

# Energy and Climate Policy for the Next Administration

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# Two main goals for energy & climate policy

1. Reduce emissions of greenhouse gases
  - Especially carbon dioxide from fossil fuel combustion
2. Reduce consumption of oil
  - Especially imported oil

# Overview of the US energy sector

- National energy use is measured in “quads”
  - 1 quad = 1 quadrillion BTUs (British Thermal Units)
  - quadrillion =  $10^{15}$

# Putting a quad in perspective ...

- Coal delivered by “unit trains”
  - 100 cars, about 1 mile long
- 1 train = 10,000 tons of coal
  - Fuels a 300 MW power plant for about 3 days
- 1 quad = 4,500 unit trains



# How many supertankers?

- 1 tanker = 1 million barrels of oil



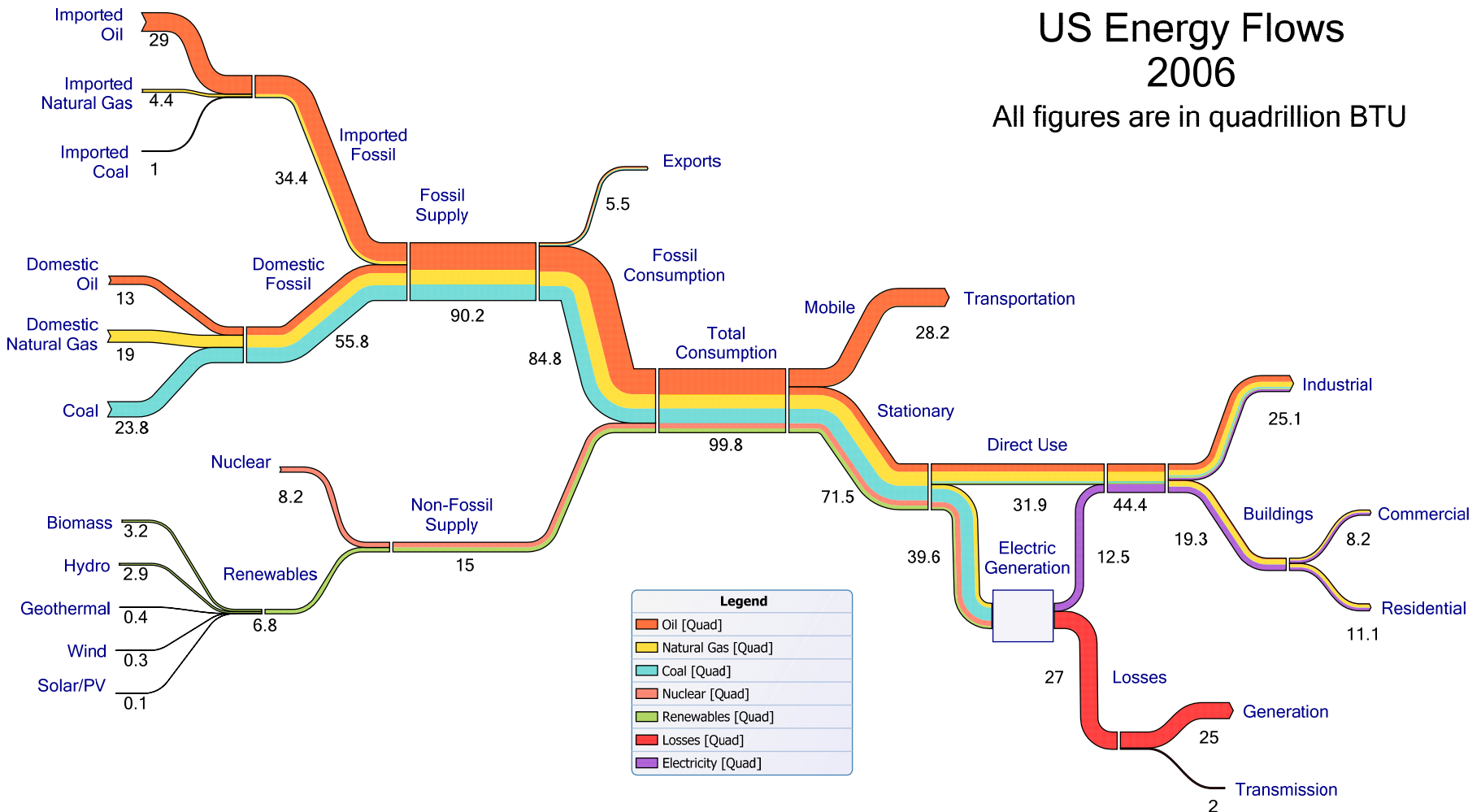
- 1 quad = 170 tankers

# How much energy is used?

- World energy consumption
  - 400 quads per year
  - 1 quad every 22 hours
- US consumption
  - 100 quads
  - 25% of world total

