

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



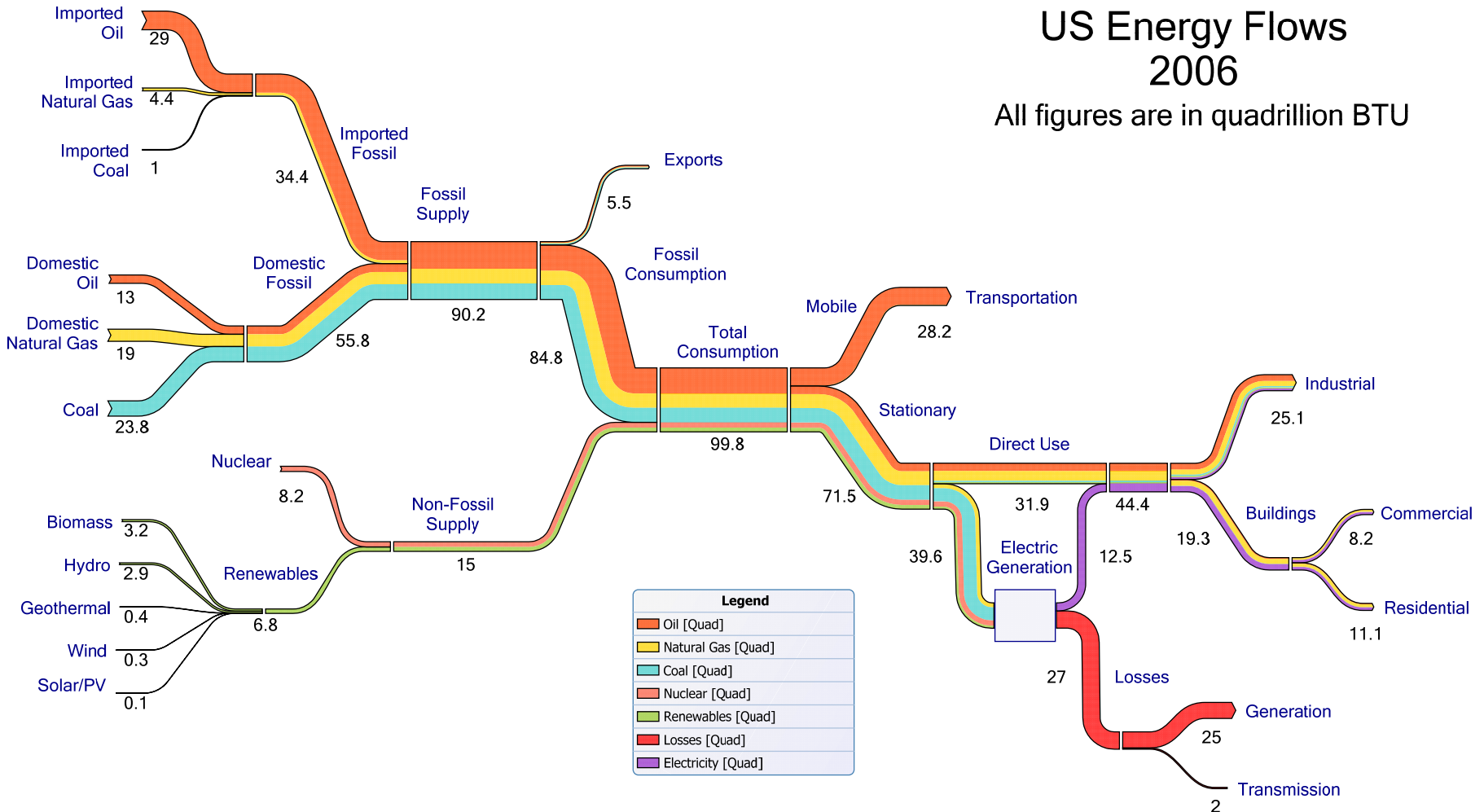
- 1 quad = 170 tankers

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

