# Recycling Waste Energy:
## Profitable climate change mitigation

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***ACEEE 30th Anniversary Symposium:***
***Energy Efficiency as an Economic Imperative***
***April 26, 2010***

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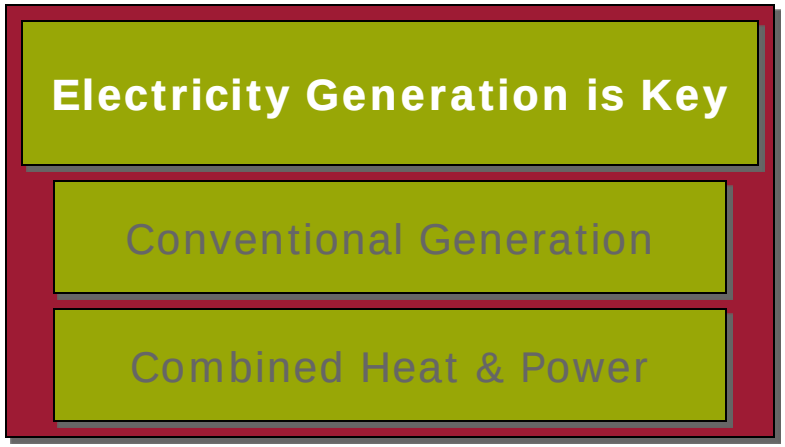
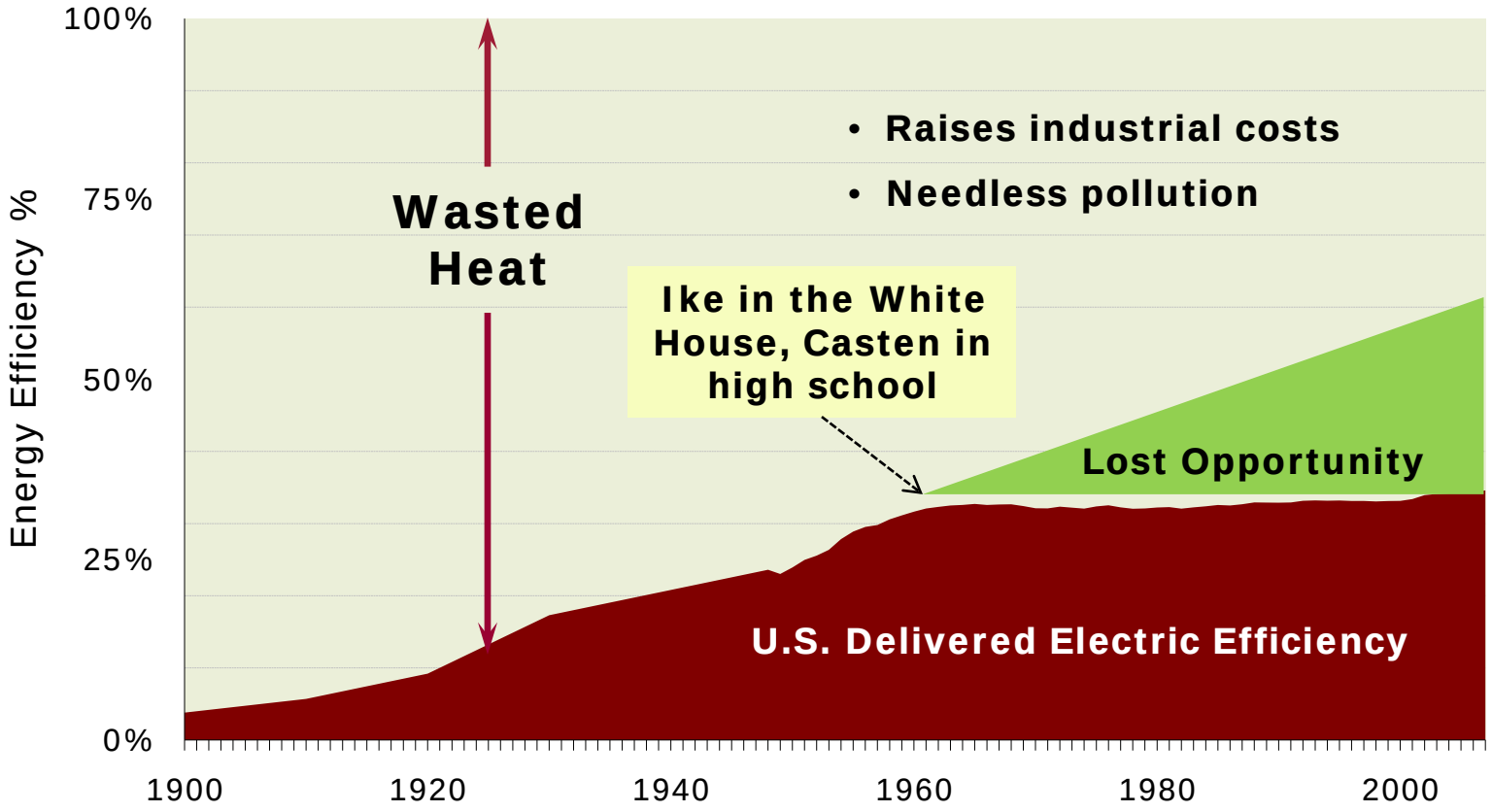
*Chairman*
*Recycled Energy Development, LLC*

# Presentation Summary

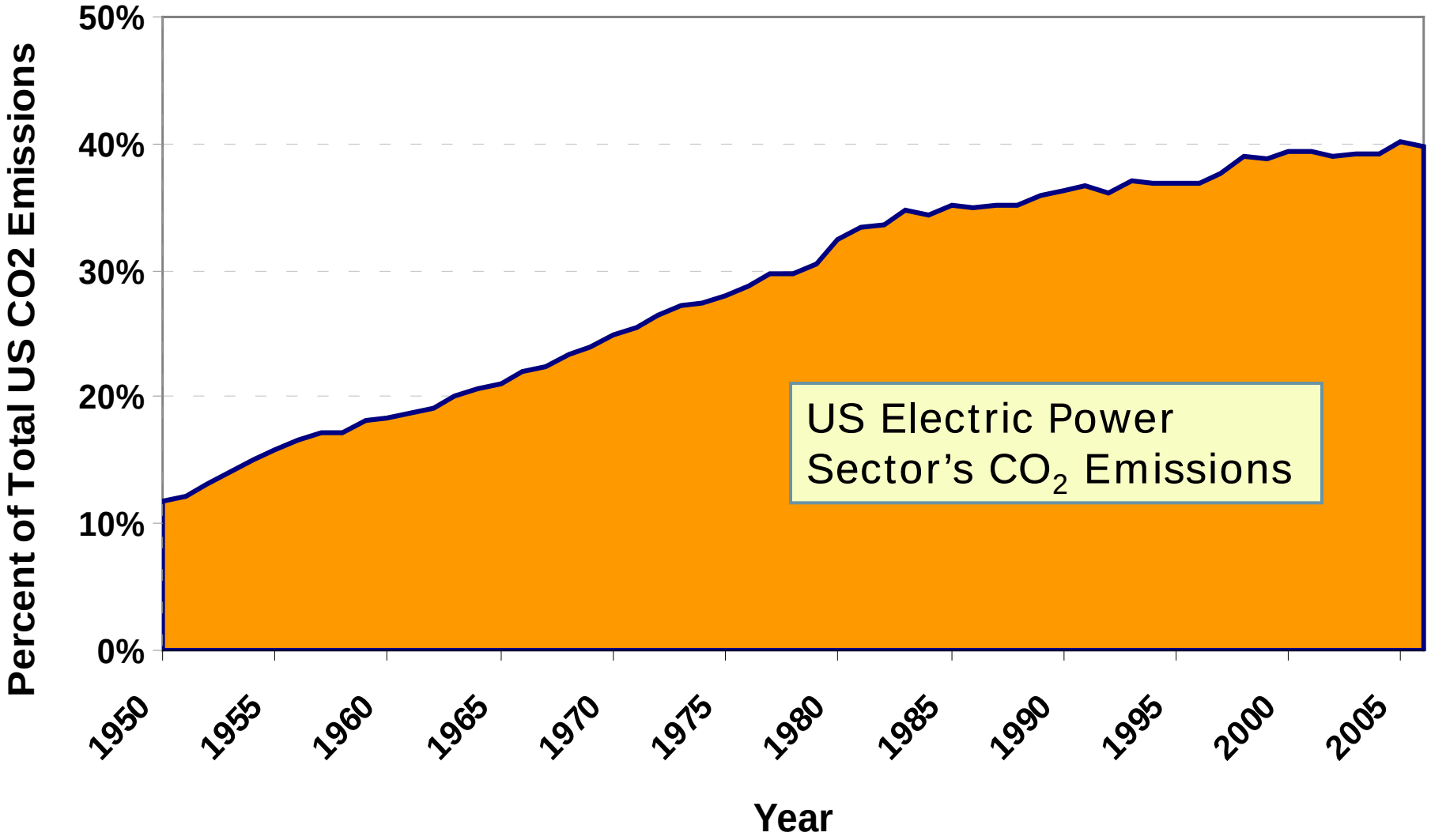
- Stagnate electricity generation is causing many problems including climate change
- Conventional separate heat and power generation is inherently inefficient and mature
- Combining heat and power generation is essential to U.S. economic and environmental future.


Electricity Generation is Key
Conventional Generation
Combined Heat & Power

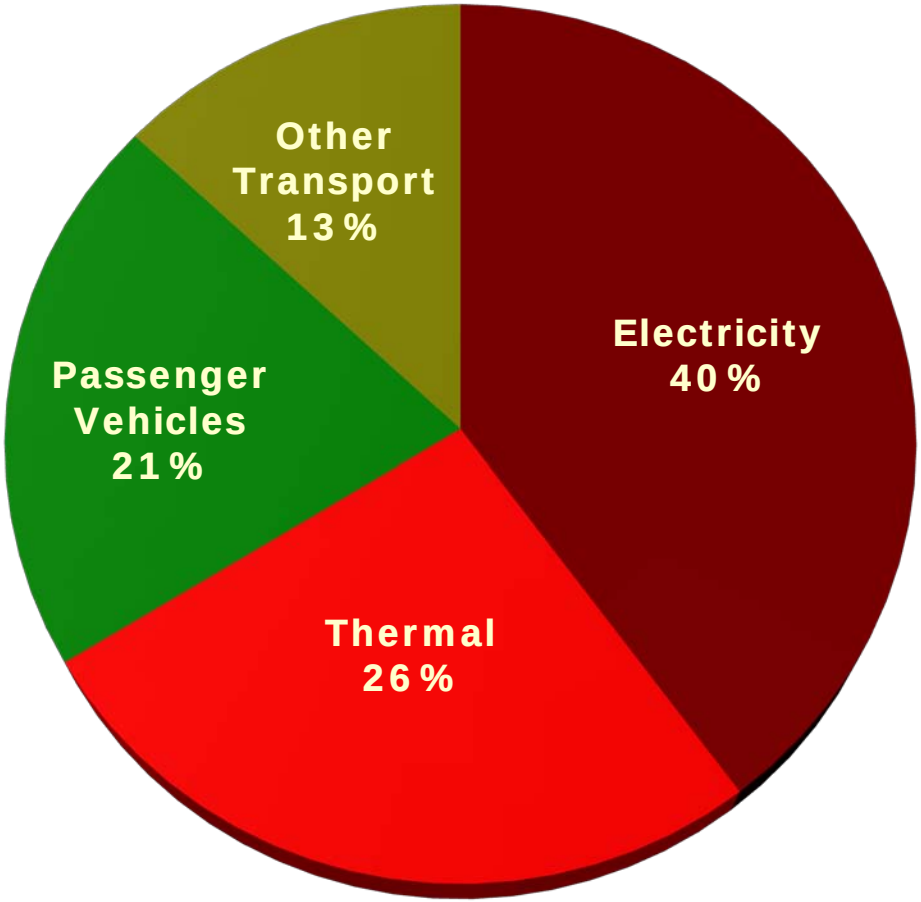
# Electricity generation efficiency is low and stagnant



