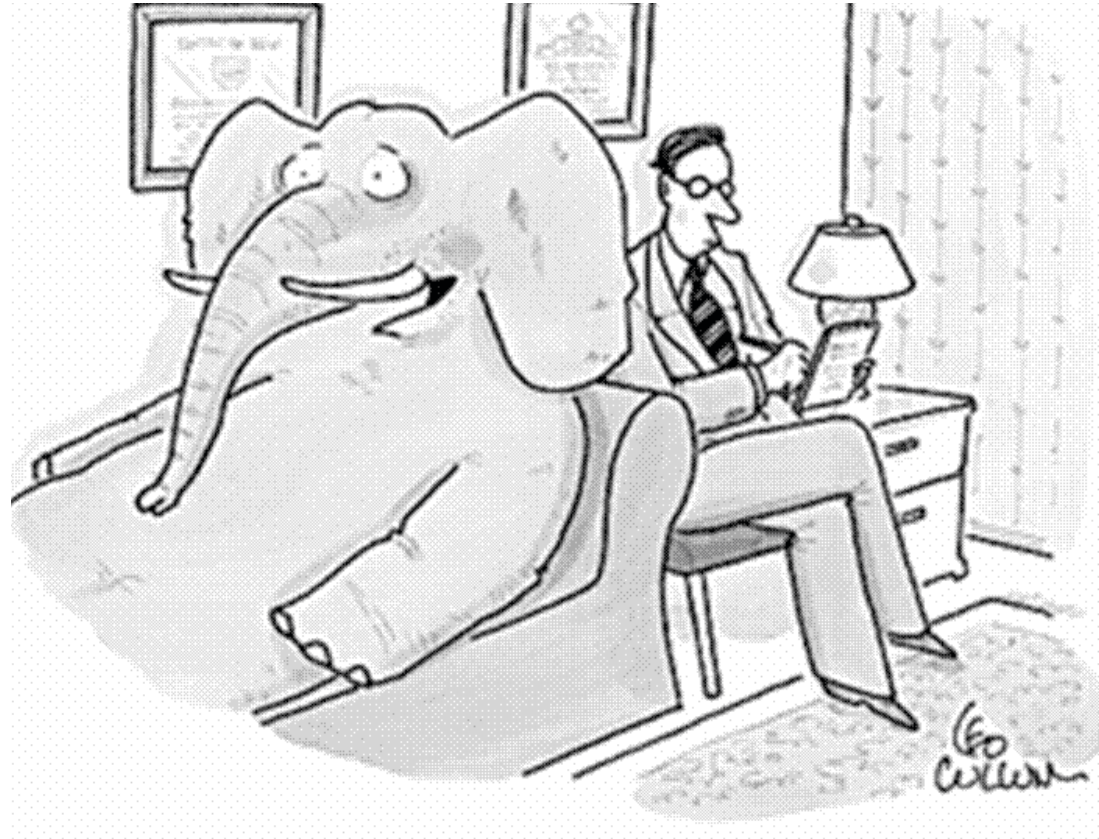
**Recommendations**



# Looking for CO<sub>2</sub> in all the wrong places

- Analysts, like latest McKinsey report, slice the world into transportation, residential, commercial, and industrial and then look for ways to reduce CO<sub>2</sub>
- Others put blind faith in technology, call for more R&D, without first understanding fifty years of stagnant generation efficiency
- Many ask for mandates/inducements to their specific path – CCS, wind, solar, bio fuel, wave power, etc. – rather than providing equal rewards to all clean generation and letting markets pick winners
- **Electricity generation inefficiency is the elephant in the room**

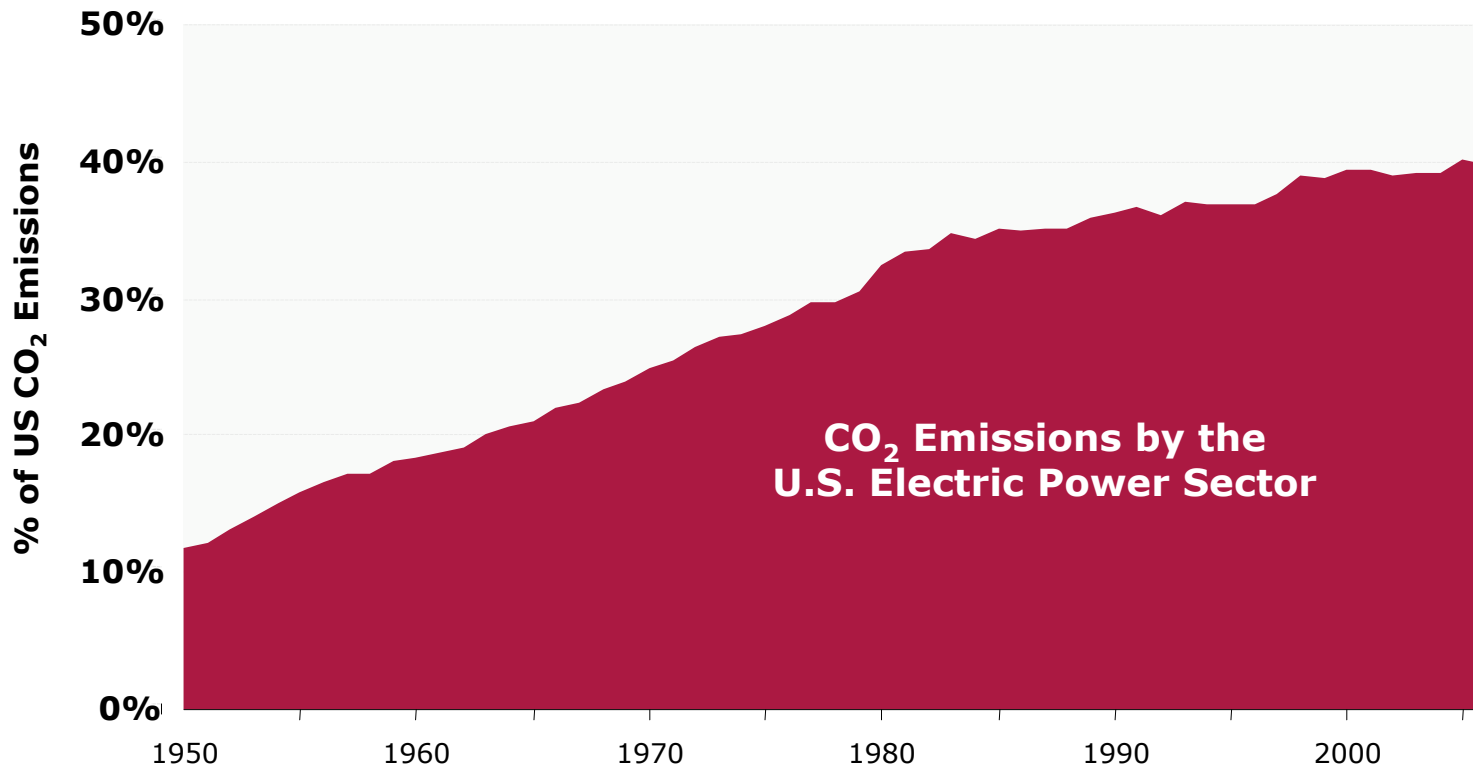
## Generation inefficiency – the elephant in the room