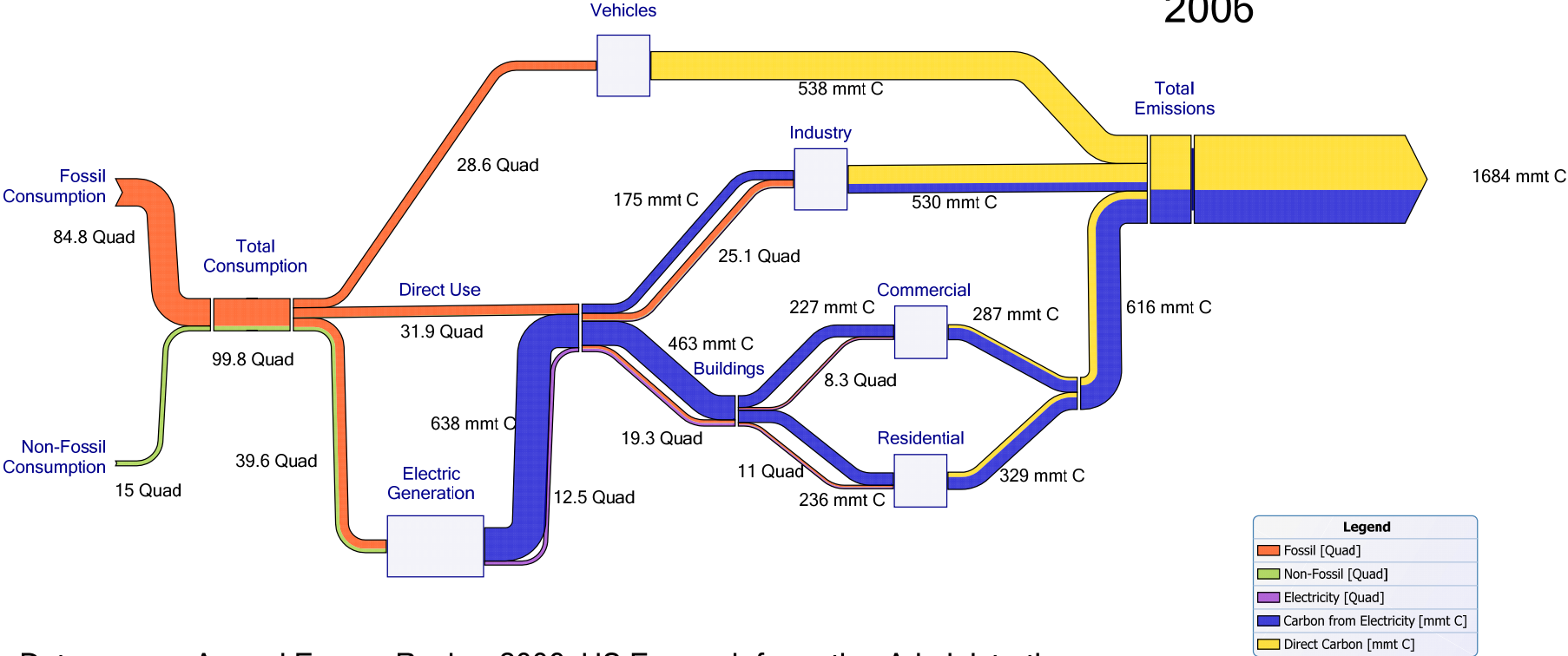
US Energy Flows 2006

All figures are in quadrillion BTU



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