# Electric Generation is a major source of fossil $CO_2$ emissions in the US

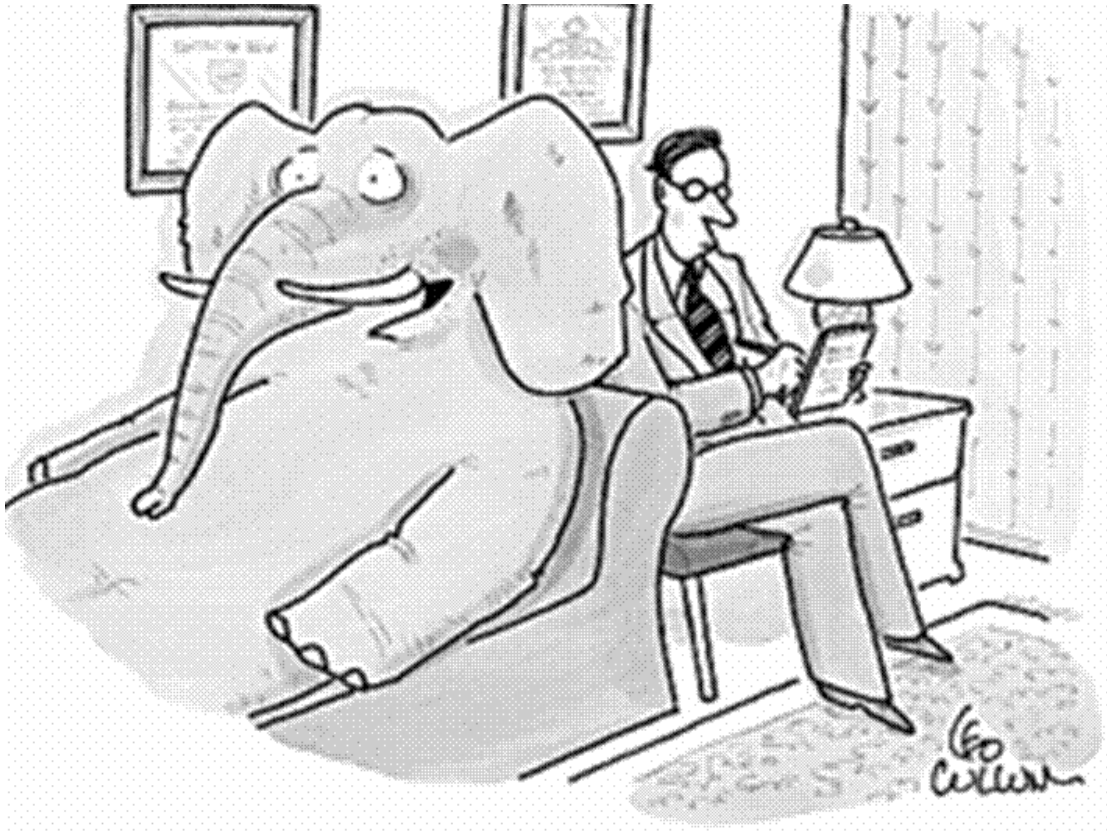


# Emissions of U.S. $CO_2$ from fossil fuels



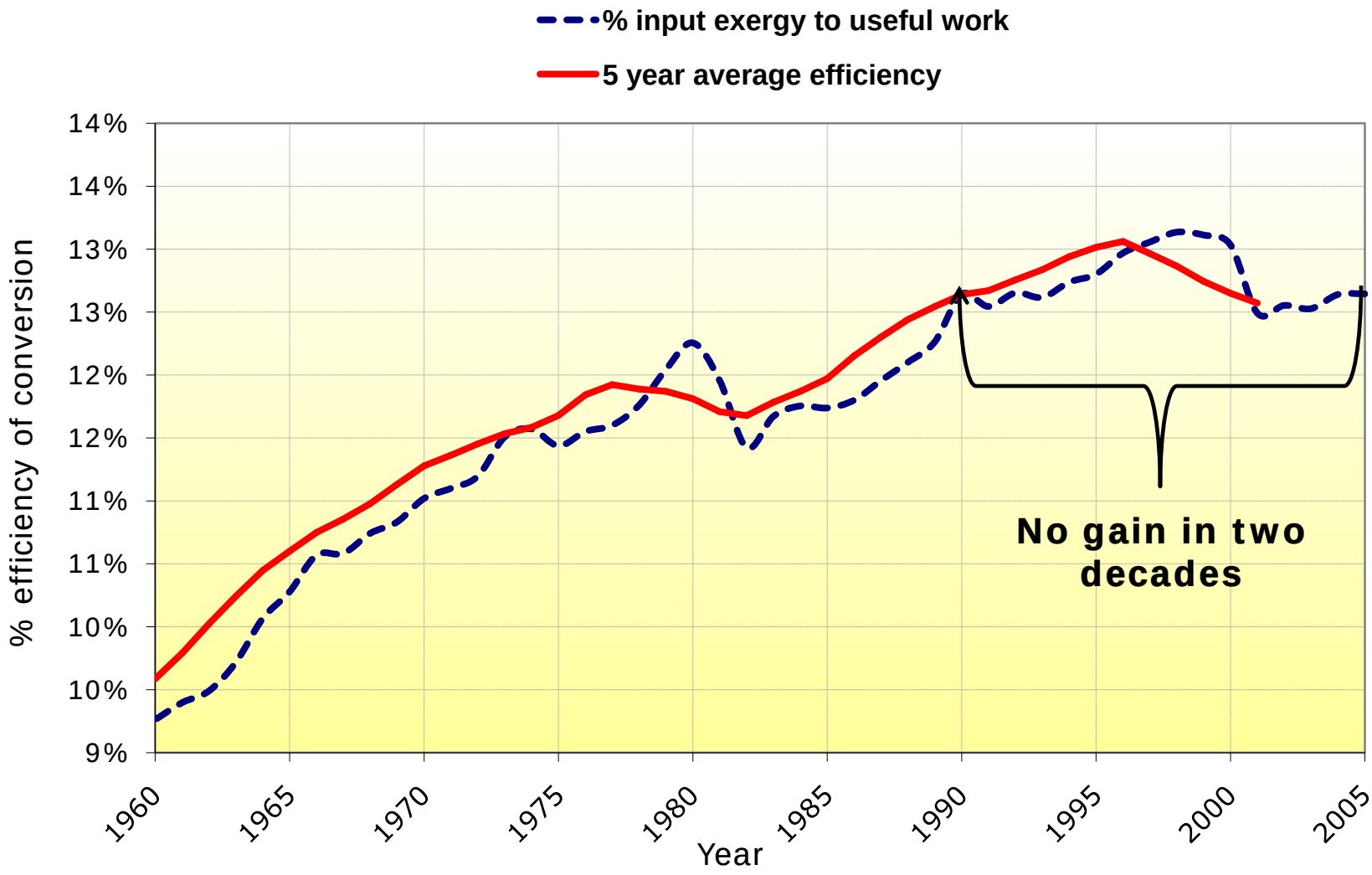

*Source: Historical Data Series: Energy-Related Carbon Dioxide Emissions by Fuel Type, 1949-2006*