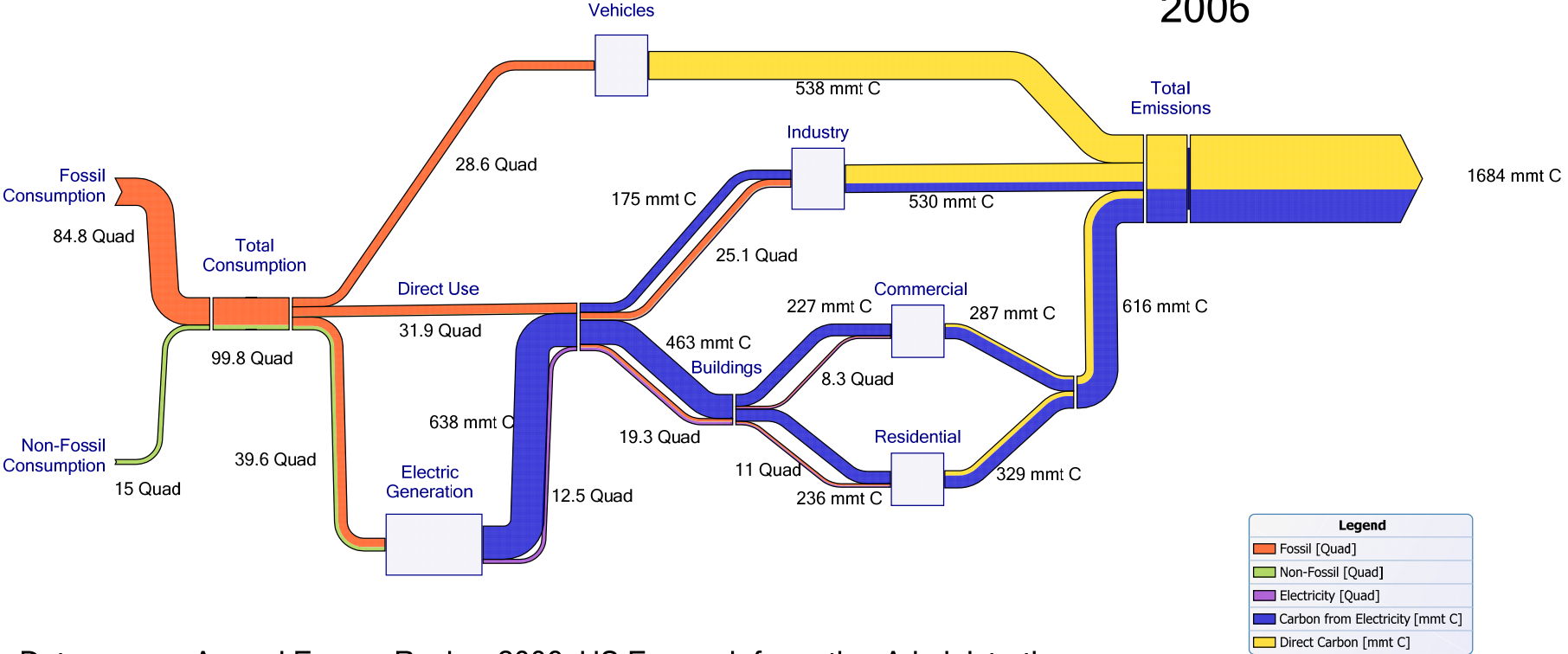
# US Energy Flows 2006

All figures are in quadrillion BTU



Data source: Annual Energy Review 2006, US Energy Information Administration