US Energy and Carbon Flows 2006



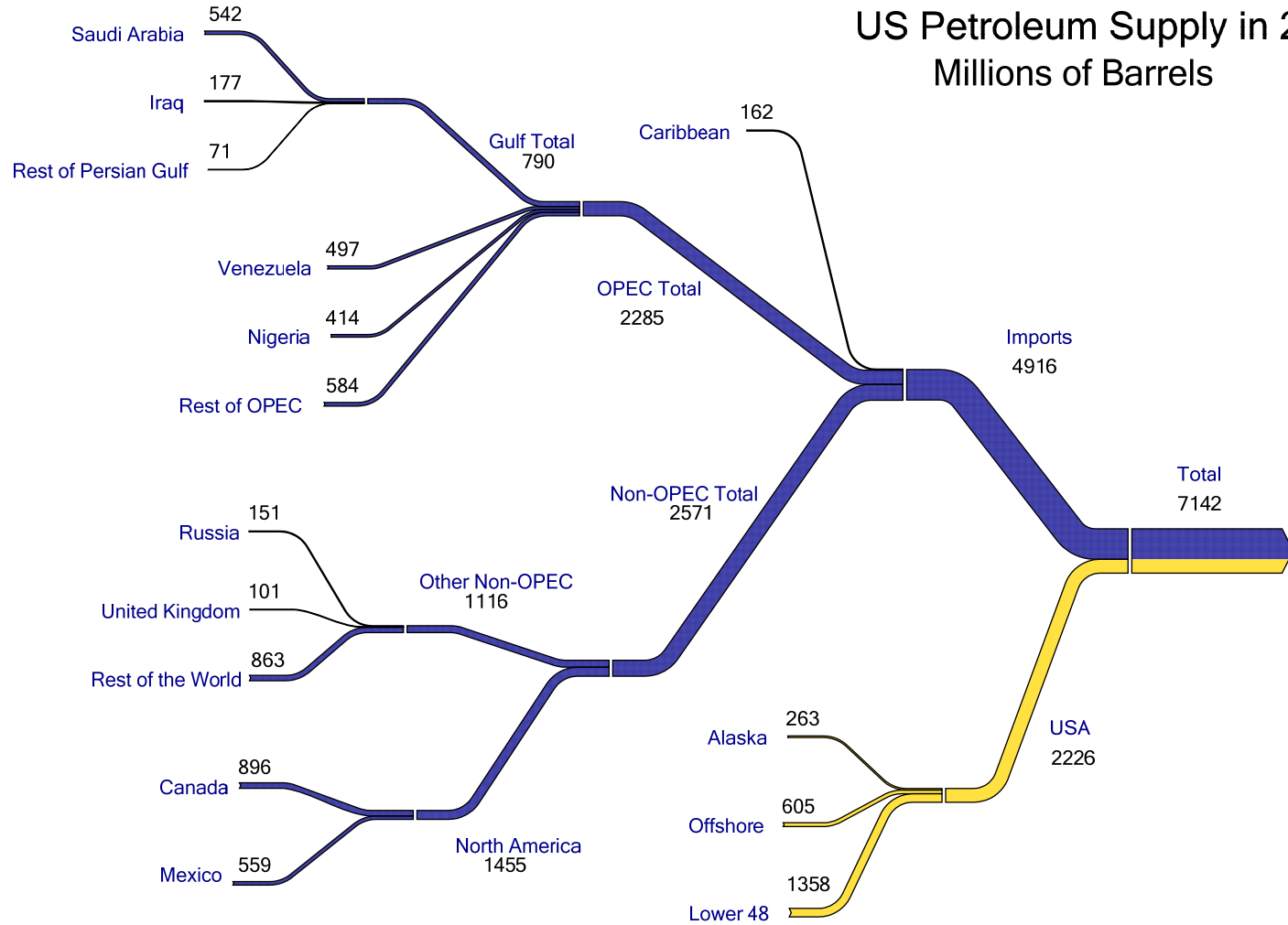
Data source: Annual Energy Review 2006, US Energy Information Administration

A very large problem ...