# Generation inefficiency is the elephant in the room

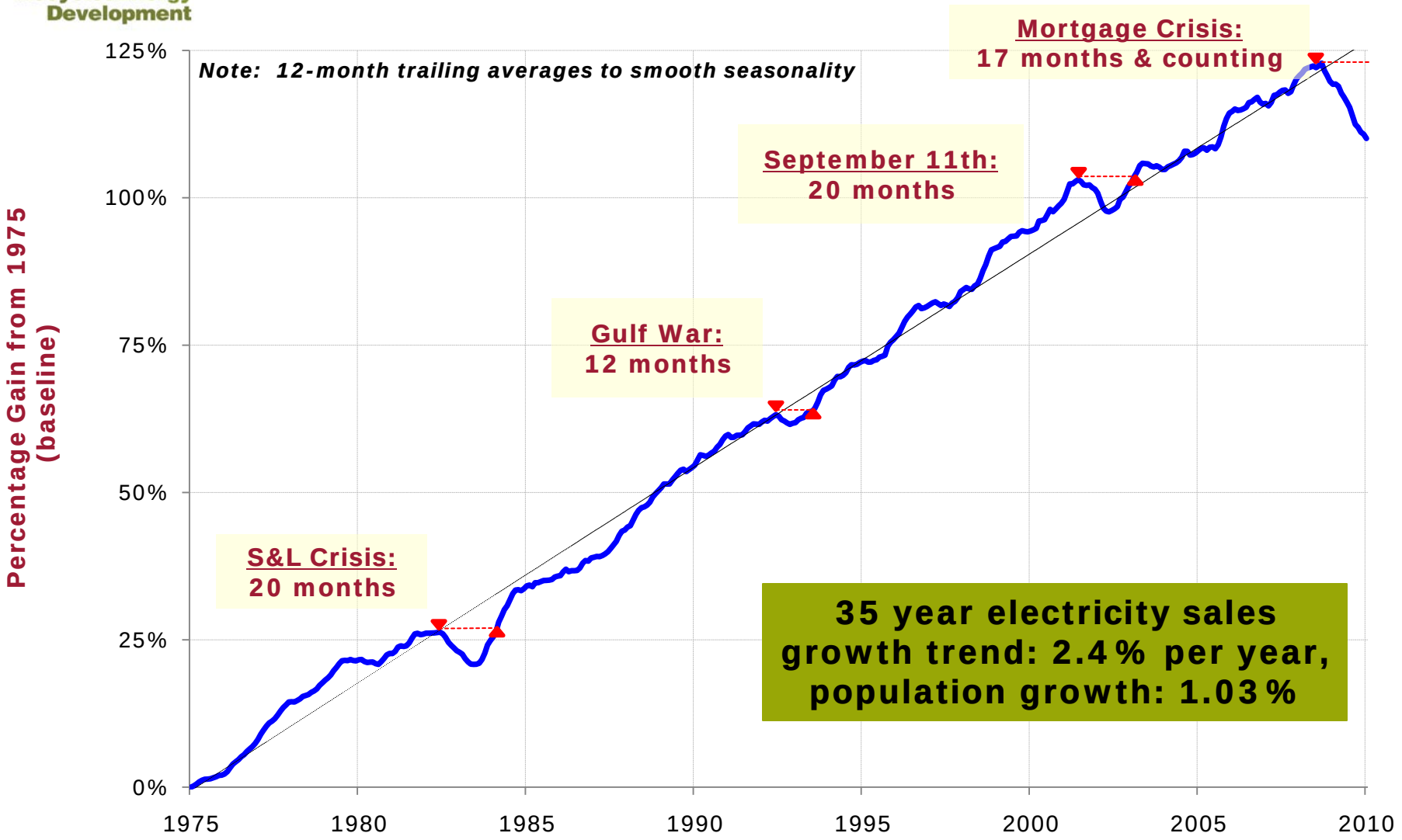


*"I'm right there in the room and no one even acknowledges me"*

# Conversion of exergy to useful work

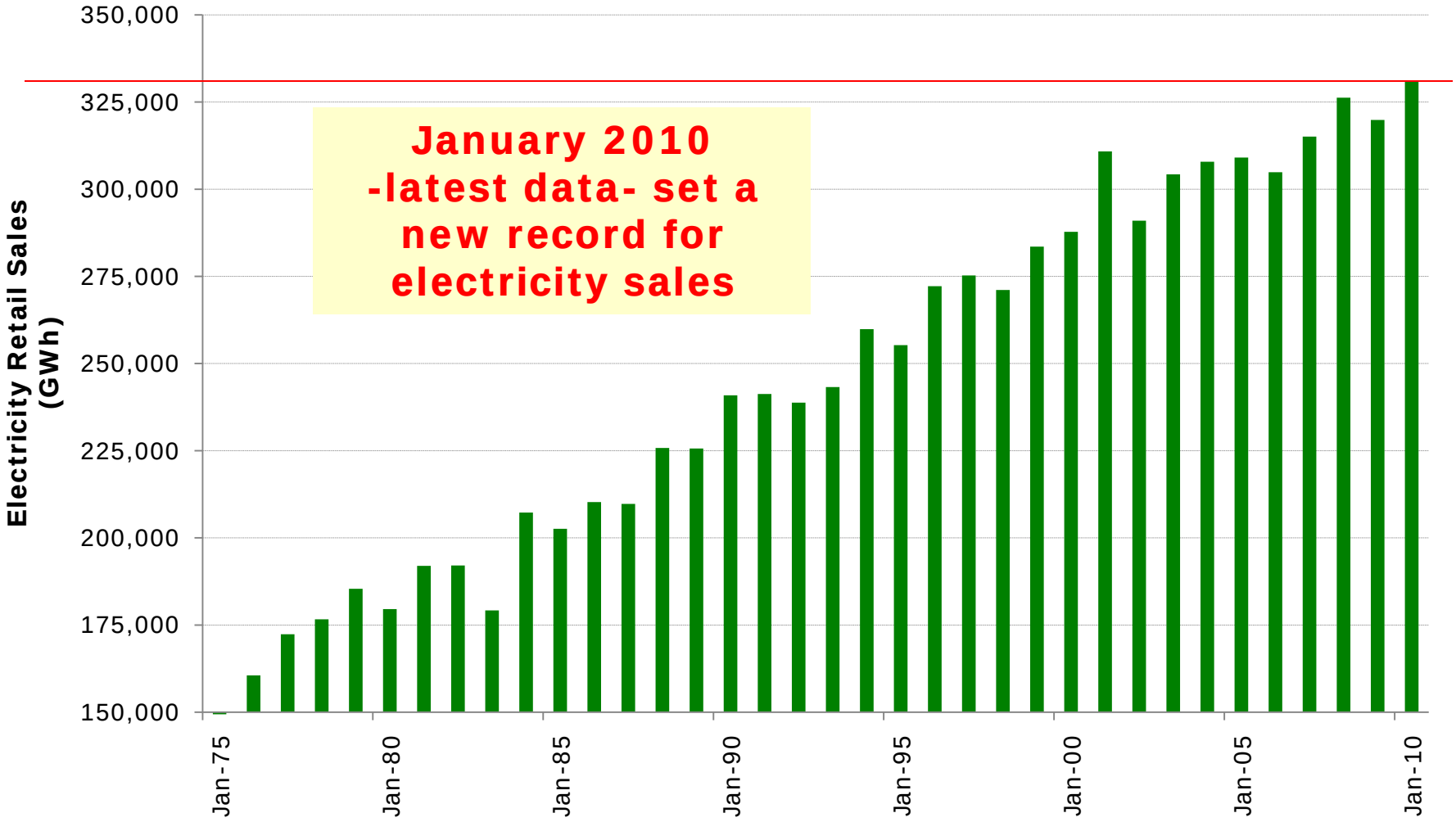


# US electric sales history; rebound?




*Source: EIA's Monthly Energy Review: Table 7.6. Electricity End Use*

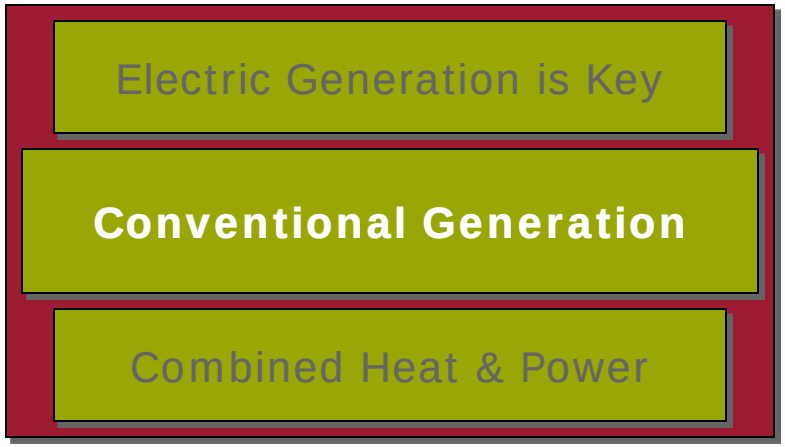
# Current retail electric sales (monthly, actual)




*Source: EIA's Monthly Energy Review: Table 7.6. Electricity End Use*

# Physics sets limits to fuel conversion efficiency

- Burning fuel releases exergy – ability to do work
  - Some exergy can be converted to work, always losses
  - All else becomes heat without producing any useful work
- Burning fuel just to make electricity wastes exergy:
  - ***Limits energy services per unit of input energy***
- Burning fuel to make low temperature thermal energy creates little work, wastes exergy :
  - ***Limits energy services per unit of input energy***
- Burning fuel to make heat and power extracts maximum work from exergy in input energy
  - ***Maximizes energy services per unit of input energy***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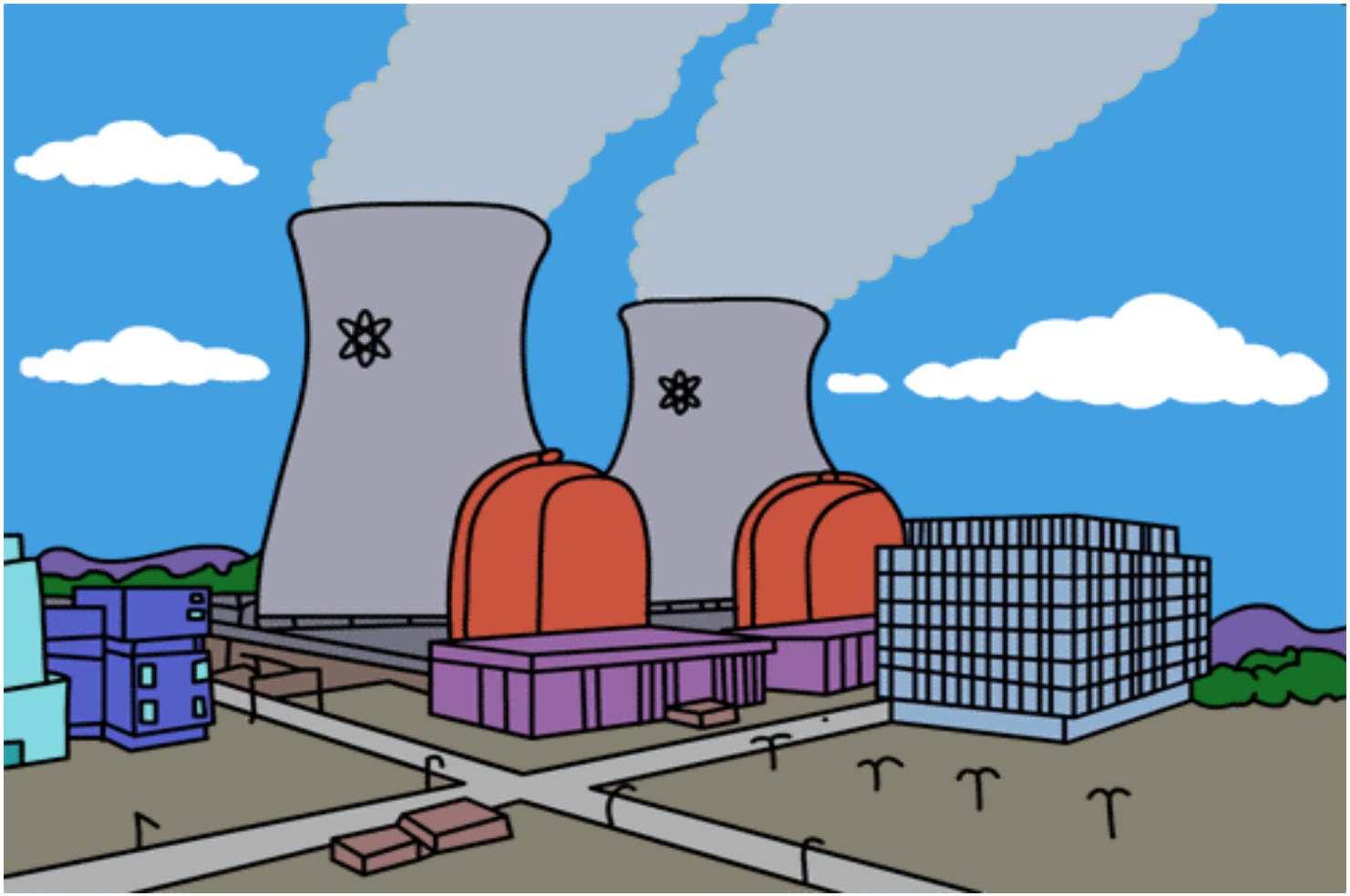
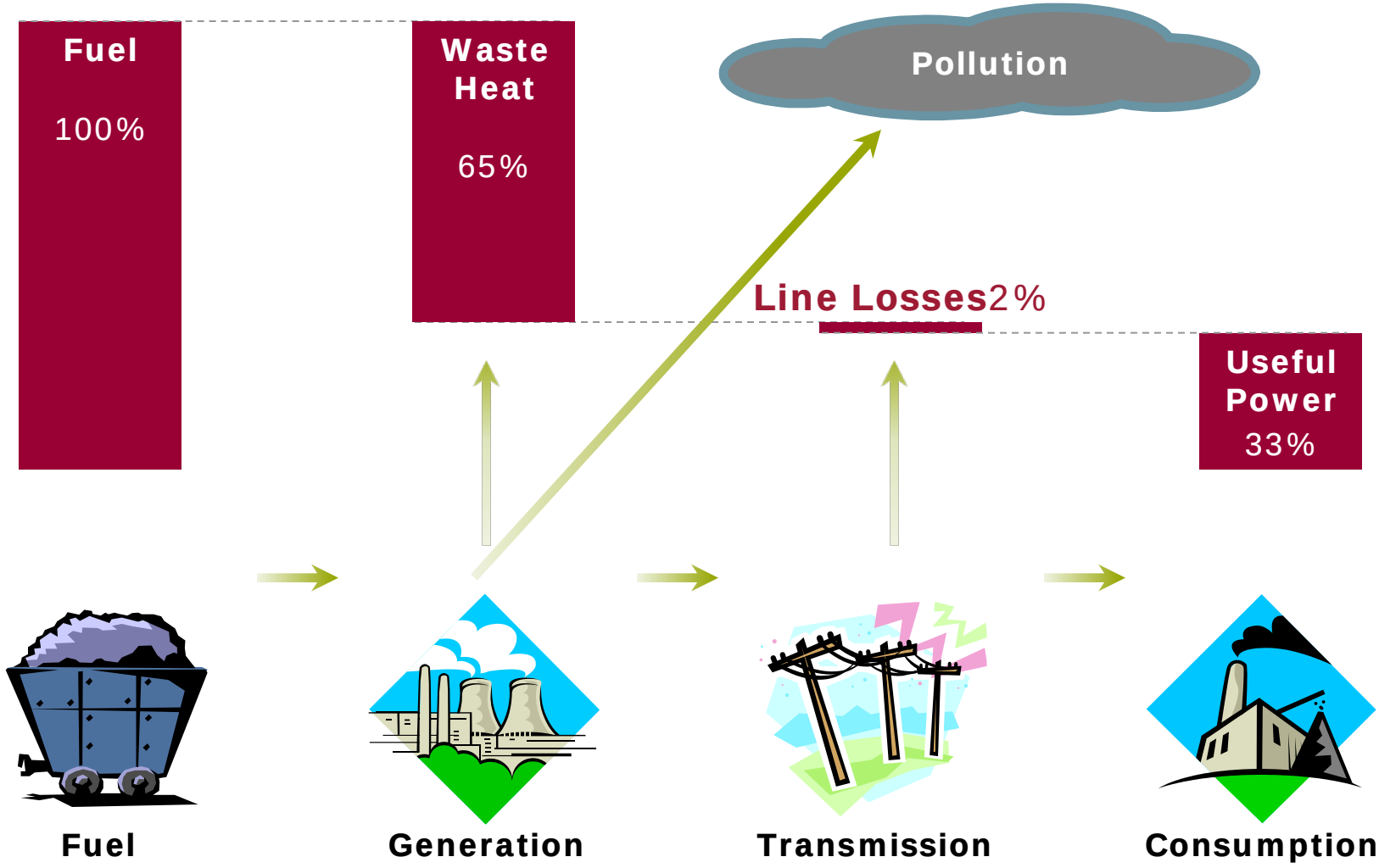
# Homer Simpson's power plant exhausts 2/3rds of the input energy