*"I'm right there in the room  
and no one even acknowledges me"*



## Electricity generation is the largest source of CO<sub>2</sub> emissions

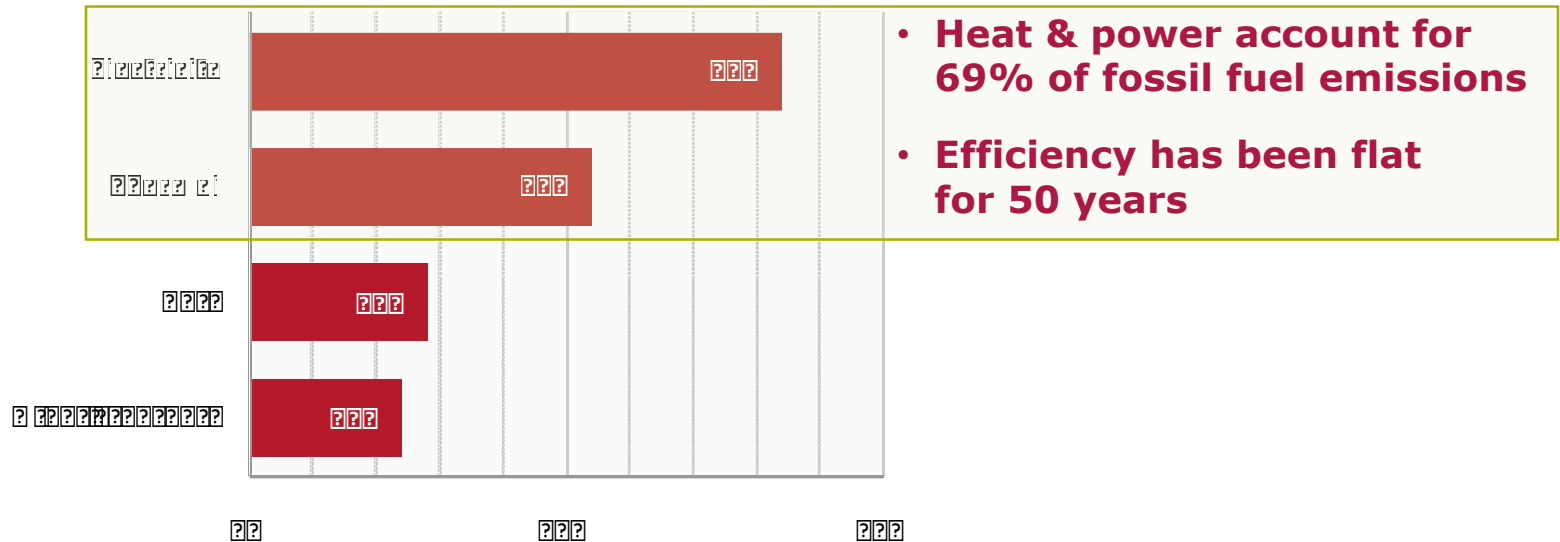


Source: RED calculations based on data from *Emissions of Greenhouse Gases in the United States 2007*; *State Energy Data Report*; and *Annual Energy Review*.



# Inefficient heat and power generation responsible for two-thirds of CO<sub>2</sub>

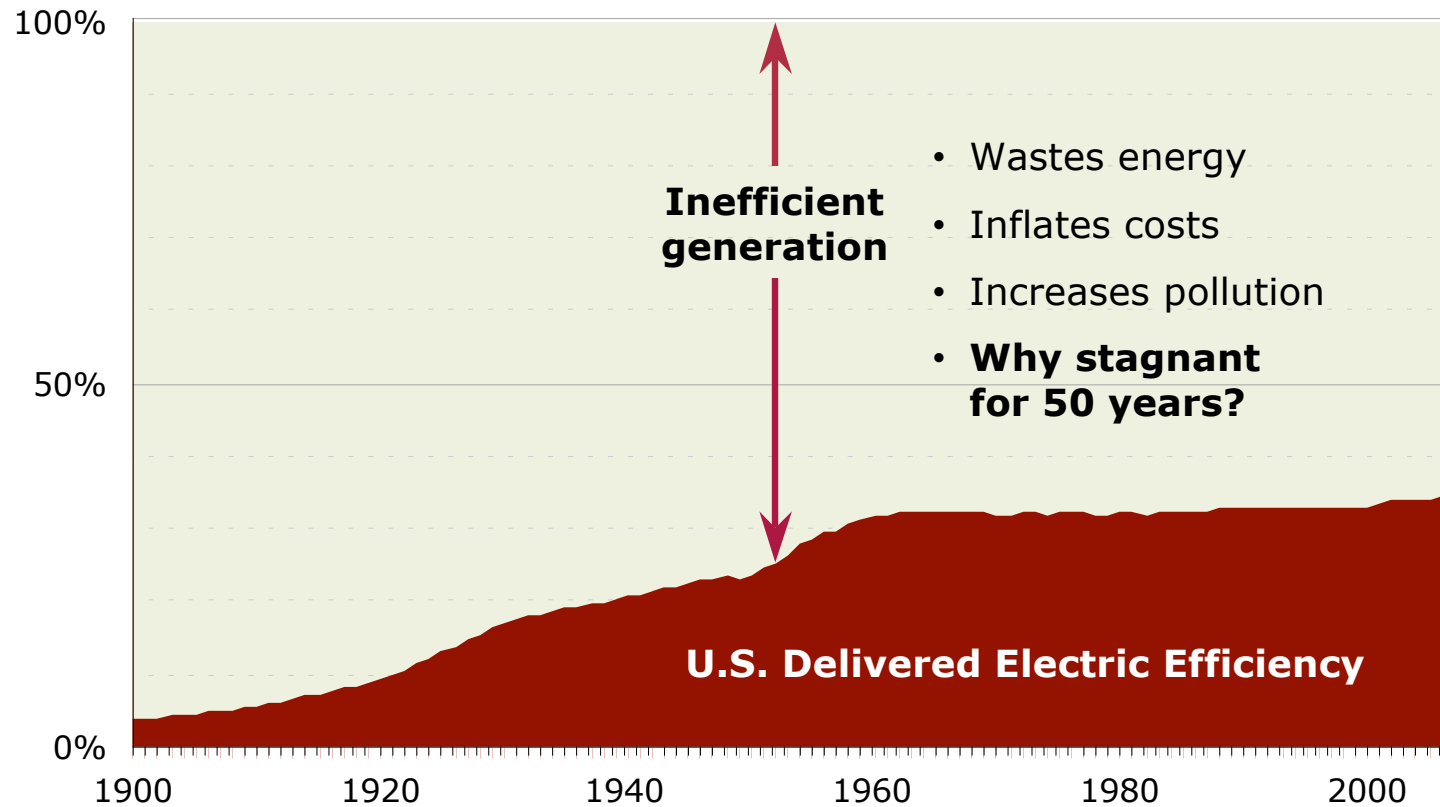
## Emissions of U.S. CO<sub>2</sub> from Fossil Fuels