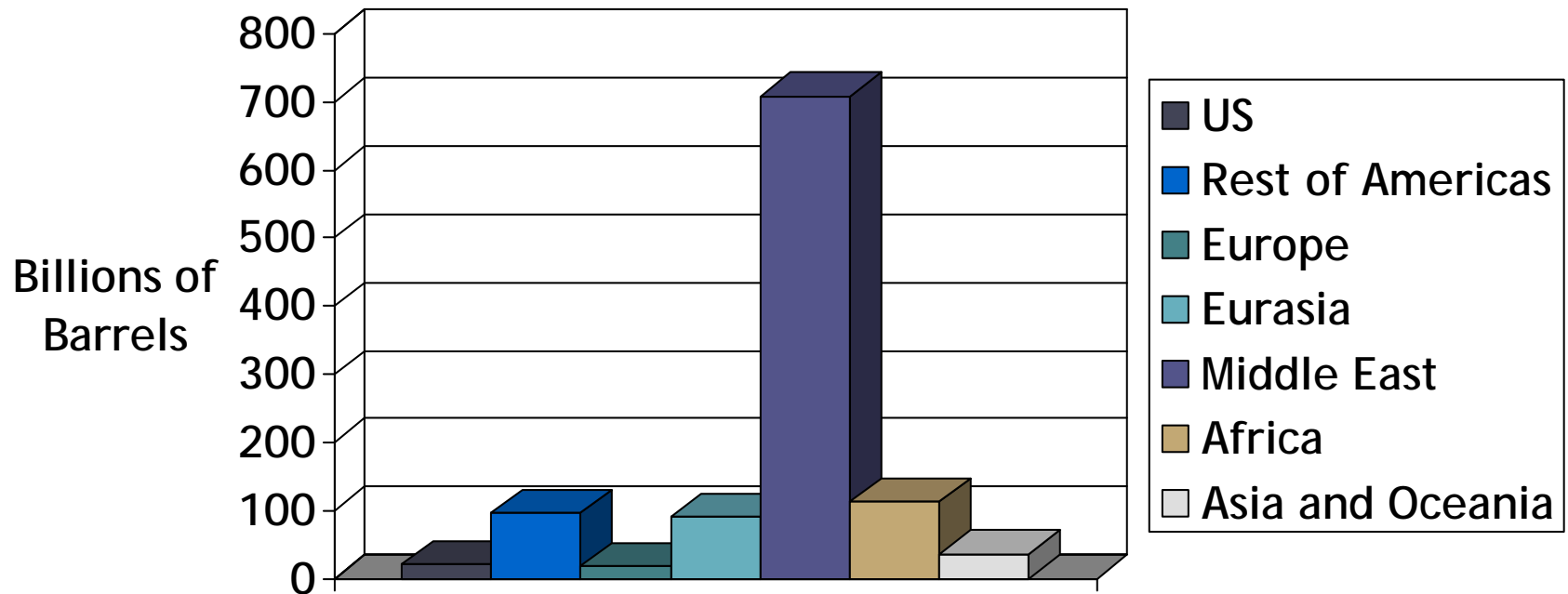
- US fossil energy
 - 86 quads
- US emissions
 - 6 billion tons of CO₂ or 1.7 billion tons of C
- In the long term, bring both down to nearly 0

Transportation

US Petroleum Supply in 2007 Millions of Barrels



Proven reserves of oil



Abating vehicle emissions

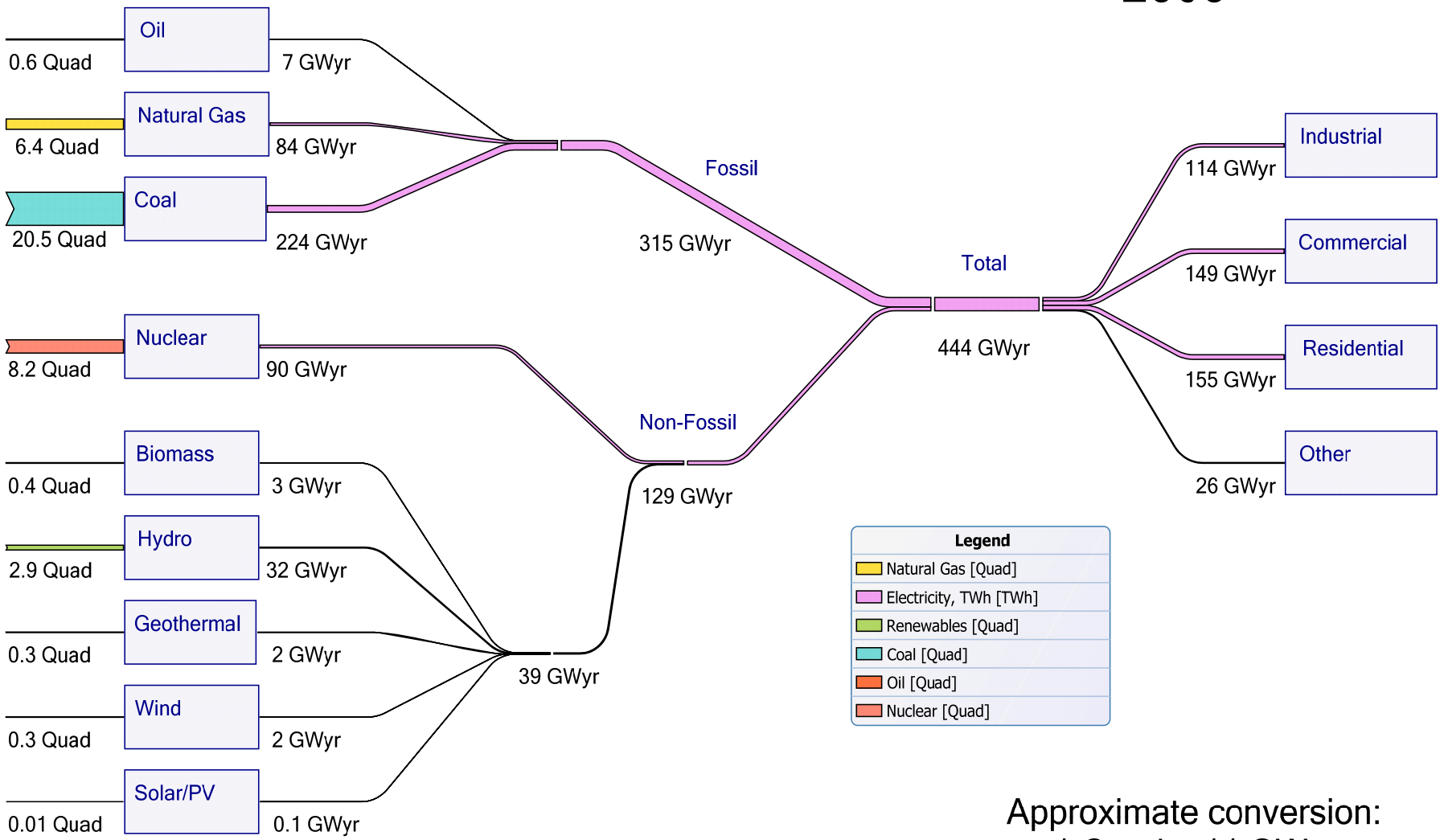
- Shift fuel mix -- less CO₂ per unit of energy, less oil
 - Toward natural gas
 - Toward biofuels (really feasible?)
 - Toward electricity with sequestration
- Improve fuel efficiency -- less energy per mile
 - Hybrids
 - Advanced diesel
 - Public transportation
- Reduce driving -- fewer miles
 - Live 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	
Yellow bar	Natural Gas [Quad]
Pink bar	Electricity, TWh [TWh]
Light Green bar	Renewables [Quad]
Teal bar	Coal [Quad]
Orange bar	Oil [Quad]
Red bar	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