# Most electric-only generation plants vent 2/3rds of input energy

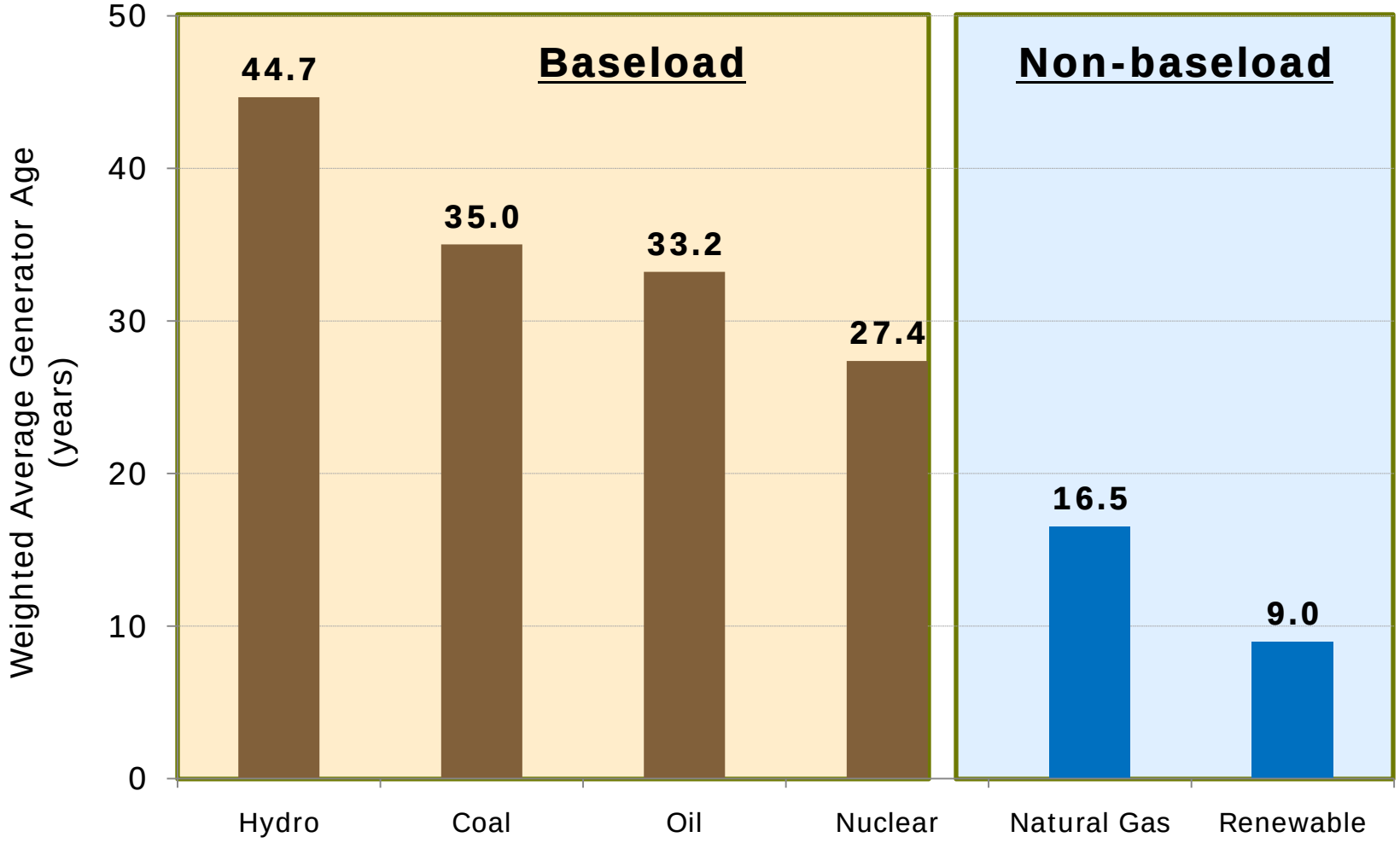
***600 MW plant,*** *Craig, CO*

# Conventional electricity generation
## 1960 (& 2010)

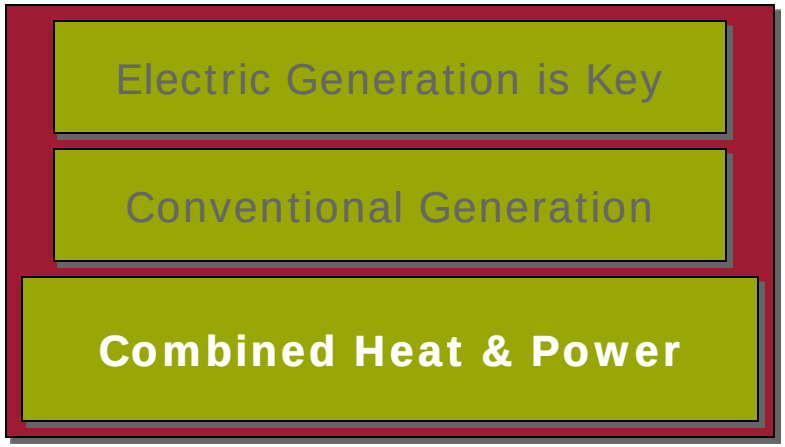


# US generating assets rely on aging technology

**2008 US generation weighed average: 29.3 years old**




*Source: EIA's Electricity Generating Capacity file, 2008 capacity additions*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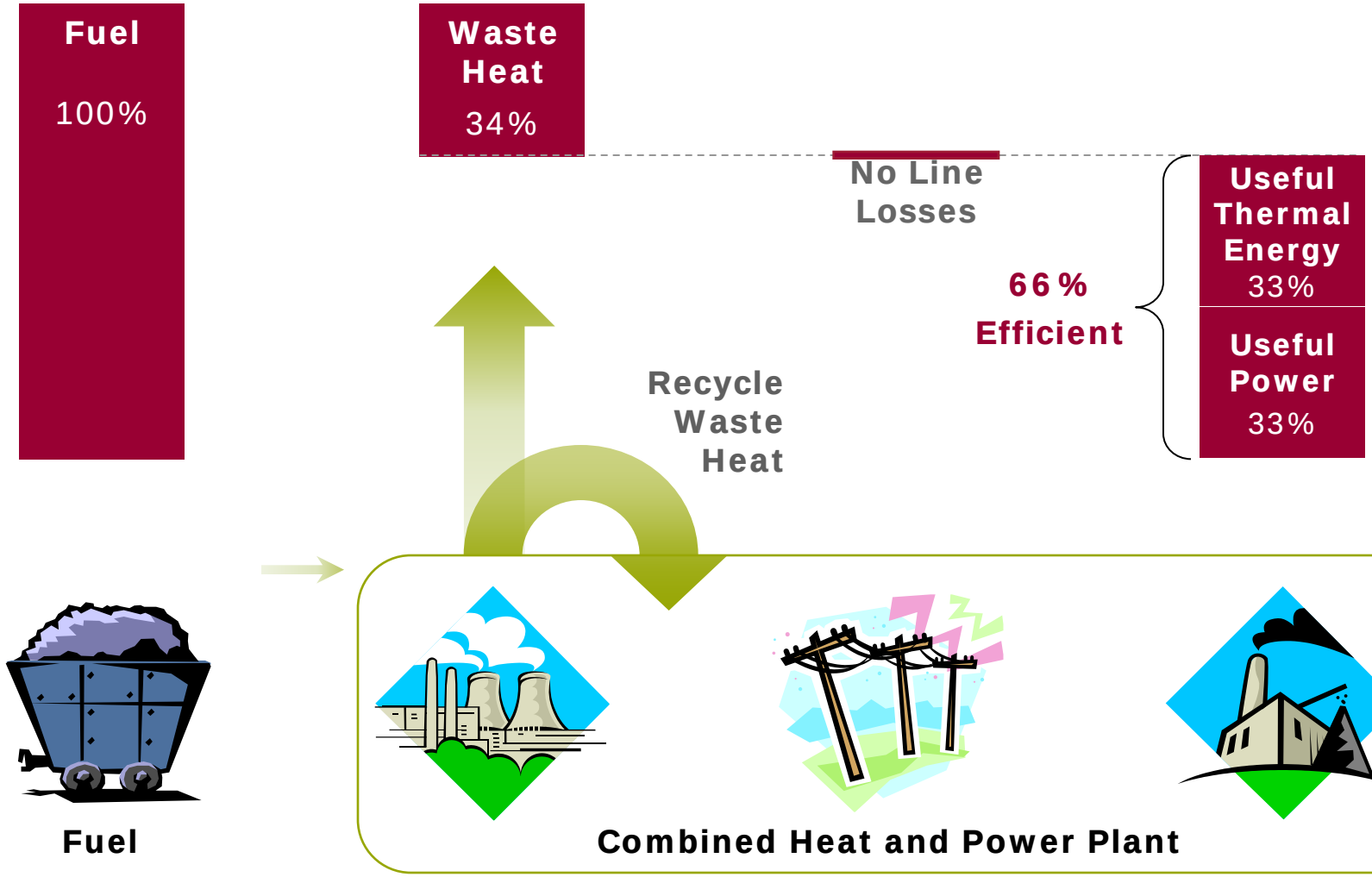
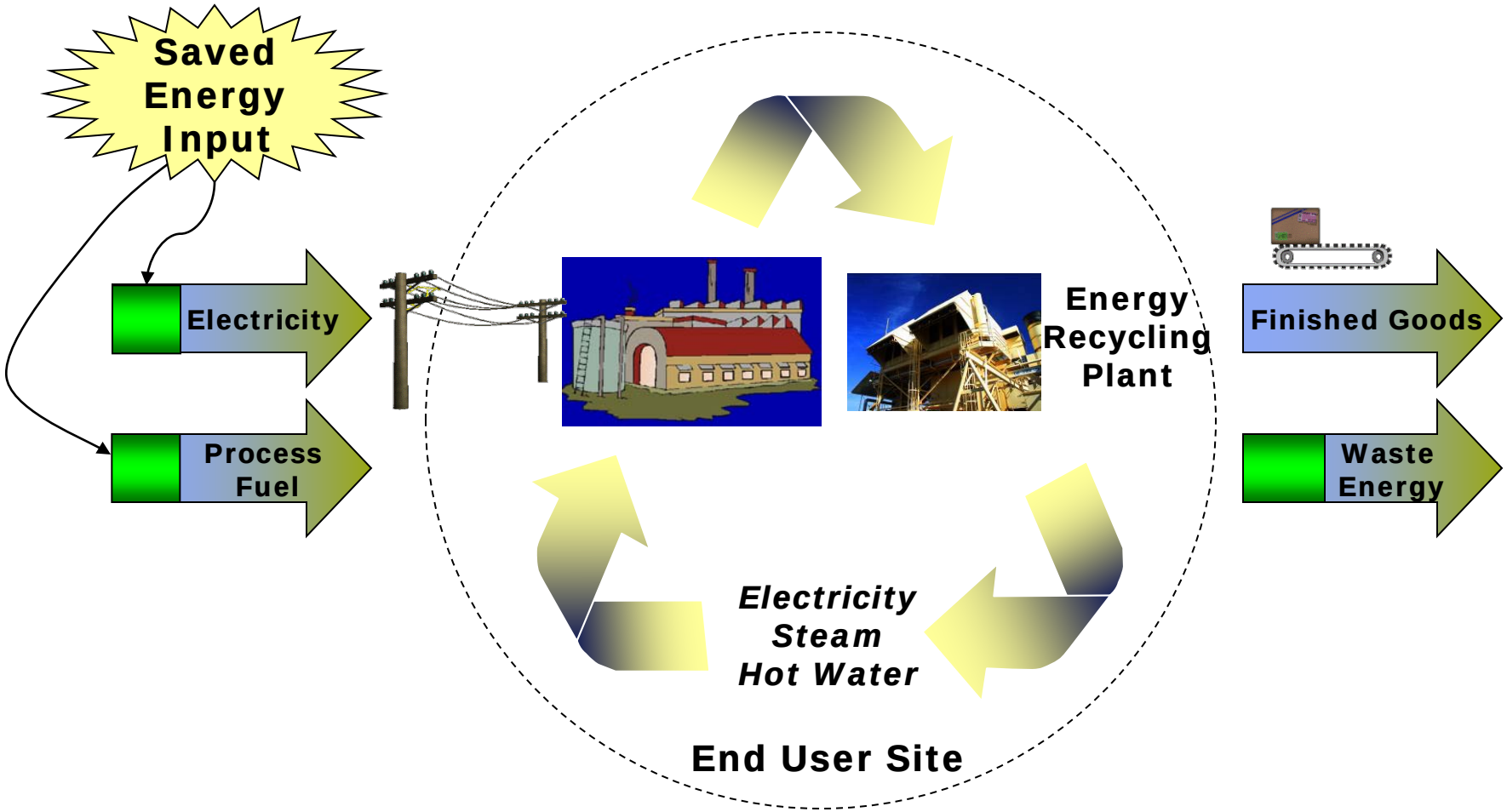