Source: RED calculations based on data from the U.S. Energy Information Agency and the U.S. Department of Transport



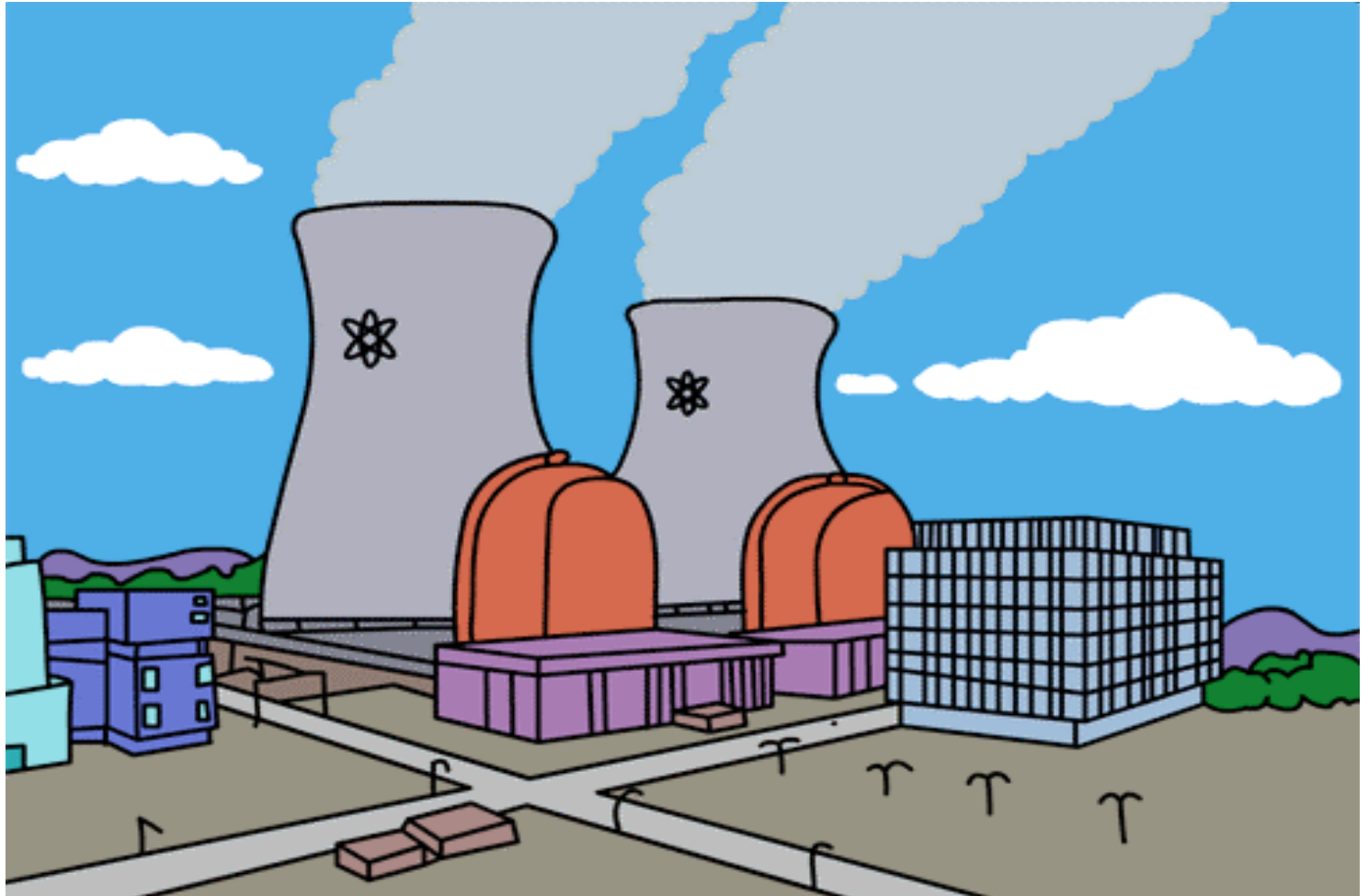
# US electricity generation is inefficient