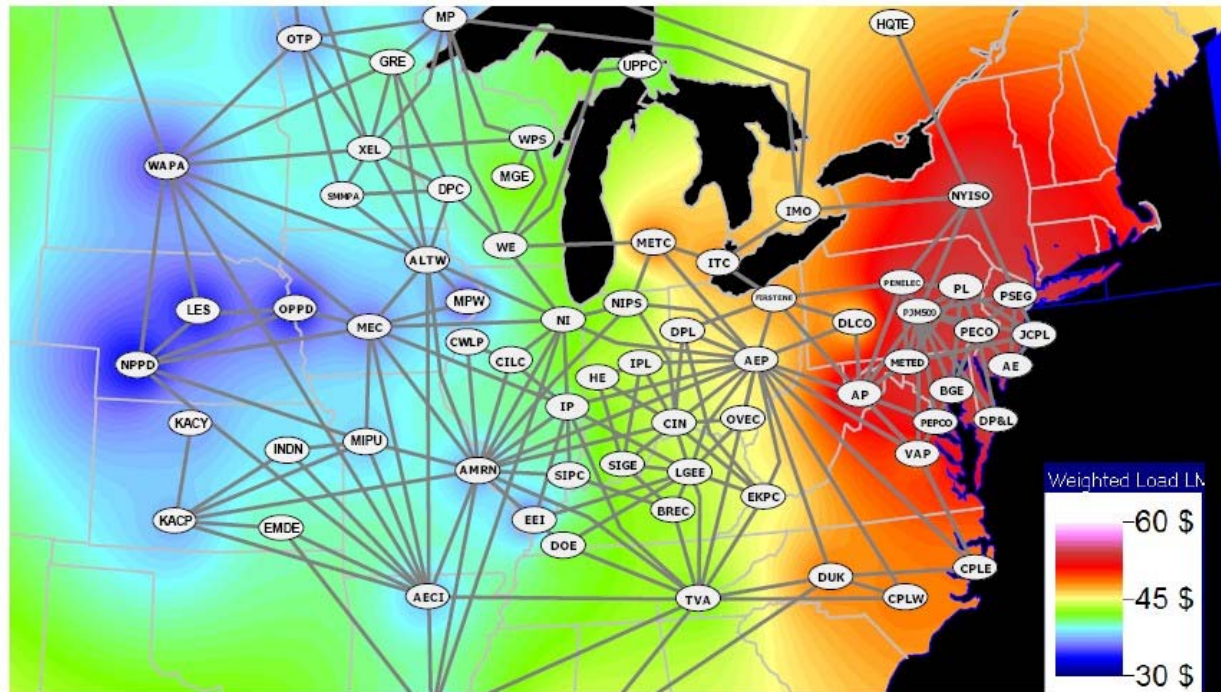


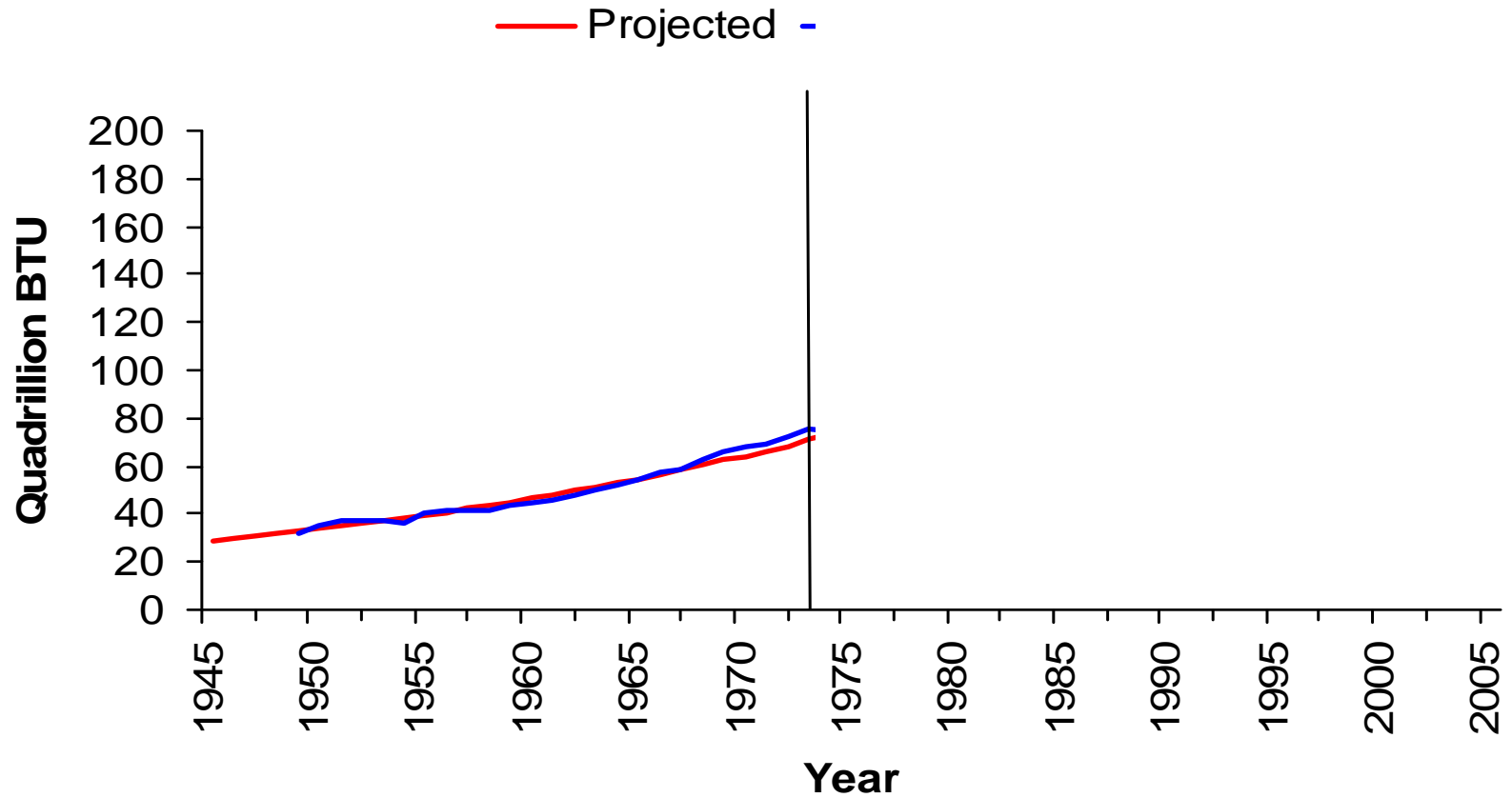
Figure 2.2-3 Contour Map of Annual Load Weighted LMP

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

Historical perspective?