# US Energy and Carbon Flows 2006



Data source: Annual Energy Review 2006, US Energy Information Administration



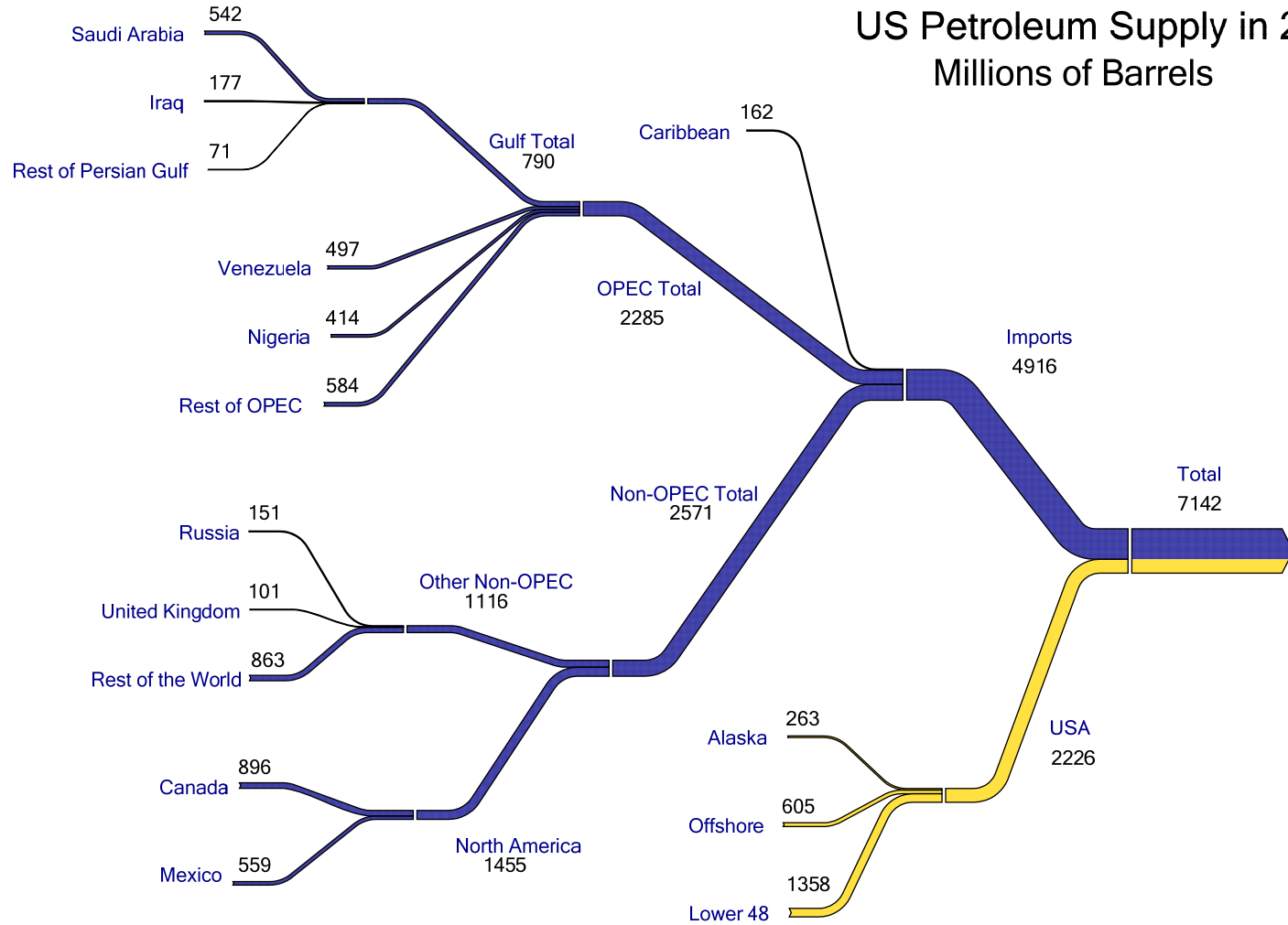
# A very large problem ...