Source: U.S. Energy Information Agency

# Homer Simpson's power plant

*Springfield, ?*





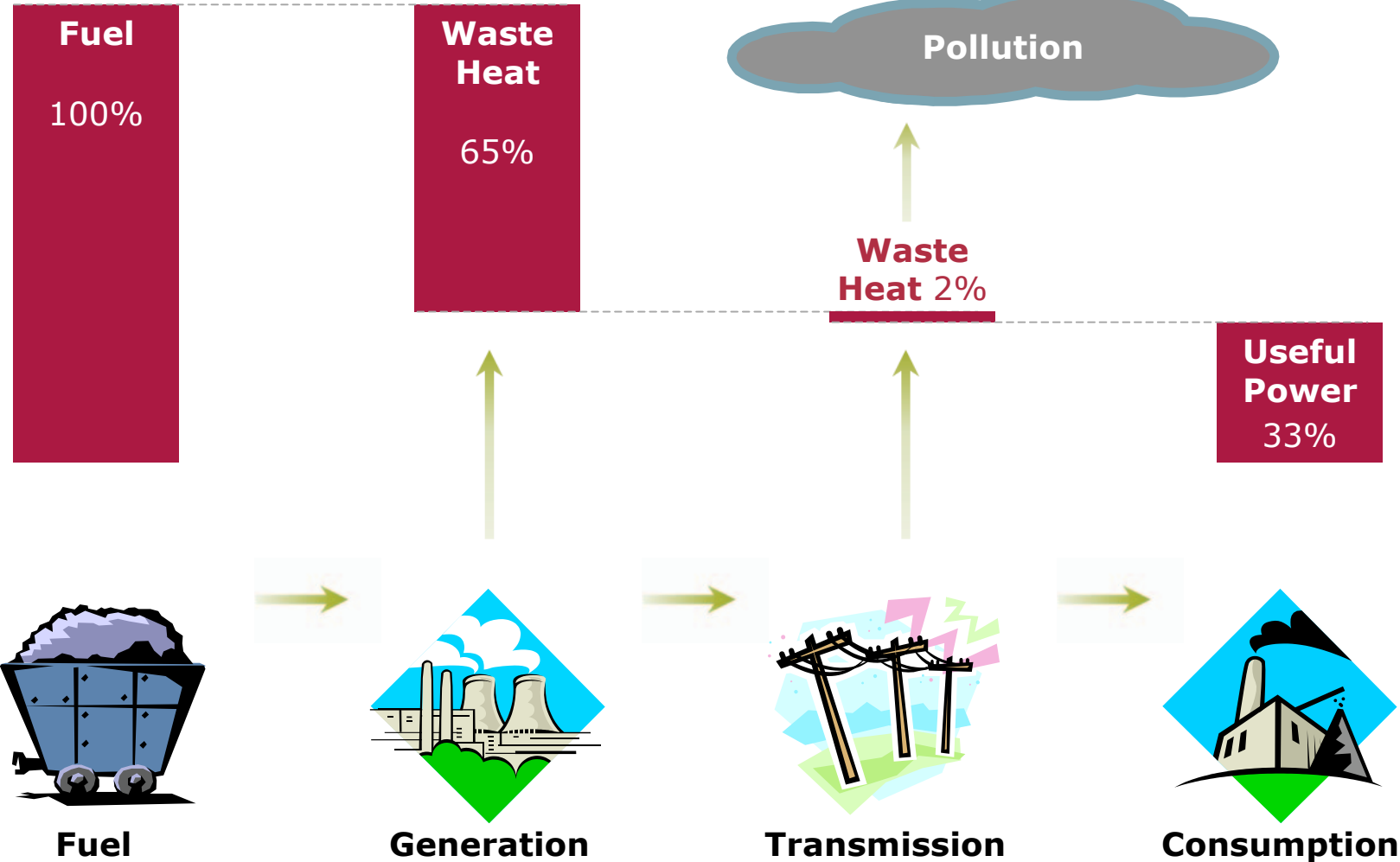
# Electricity generation plant

## *Craig, CO*

*Two-thirds of  
the energy  
generated  
is released  
into the  
atmosphere*

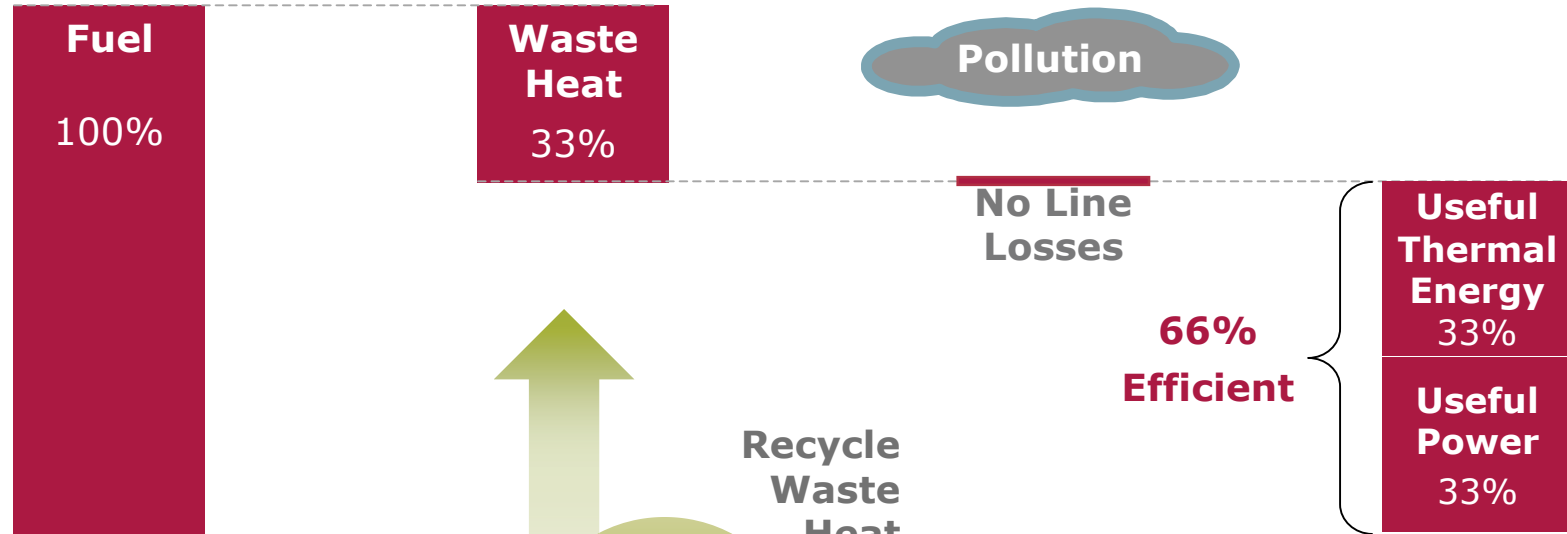


# Conventional electricity generation 1960 (& 2009)



# Use energy twice

## Local generation producing heat and power



Recycle  
Waste  
Heat



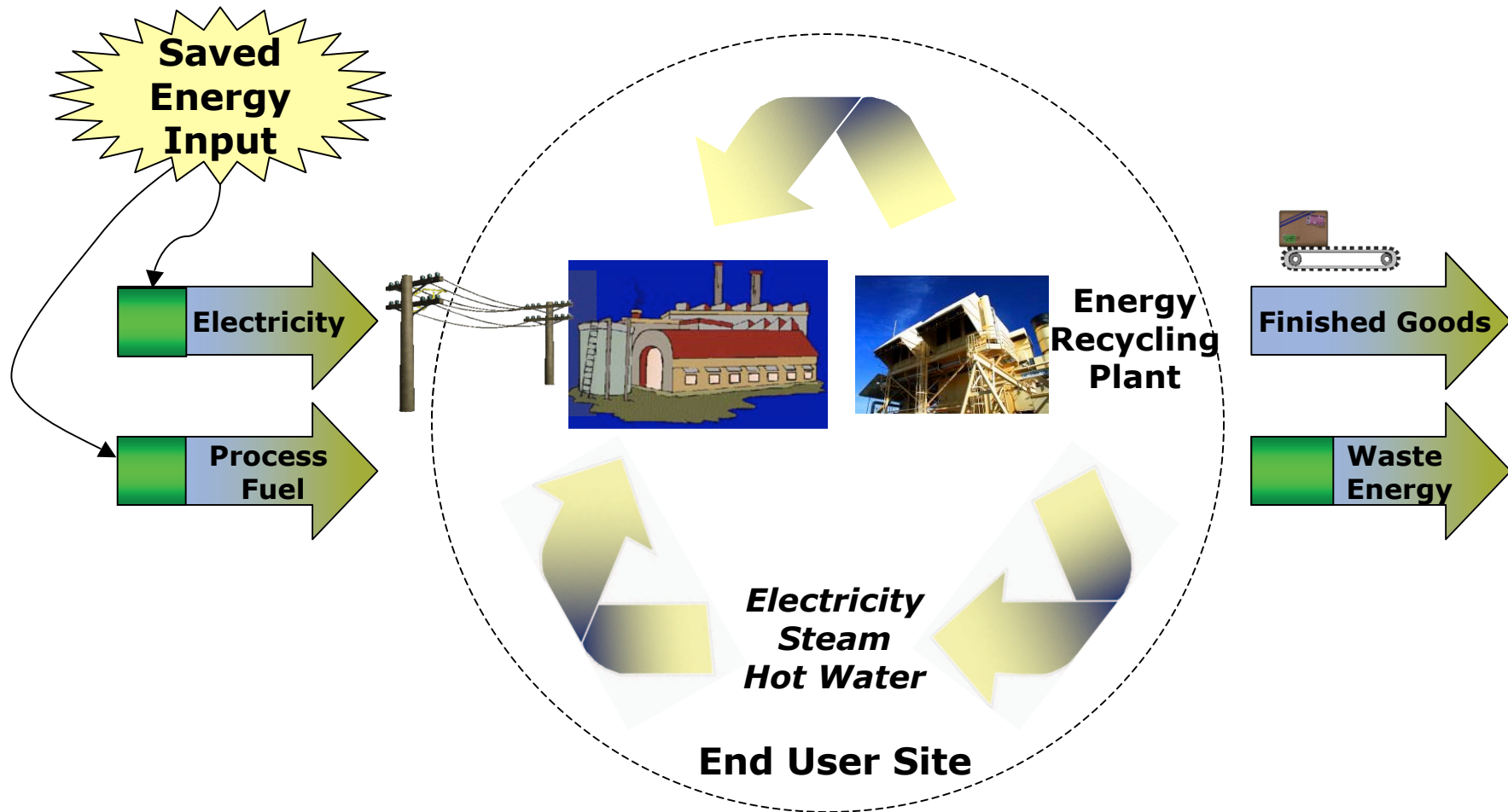
Fuel



Combined Heat and Power Plant



# Recycling industrial waste energy: Cost effective clean energy



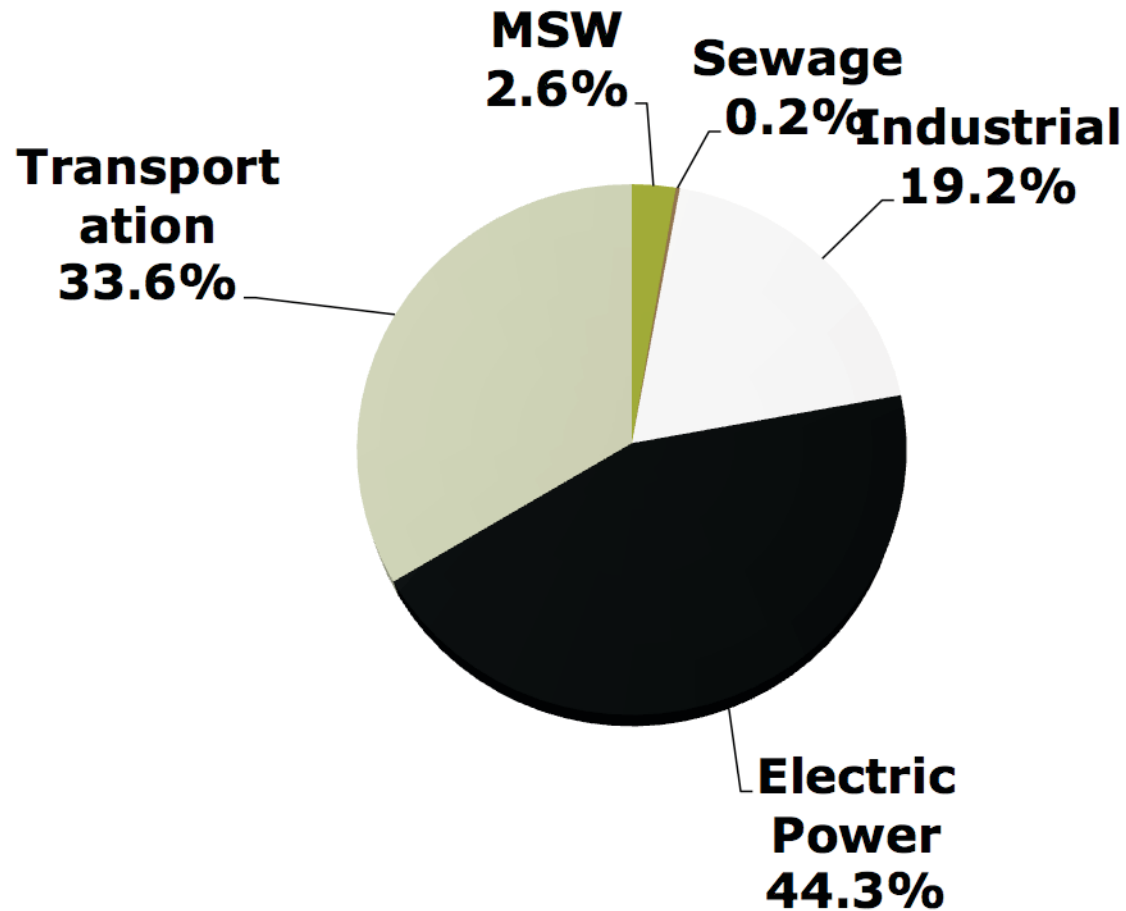


## CHP covers many technologies, kilowatts up to hundreds of megawatts

- Mental image of many is CHP is a micro turbine, with a few kilowatts of capacity
- CHP is any sequential generation of mechanical/electrical energy and thermal energy.
  - **Topping cycle** burns fuel to generate electricity, then recycles the waste heat to displace boiler or process fuel
  - **Bottoming cycle** burns fuel/uses electricity to convert raw materials into more finished goods and then uses the waste energy flows to produce heat and power
- Potential is to replace nearly 30% of today's electricity-only generation (with 33% efficiency) with new CHP generation (65% to 95% efficiency)