# Topping cycle cogeneration

## Local generation producing heat and power



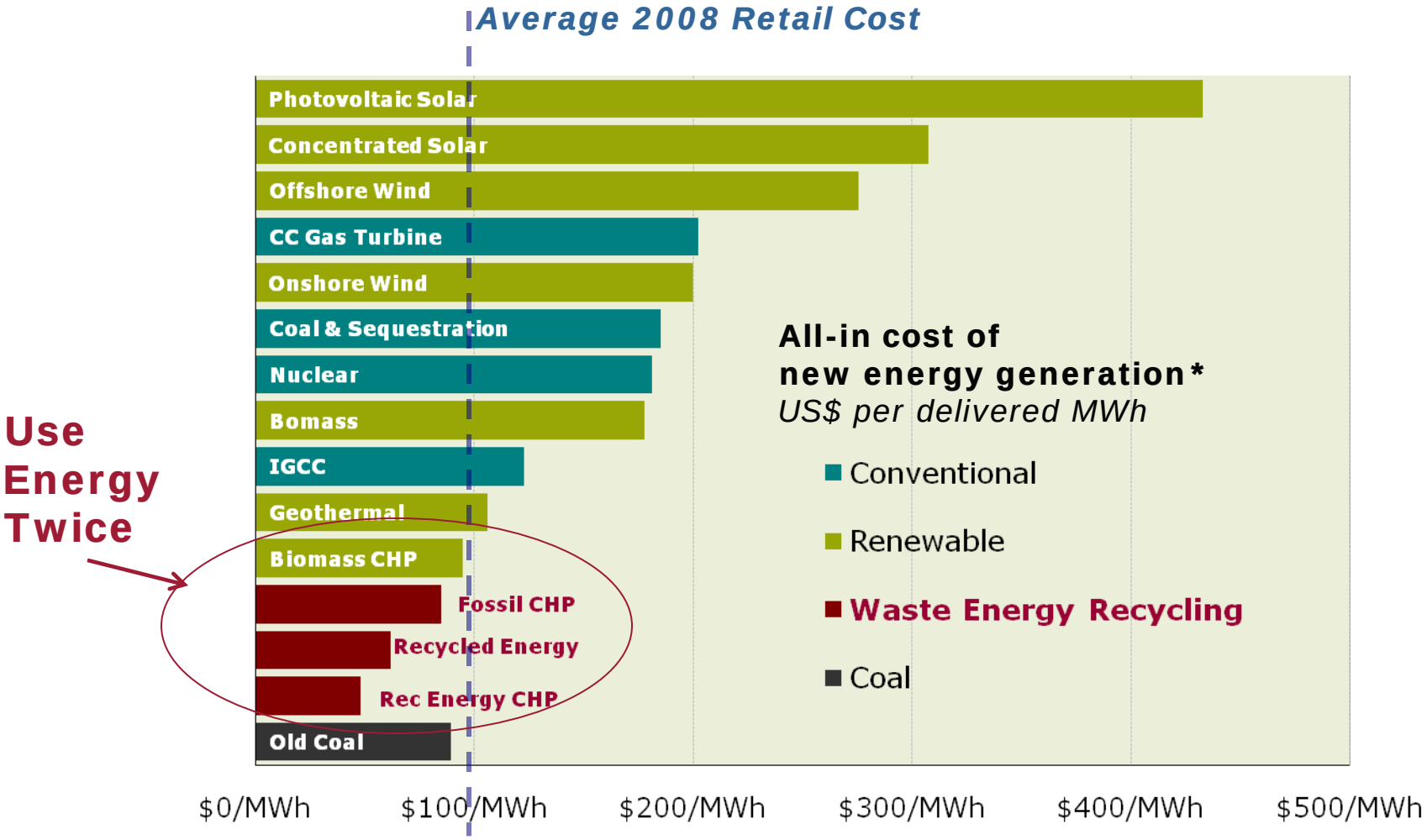
# Bottoming cycle cogeneration
# Recycling industrial waste energy



# U.S. potential to recycle waste energy

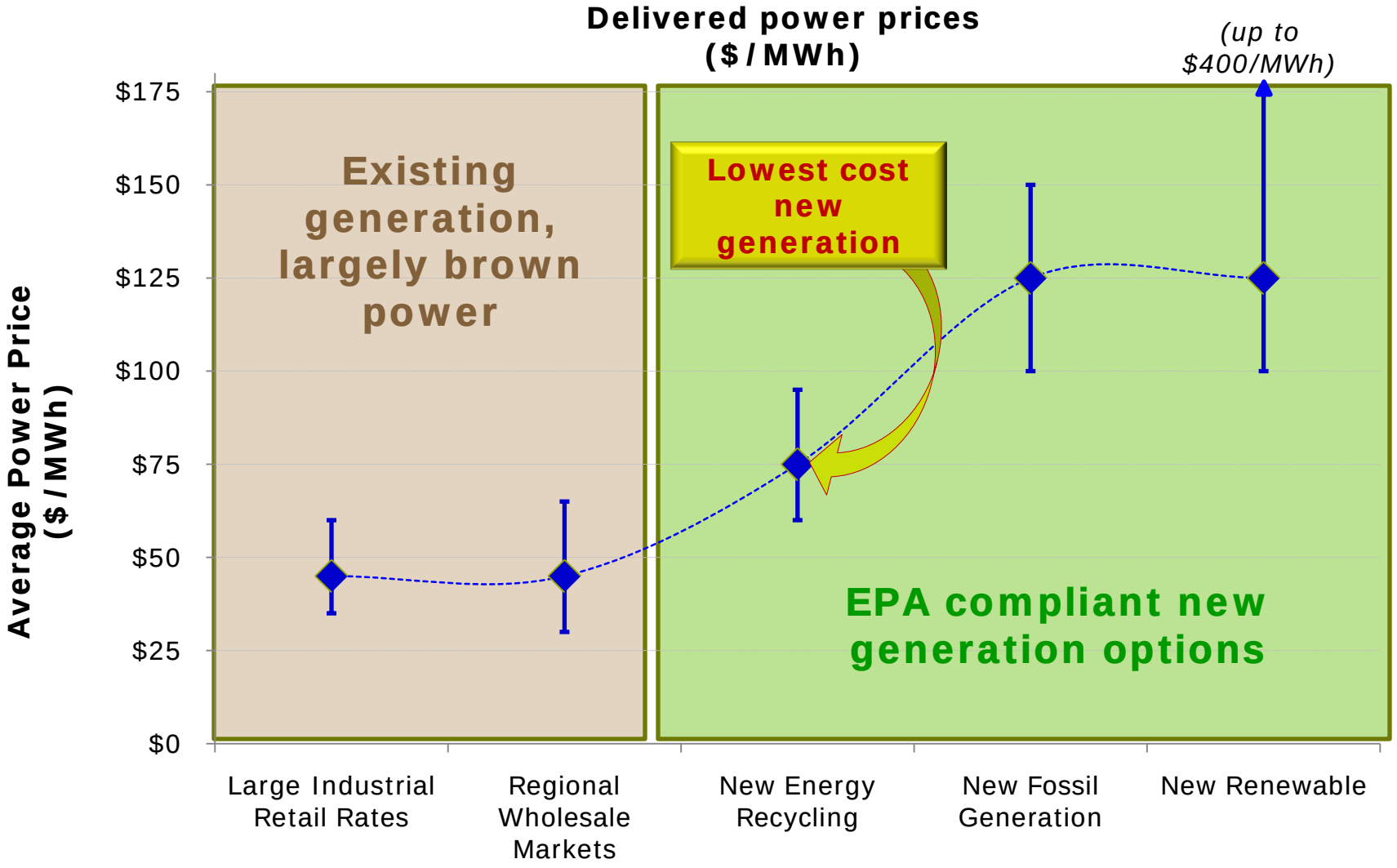
- New CHP could replace 50% of US fossil generation, per EPA and DOE studies
- This new CHP would reduce U.S. $CO_2$ by 20% and save $80 to $100 billion per year**,** *World Alliance for Decentralized Energy (WADE) study*
- **Good CHP, by recycling exergy, saves $20 to $90 per ton of avoided carbon**