- US fossil energy
  - 86 quads
- US emissions
  - 6 billion tons of CO<sub>2</sub> or 1.7 billion tons of C
- In the long term, bring both down to nearly 0

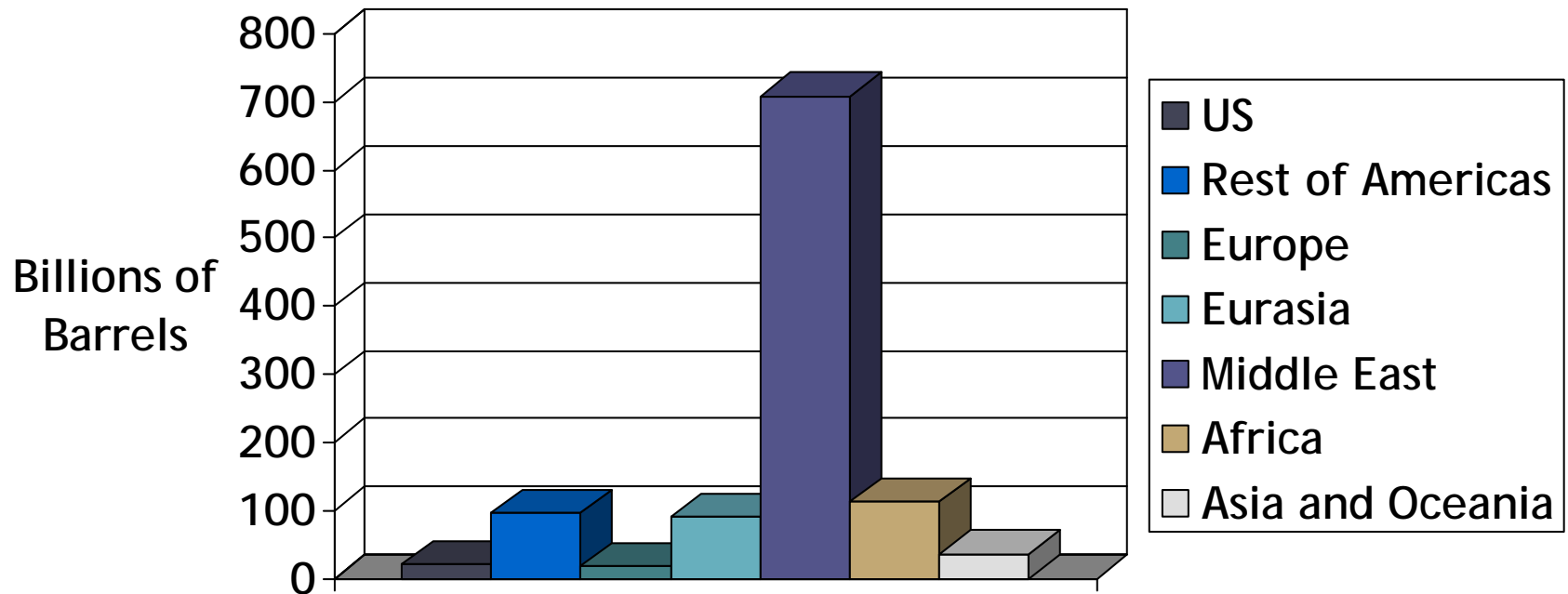
# Transportation

# US Petroleum Supply in 2007

## Millions of Barrels



# Proven reserves of oil



# Abating vehicle emissions

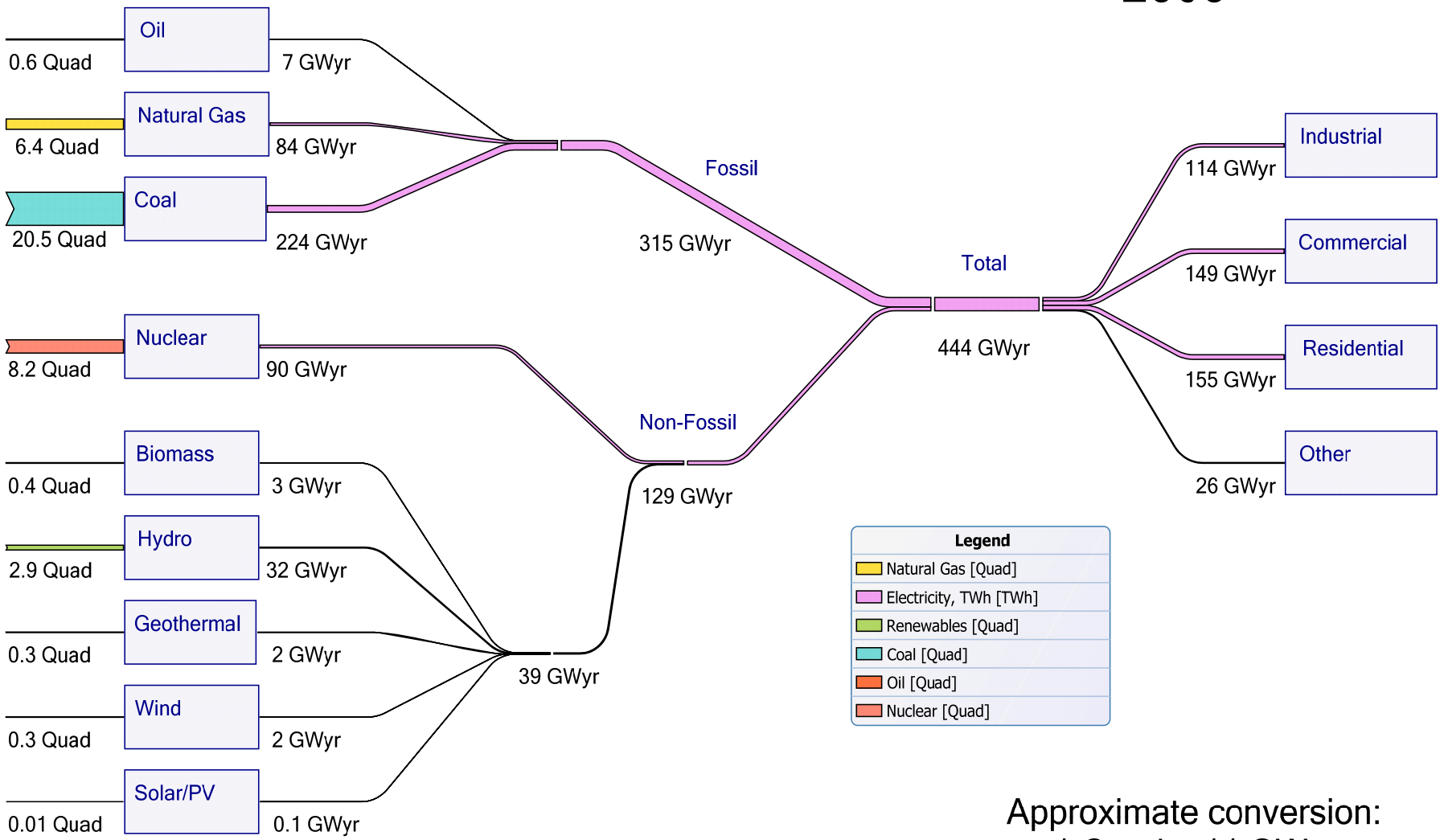
- Shift fuel mix -- less CO<sub>2</sub> per unit of energy, less oil
  - Toward natural gas
  - Toward biofuels (really feasible?)
  - Toward electricity with sequestration
- Improve fuel efficiency -- less energy per mile
  - Hybrids
  - Advanced diesel
  - Public transportation
- Reduce driving -- fewer miles
  - Live closer to work
  - Change habits

# Electricity

# Electric sector has multiple roles

- **Adapting to climate change**
  - Higher summer temperatures
  - Potentially greater peak demand for electricity
- **Implementing climate policies**
  - Generation and delivery of renewable power
  - Replace on-site fuel use in order to sequester carbon
  - Support plug-in hybrids
- **Implications**
  - Even greater role for the grid

# US Electricity Flows 2006



Legend	
<span style="color: yellow;">█</span>	Natural Gas [Quad]
<span style="color: pink;">█</span>	Electricity, TWh [TWh]
<span style="color: lightgreen;">█</span>	Renewables [Quad]
<span style="color: cyan;">█</span>	Coal [Quad]
<span style="color: orange;">█</span>	Oil [Quad]
<span style="color: red;">█</span>	Nuclear [Quad]

Approximate conversion:  
1 Quad = 11 GWyr

Data source: Annual Energy Review 2006, Energy Information Administration



# Leading options for replacing fossil

- Integrated gasification combined cycle coal (IGCC)
  - With carbon capture and sequestration (CCS)
- Combined cycle gas (CC)
  - With CCS
- Nuclear
- Renewables
  - Wind
  - Biomass
  - Hydro
  - Solar thermal or photovoltaic