# Identified US Energy Waste Streams (in Quadrillion BTUs)





# Recycling industrial waste energy

## Cokenergy Mittal Steel, Northern Indiana

*Produces as much clean energy each year as all grid-connected photo-voltaic solar generation produced in 2004*

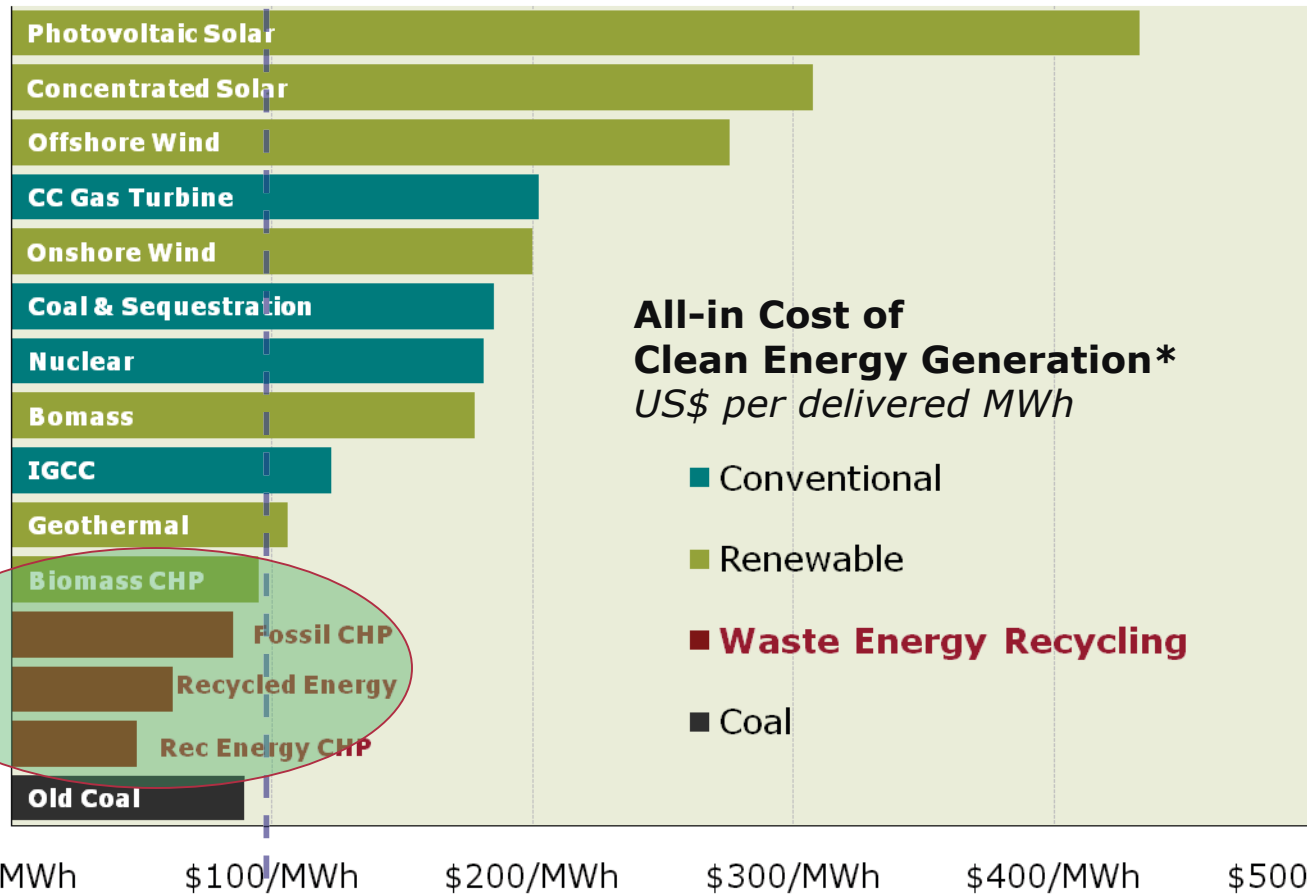
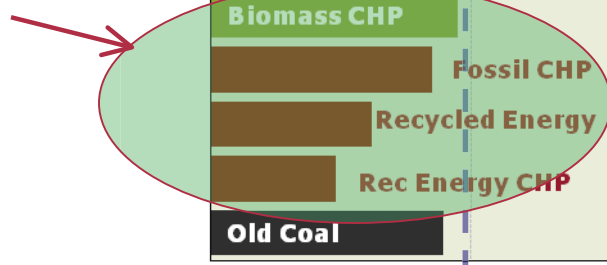




# Waste energy recycling is cost-effective

Average 2008 Retail Cost

Use Energy Twice



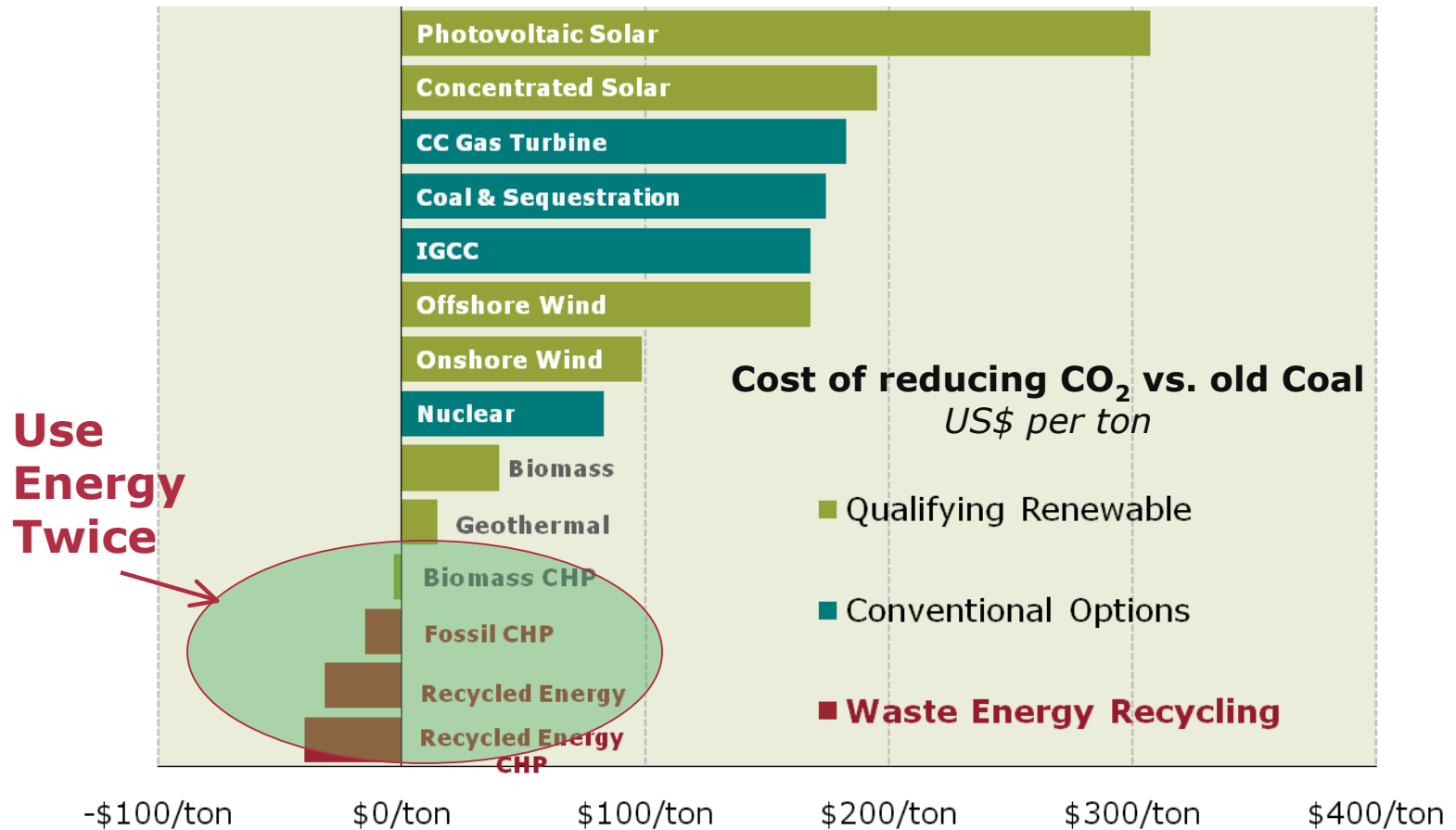
All-in Cost of Clean Energy Generation\*  
US\$ per delivered MWh