# Waste energy recycling is the lowest cost EPA compliant new generation




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

# U.S. electricity markets are economically inverted



# Industrial Waste Energy Recycling Examples

# Recycling industrial waste energy

## Cokenergy, Mittal Steel, Northern Indiana

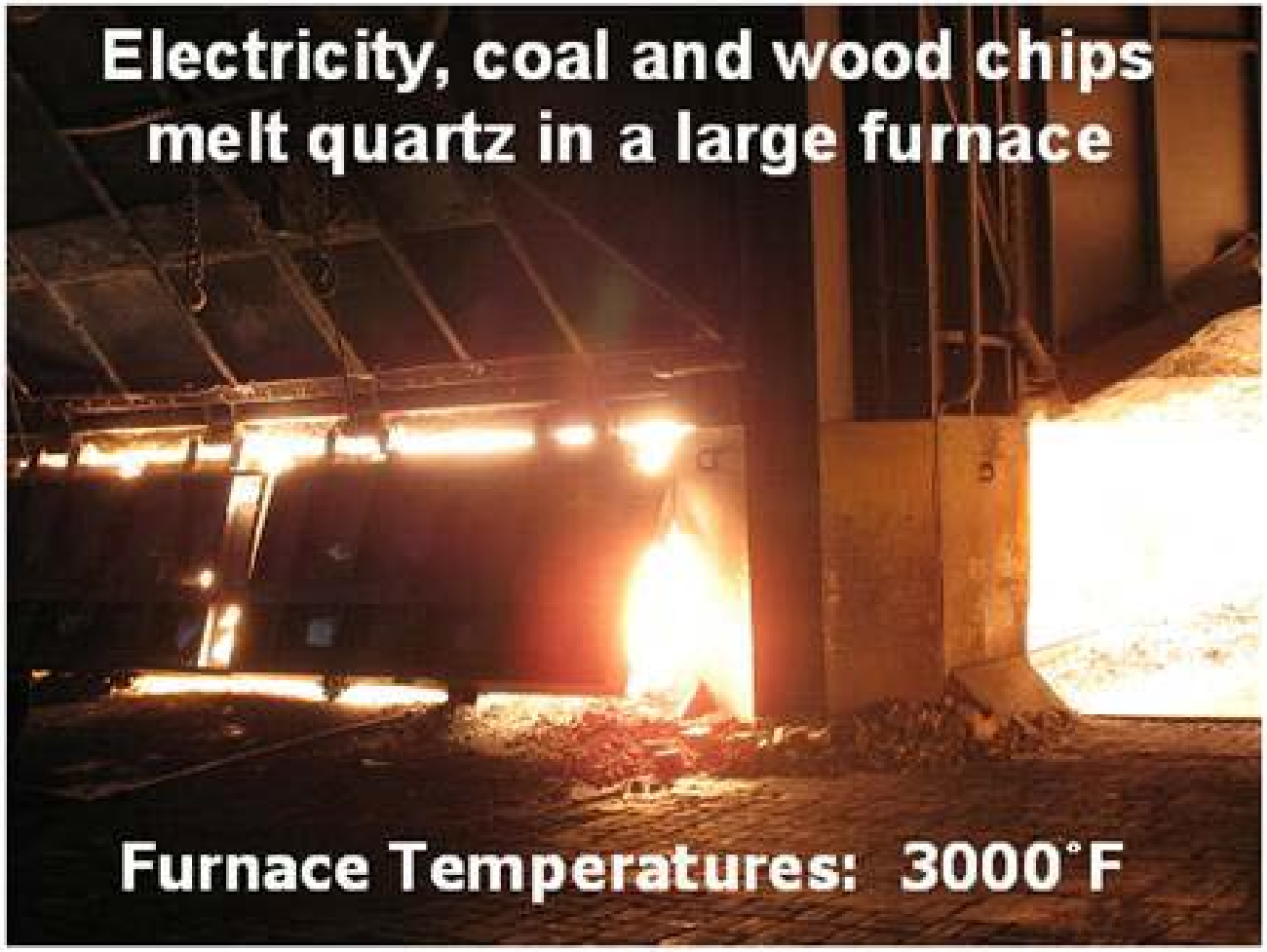
***Produces as much clean energy each year as world's grid-connected photo-voltaic solar generation in 2004***

# Glass plant waste energy

# Using energy twice
# Recycled CHP

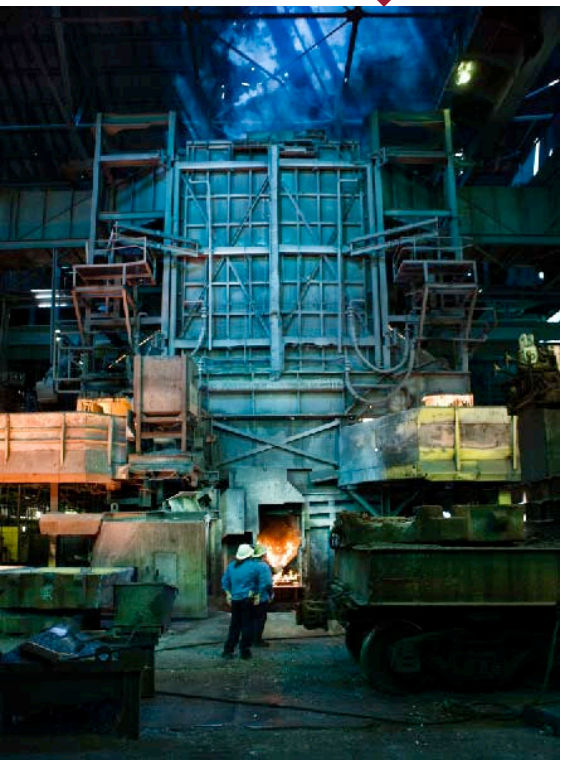
# WVA Manufacturing (Alloy, WV)