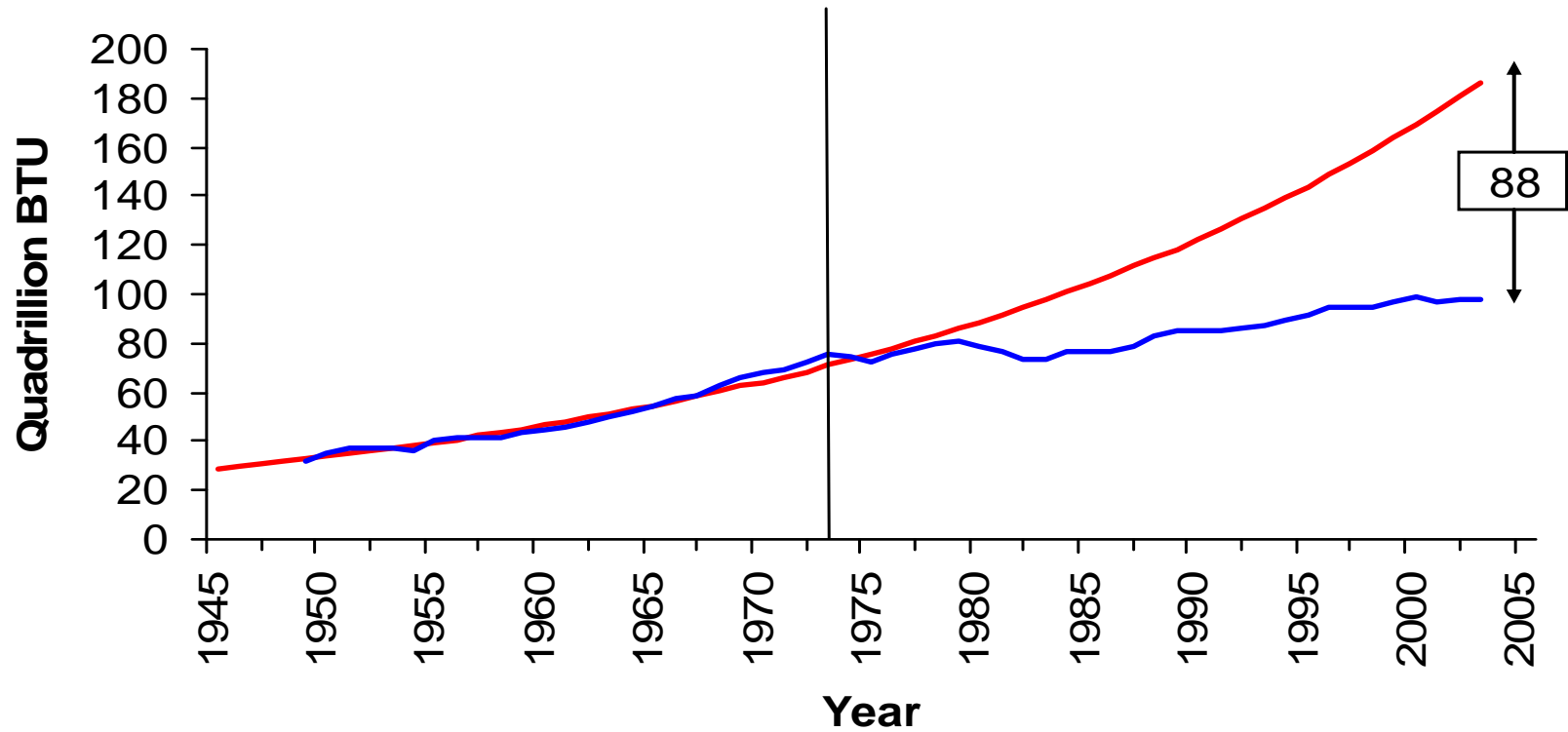
- Does fuel use rise inexorably no matter what?
- What do we know from history about fuel use?

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 CO₂ 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