- Conventional
- Renewable
- Waste Energy Recycling
- Coal

\* Includes T&D, line losses, backup generation and subsidies

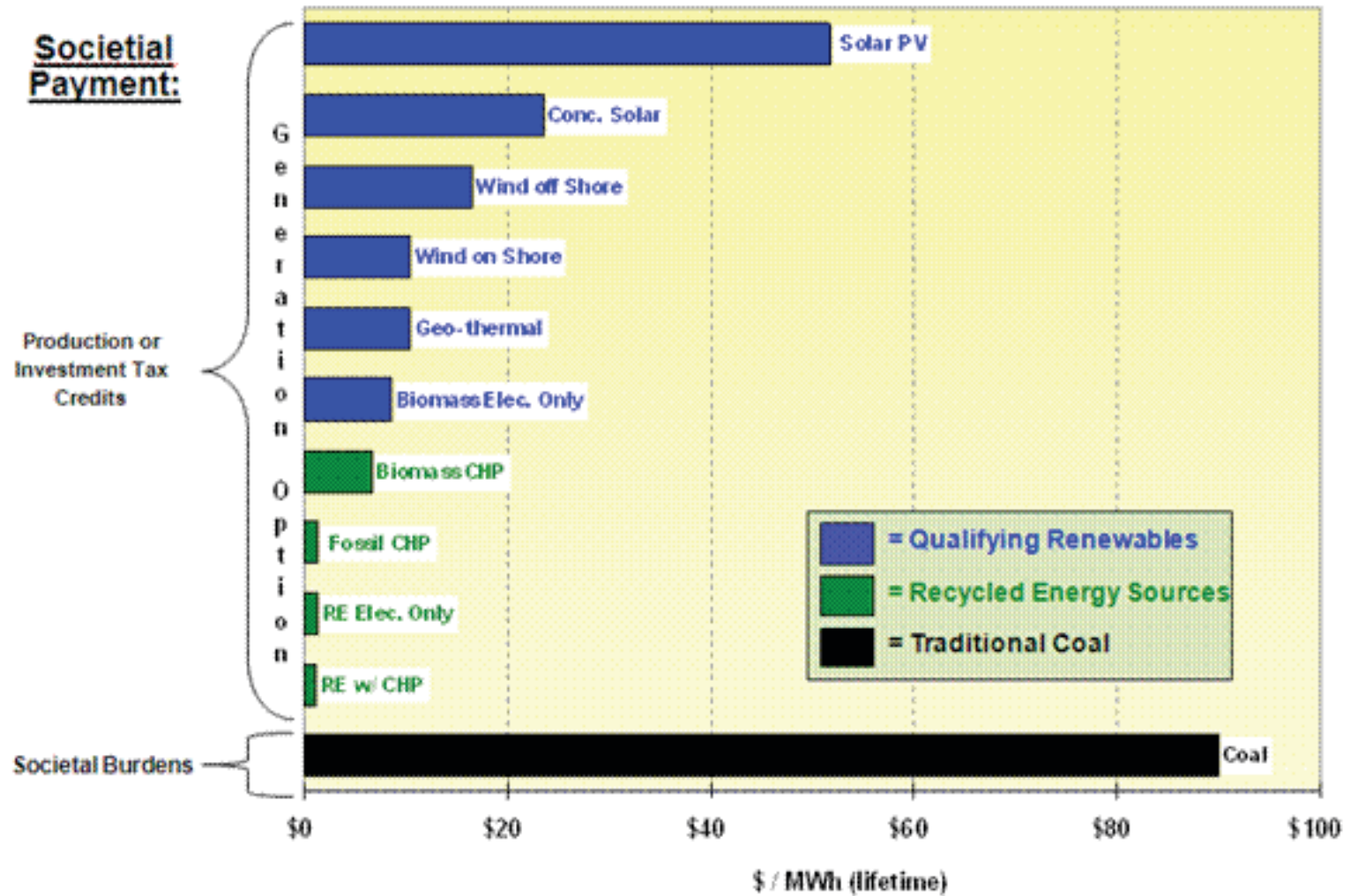


# Only waste energy recycling makes CO<sub>2</sub> reduction profitable to society





# Subsidies are backwards



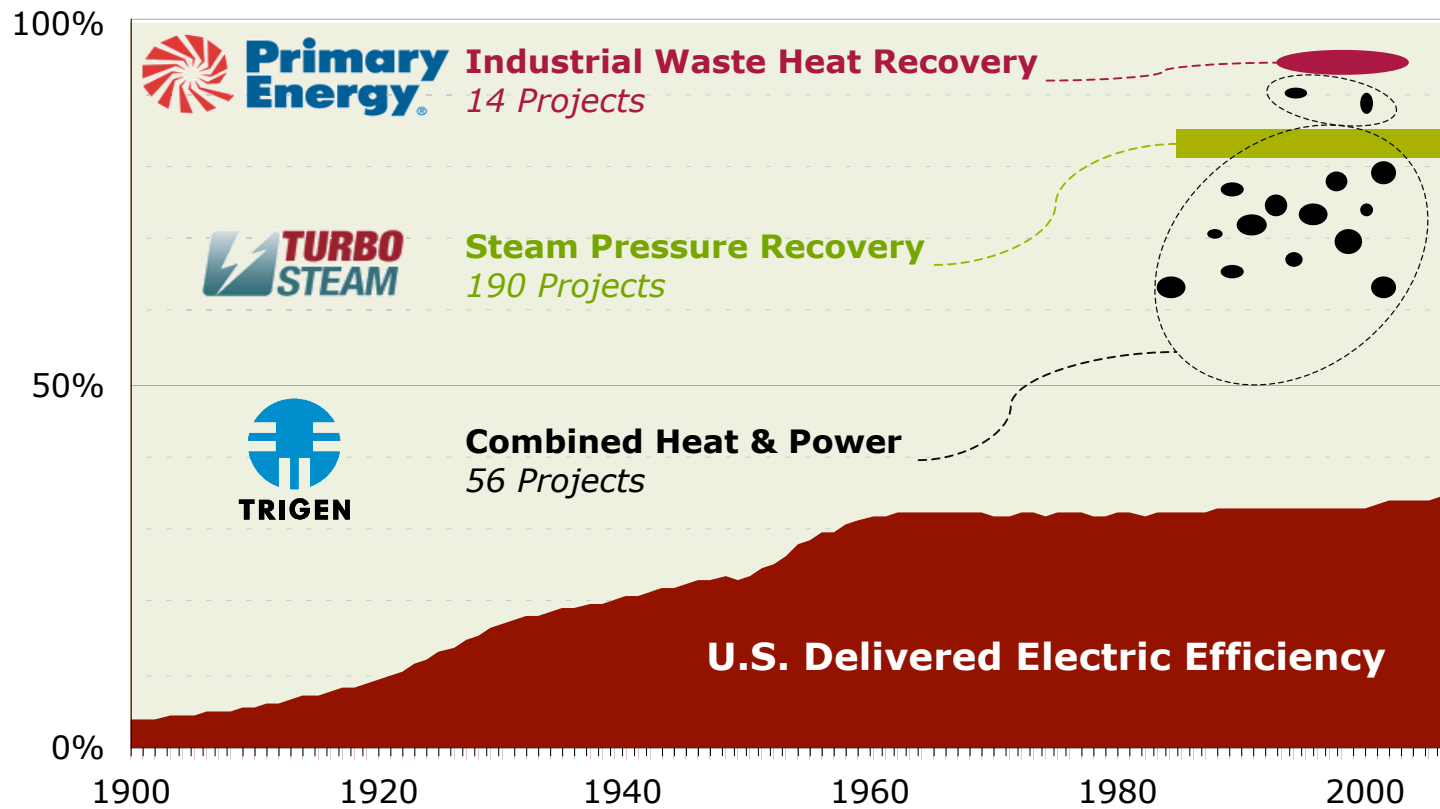


## The potential to use energy twice

- EPA study (Lawrence Livermore) identifies 64,000 MW potential to recycle waste energy in 16 industries
- DOE study identifies 135,000 MW potential for fueled CHP that replaces thermal generation with waste heat from new electricity generation
- World Alliance for Decentralized Energy (WADE) study found potential to reduce U.S. CO<sub>2</sub> by 20% and save \$80 to \$100 billion per year



# We have proven this thesis with 200 projects (\$2.0 billion) with double conventional efficiency





## Policy observations

- ***All currently profitable low-carbon options involve recycling waste energy to increase efficiency***
- But; the CAA treats investments in generation efficiency as a 'Major Modification' and allows EPA to void the operating permit.
  - Most existing electrical and thermal generation plants cannot economically meet current BACT
  - Capital punishment may or may not deter crime, but it certainly deters investments in generation efficiency.
- Penalizing all carbon emissions (Waxman Markey) will further slow construction of new more efficient generation
  - Old inefficient electricity-only plants with free allowances will be less expensive than new efficient plants that must buy allowances, so new efficient plants will not be built to optimal limits.



The Energy/Carbon Story

The Generation Story

**Recommendations**



## Recommendation #1

- California environmental regulators treat efficiency improvements as 'pollution control devices' ending threat of capital punishment
  - Treat any investment that produces a 5% or greater reduction of carbon per unit of output as a pollution control device.
  - This can be done administratively, without new legislation
  - By removing fear of lost operating permit, this will stimulate deployment of efficiency technology, including using presently wasted energy
  - The increased efficiency, by displacing fuel, will also reduce criteria pollutants