**This $170 million project will recover 65 MW, equivalent to 325 MW solar that would cost $1.6 billion**



# WVA: Existing Process

Silicon tap

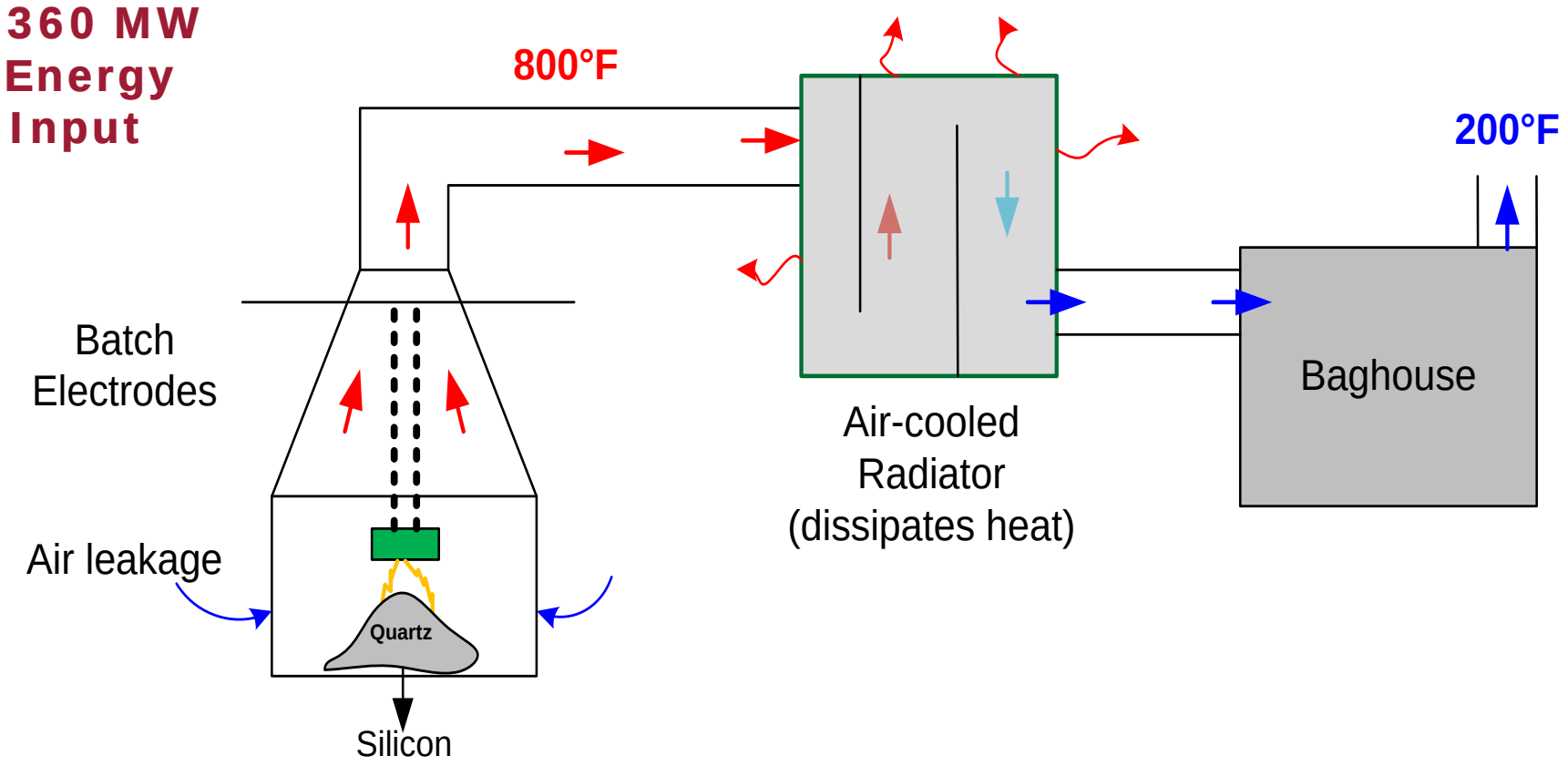


Coal-fired generation

Furnace top

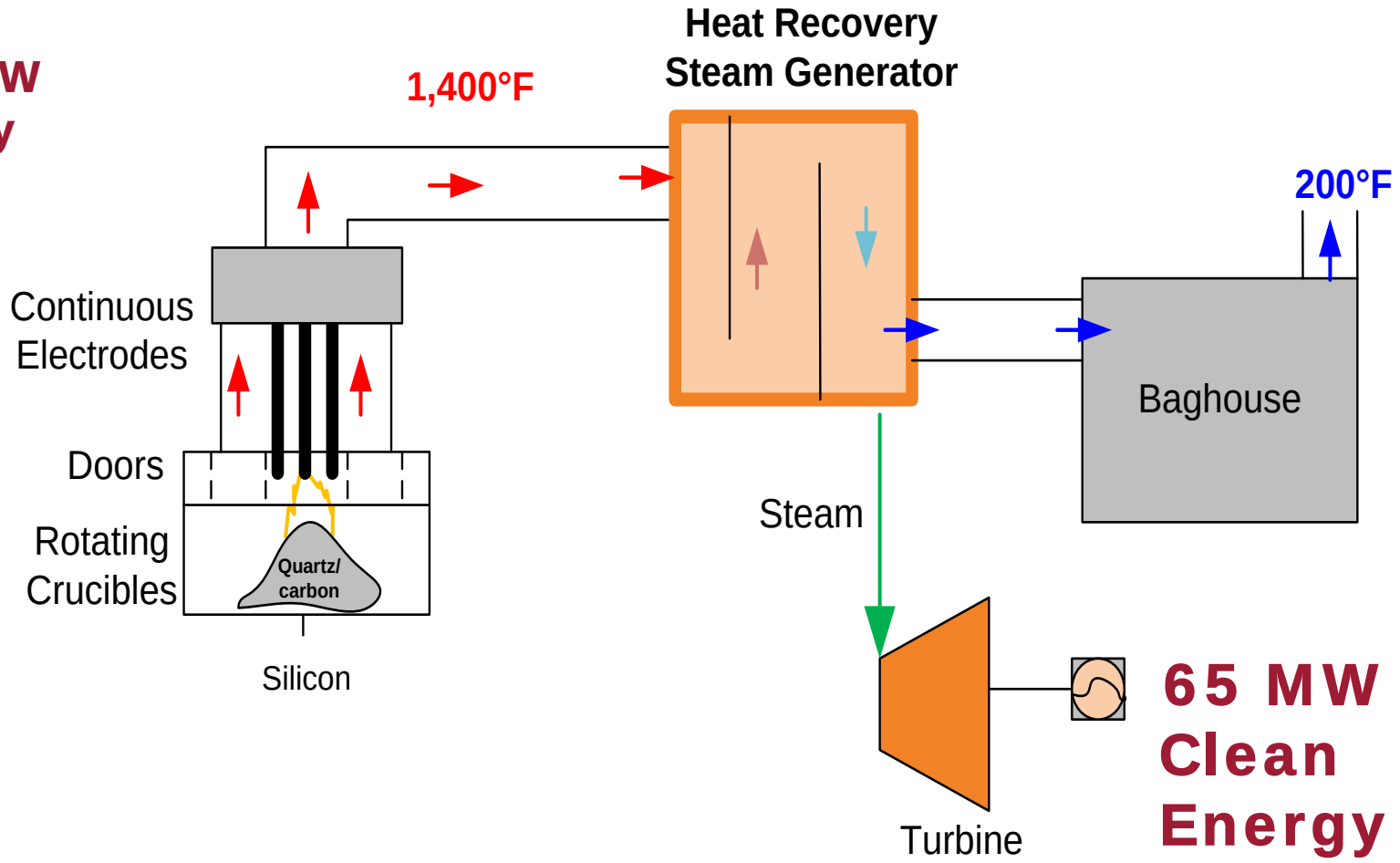
Hairpin Coolers

# Current silicon metal production



# Silicon metal with energy recycling

**360 MW Energy Input**




**65 MW Clean Energy**

# WVA heat recovery and power generation plant arrangement

# Bottoming cycle opportunities

## With proven recovery technologies:

- Metals
- Lime & cement
- Glass (plate, bottles, fiberglass)
- Blast furnace coke
- Carbon black
- Gas compressor stations
- Brick making
- Chemicals
- Refineries
- Large pressure reducing valves

## With advanced recovery technologies:

- Aluminum
- Transportation (train and truck engines)
- Smaller pressure reducing valves
- Power boiler exhausts (biomass)
- Foundries

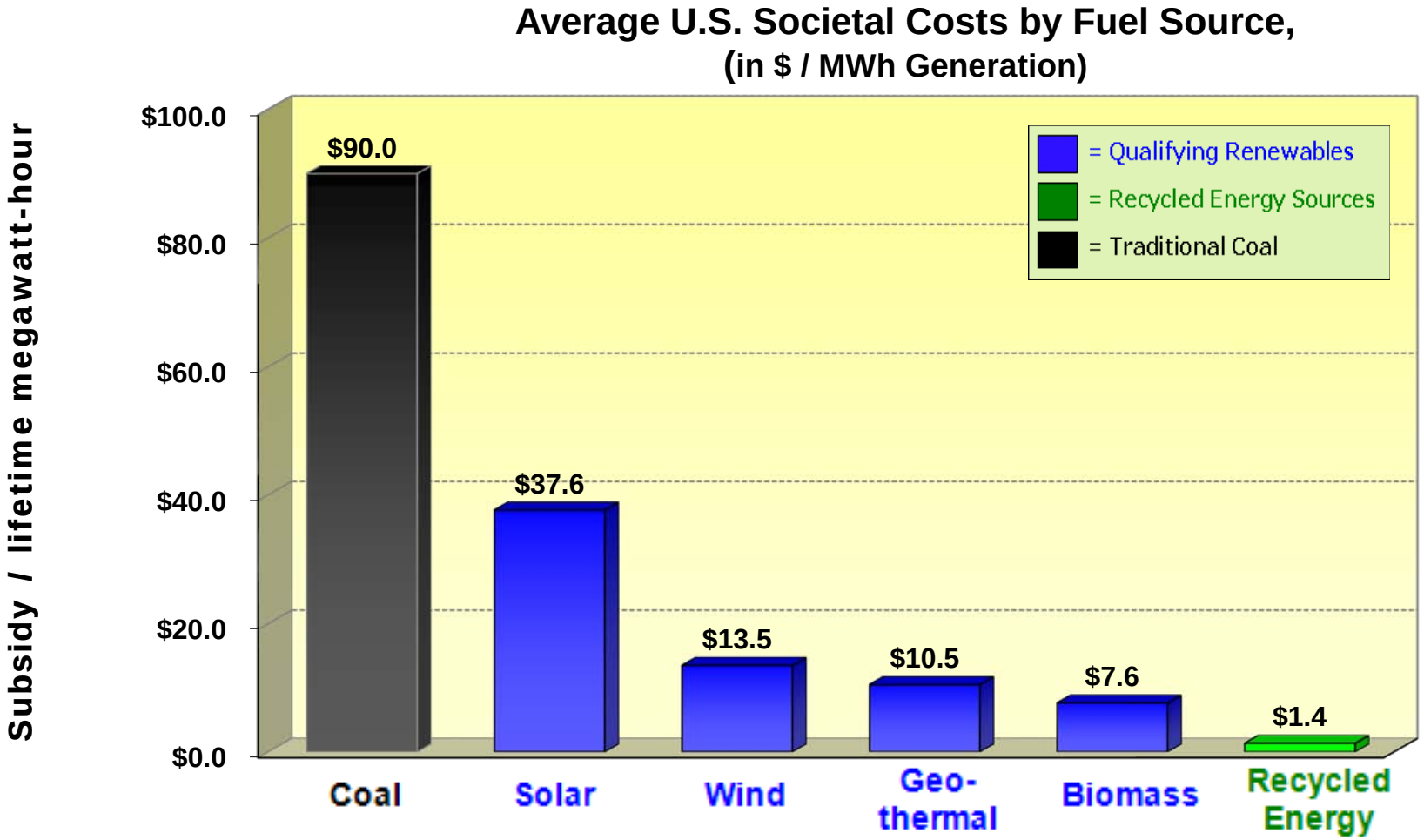
# Topping cycle opportunities

| With proven recovery technologies: | With advanced recovery technologies: |
| --- | --- |
| • food processing<br>• breweries<br>• all industrial process heating, commercial heating and cooling<br>• hospitals, universities, large shopping centers<br>• high rise housing/planned communities<br>• chemicals<br>• refineries<br>• Paper products<br>• wallboard<br>• ceramics, bricks, etc | • Single family homes<br>• strip malls<br>• big box retailers<br>• schools |