# Replacing fossil capacity

- Summer fossil capacity now 741 GW
- Replace with IGCC CCS coal plants?
  - Optimistic cost = \$1.5 trillion
  - For comparison: US GDP approx \$13 trillion
- Not impossible but definitely expensive
  - Also, very uncertain: no large scale CCS plants
  - Population growth makes things worse

# Transmission grid

- Can we get power where it's needed?
- Especially important for wind and solar
  - Best locations are far from cities
  - Need geographic dispersion

# Insufficient grid capacity for wind

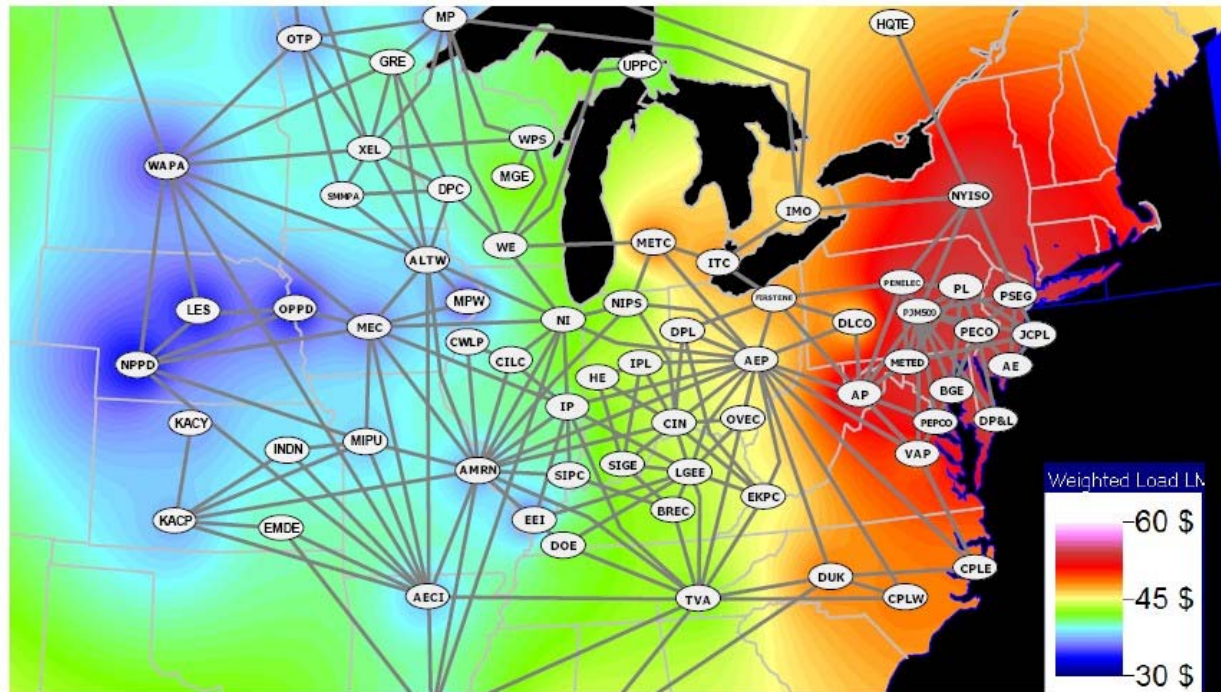


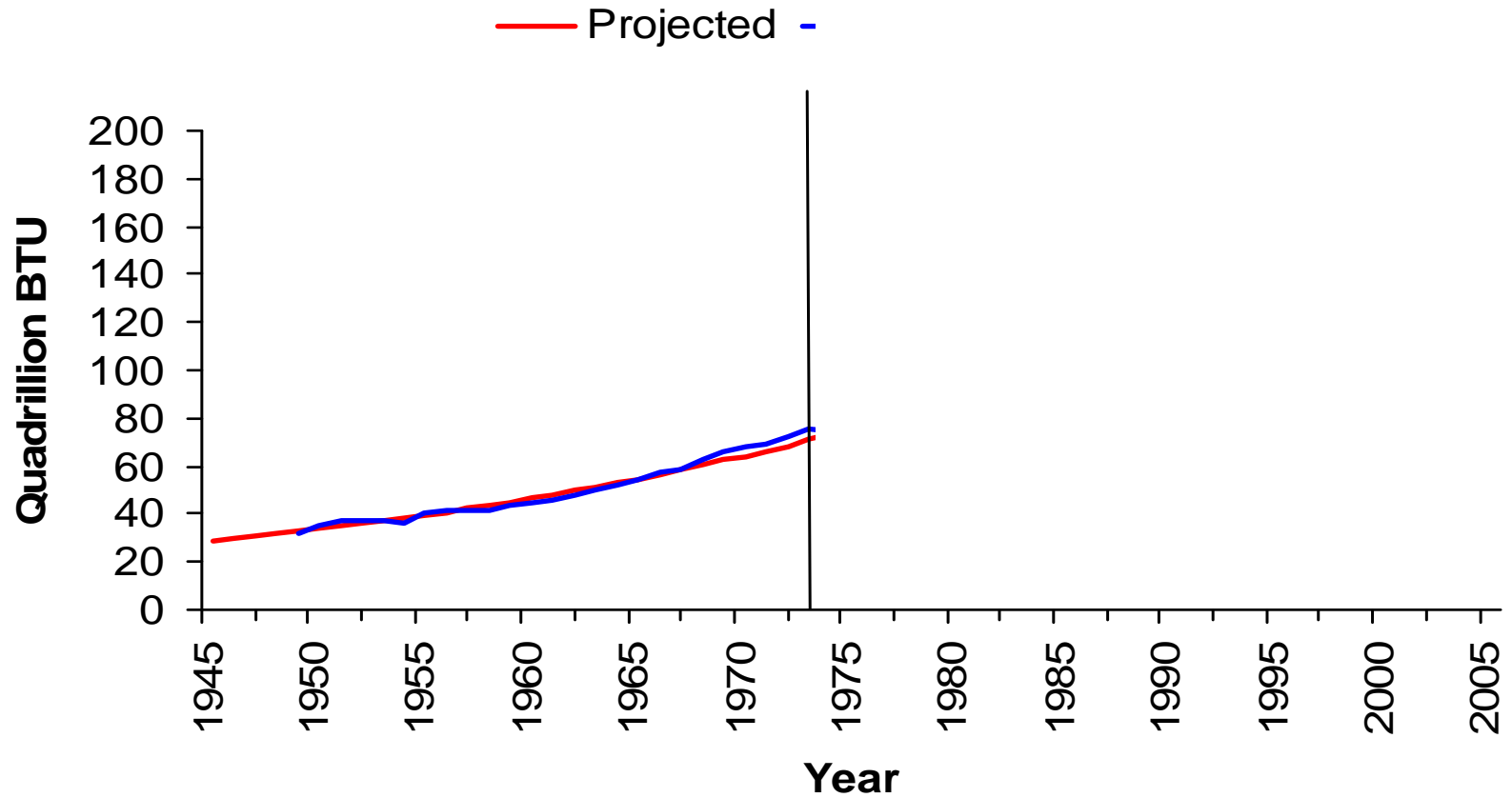
Figure 2.2-3 Contour Map of Annual Load Weighted LMP

From “2006 Midwest ISO-PJM Coordinated System Plan (CSP),” revised December 20, 2006.