  - Resulting efficiency will lower cost of manufacturing, preserving and increasing jobs while lowering pollution



## Recommendation #2

- Move to output based standards, rewarding clean generation, penalizing dirty generation
  - Calculate average pollutant per unit of output for entire country; for example pounds of NOx per MWh of electricity and per MMBtu of thermal energy from all generation
  - Give each heat and/or power generation plant an allowance equal to the U.S. average of each pollutant, per unit of output
  - Lower the allowances per schedule, and further lower to reflect all growth in total production of heat and power
  - Require each generator to produce allowances equal to their annual pollutant output
    - Dirty plants purchase allowances from clean plants
  - **This approach will make 'efficiency the fuel of the future'**



## Recommendation #3

- Replace most of Waxman Markey with a CO<sub>2</sub> output standard, as in prior recommendation for criteria pollutants
  - Give all heat and power generators an allowance of the 2008 average CO<sub>2</sub> per unit of output.
  - Lower the allowances every year to achieve same 17% reduction or more by 2020, and correct for any increase of heat and power output
  - Eliminate all other awarding of allowances
  - No immediate rise in average cost. Each allowance purchase by high-carbon plant is a sale by a low-carbon plant.
  - Utilities will sell permits from their nuclear and other low carbon plants to their coal plants, minimizing impact per utility
  - Market forces will be unleashed to deploy every conceivable method of lowering CO<sub>2</sub> per unit of output



## Conclusions

- Using energy twice could cut CO2 by 20% while saving \$80 to \$100 billion per year, but:
  - Current environmental regulation ignores efficiency
- Changes to existing thermal or electric generating plants are a capital offense, potentially costing the operator the right to operate
- Modify regulations to reward efficiency and penalize inefficiency, to make **'efficiency the fuel of the future'**.
- Willie Sutton robbed banks because that was where the money was. **To profitably lower CO2 emissions, we must change the way the world generates electric and thermal energy.**



**Thank you**