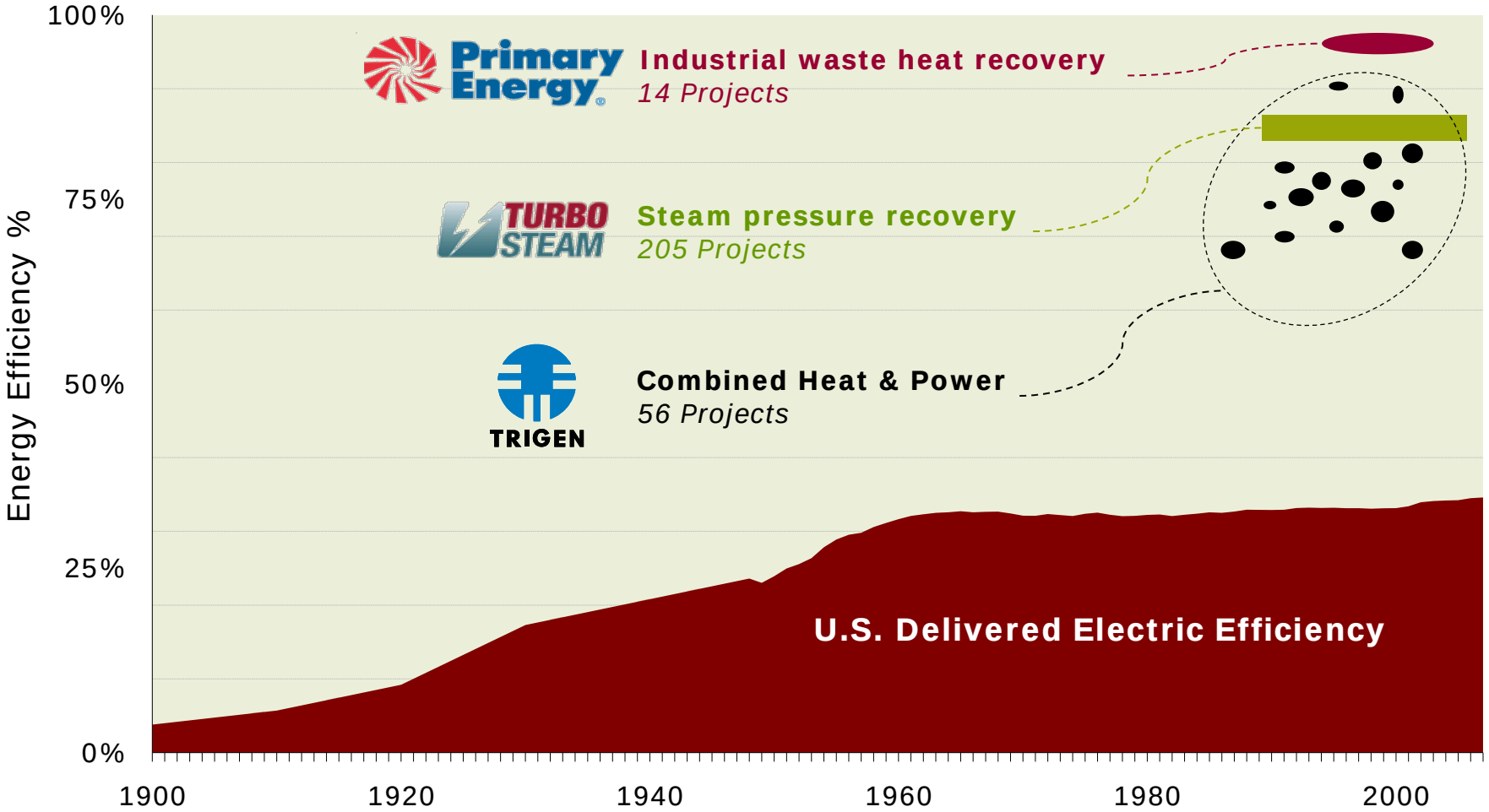
# Why do $100 bills litter the ground?
## *Policies block efficiency*

- Utilities not rewarded for efficiency
- Monopoly rules shelter utilities from competition
- Old plants allowed 50 to 99 times the emissions of new plants, **which gives old plants immortality**
- Efficiency investments to existing thermal or electricity plants void the operating permit
- Environmental rules are pass/fail, with no value for reducing pollution below permitted level
- CHP plants capture only part of value they create

# Subsidies & uncosted externalities distort investment decisions

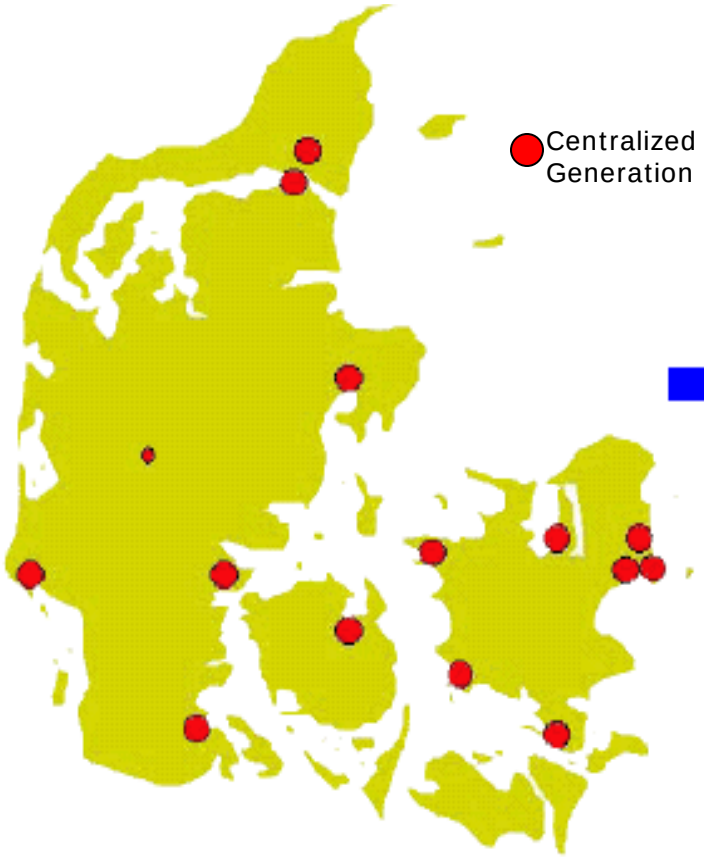


# 275 projects avoid 5 million tons $CO_2$ and capture <1% of opportunity

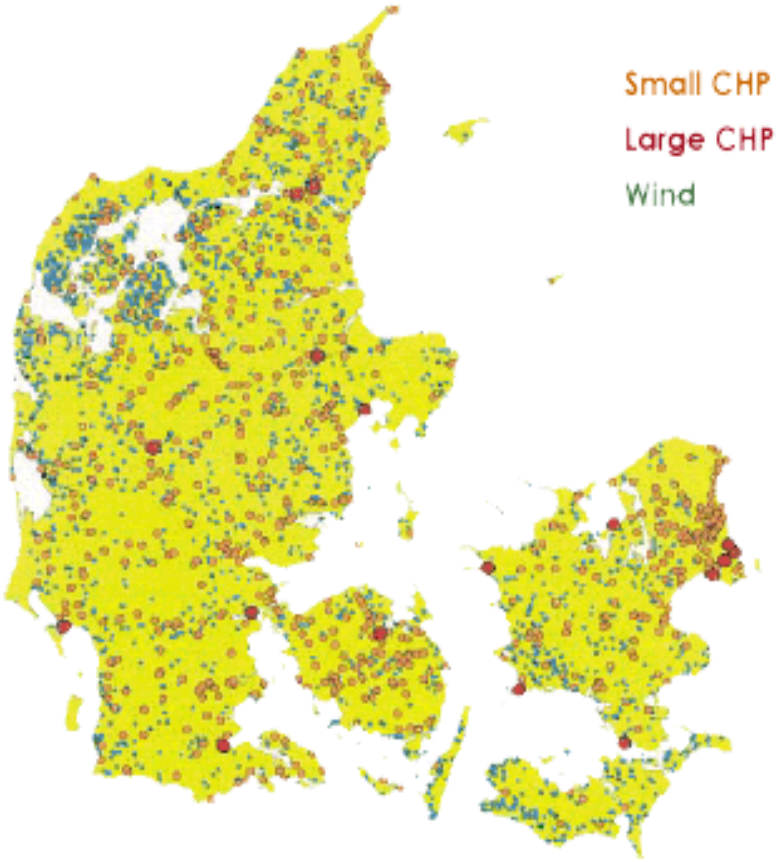


# Rapid move to CHP is possible:
## Denmark decentralized generation in 2 decades

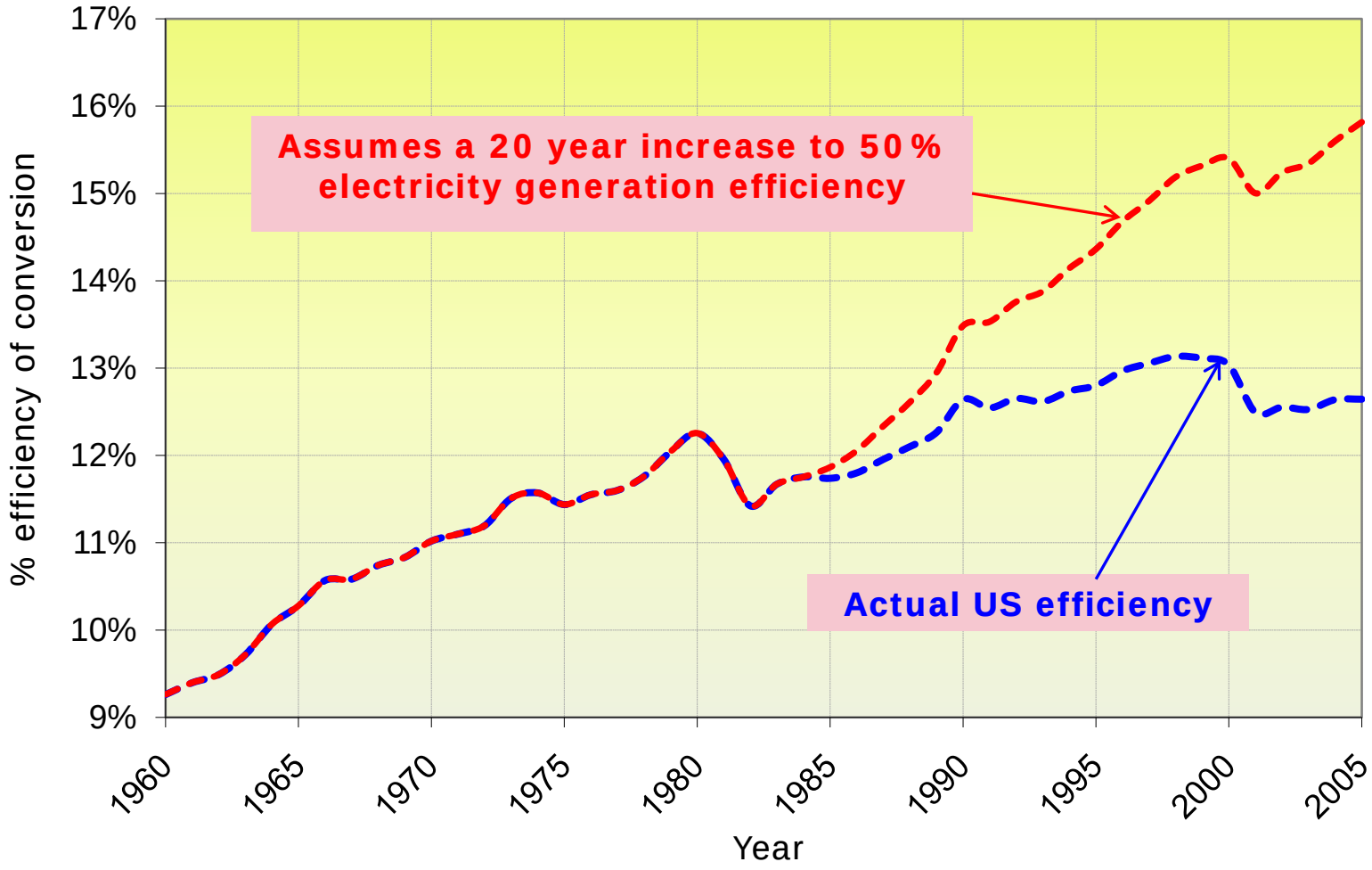
**Centralized System: 1980's**




**Decentralized System: 2010**



# What if US had mimicked Denmark?



# Conclusion: Using energy twice addresses many key problems

- Using energy twice could cut U.S $CO_2$ by 20% while reducing the cost of useful energy services, thus promoting economic growth
- U.S. would use energy twice, but for regulations that ignore efficiency, distort prices and block competition
- Unintended consequence of overall energy and environmental regulations: We force citizens to pay to heat the planet
- To prosper & survive, the world must fix heat and power generation efficiency

# Thank you