# Historical perspective?

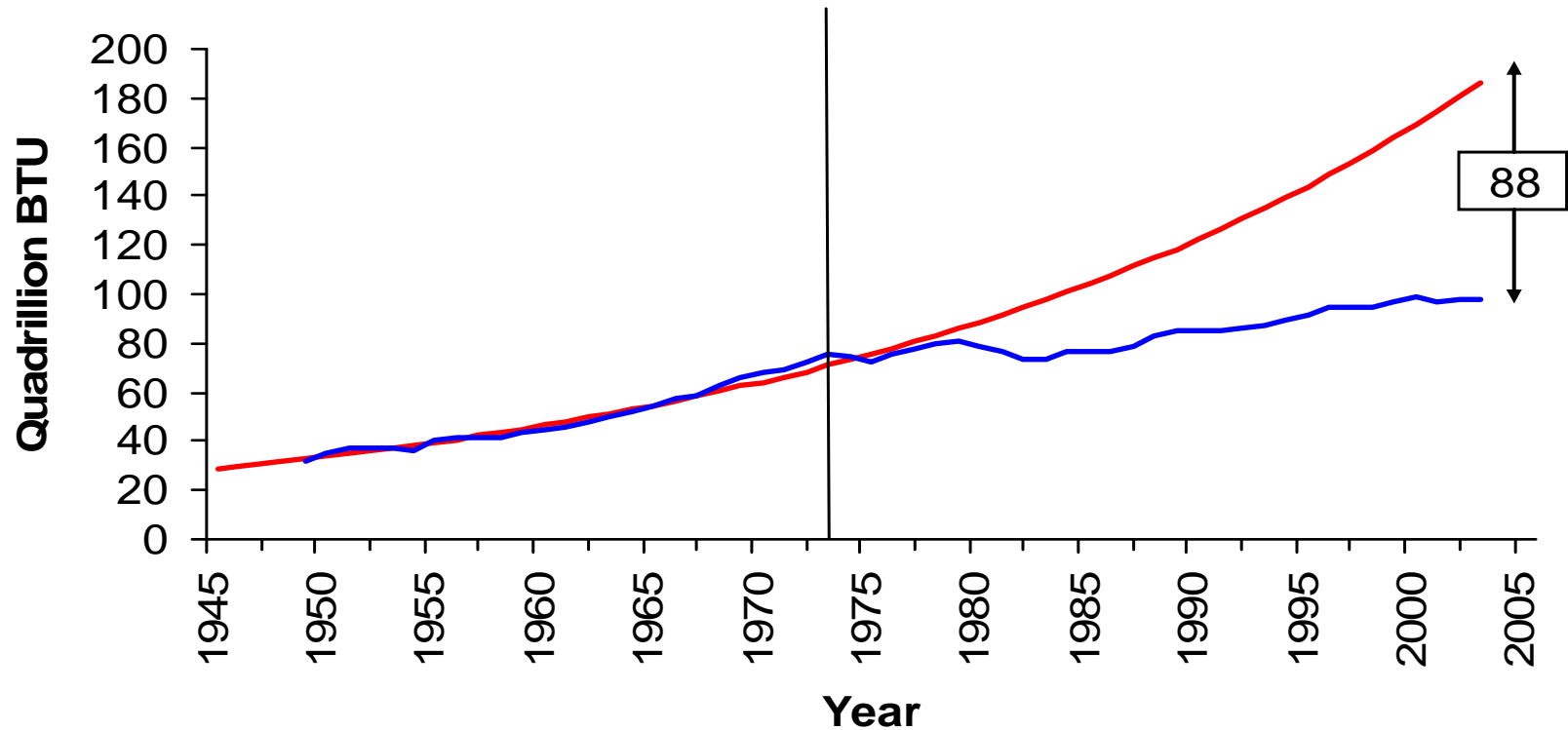
- Does fuel use rise inexorably no matter what?
- What do we know from history about fuel use?

# US Energy Consumption, 1949-2003



# US Energy Consumption, 1949-2003

— Projected — Actual



# Energy prices matter!

- Price spikes stabilized US energy consumption
- GDP growth was a little slower
  - Reduced by about 0.2% per year



# Carbon tax

- Tax on fossil fuels in proportion to carbon content
- Would reduce emissions substantially
  - Powerful incentive to reduce fuel use
  - Incentive to adopt alternative technologies
  - Incentive for R&D on alternative technologies
  - Consistent with historical evidence on energy prices
- Would reduce imports of oil

# Alternatives to a tax

- **Tradable emissions permits**
  - Issue a limited number of permits to burn fossil fuels
  - Allow owners to buy and sell
  - Would raise fuel prices
  - Costs may be very high
- **Hybrid policy**
  - Some tradable permits
  - Tax provision for exceeding permits
  - Raises fuel prices with fewer political problems

# Technology policies

- Subsidies for hybrid cars
- Subsidies for alternative fuels
  - Corn-based ethanol not a good solution
  - Cellulosic ethanol great but expensive to produce
- Subsidies for R&D
  - A Manhattan Project for energy ?
- Carbon capture and sequestration
  - Would allow coal use without climate damage
  - Basic technologies are known
  - Need large scale demonstration projects

# Energy policy portfolio

- Introduce a carbon tax or permit system
  - Will reduce CO<sub>2</sub> emissions AND reduce demand for imported oil
- Promote non-fossil electricity generation
  - Advanced nuclear, wind
- Renovate and expand the electricity grid
- Encourage alternative vehicle technologies
  - Natural gas, plug-in hybrids, electric vehicles
- Research and development
  - Cellulosic ethanol, carbon capture and sequestration