

Future Grid: The Environment



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Objectives

Present the significant near- and long-term unresolved environmental issues relevant to the future electric grid

Summarize the technologies that will help resolve them

Importance to Future Grid

The issues are unavoidable in the next 5-40 years.

Effective regulations are needed.

Significant work is needed.

Paths to Resolution

Research:

Will technologies and regulations address the issues?

Magnitude and location: issues are regional

Effectiveness of Technologies

Interactions among Technologies

Costs

Policies and Regulations:

National regulations are needed for consistency across the industry

Evaluation is difficult due to complexities of electric supply system

Interactions and secondary effects

Costs

Life Cycle Planning

The Issues

Greenhouse gas mitigation

Figure 2. U.S. energy-related carbon dioxide emissions by major fuel, 2009
million metric tons carbon dioxide

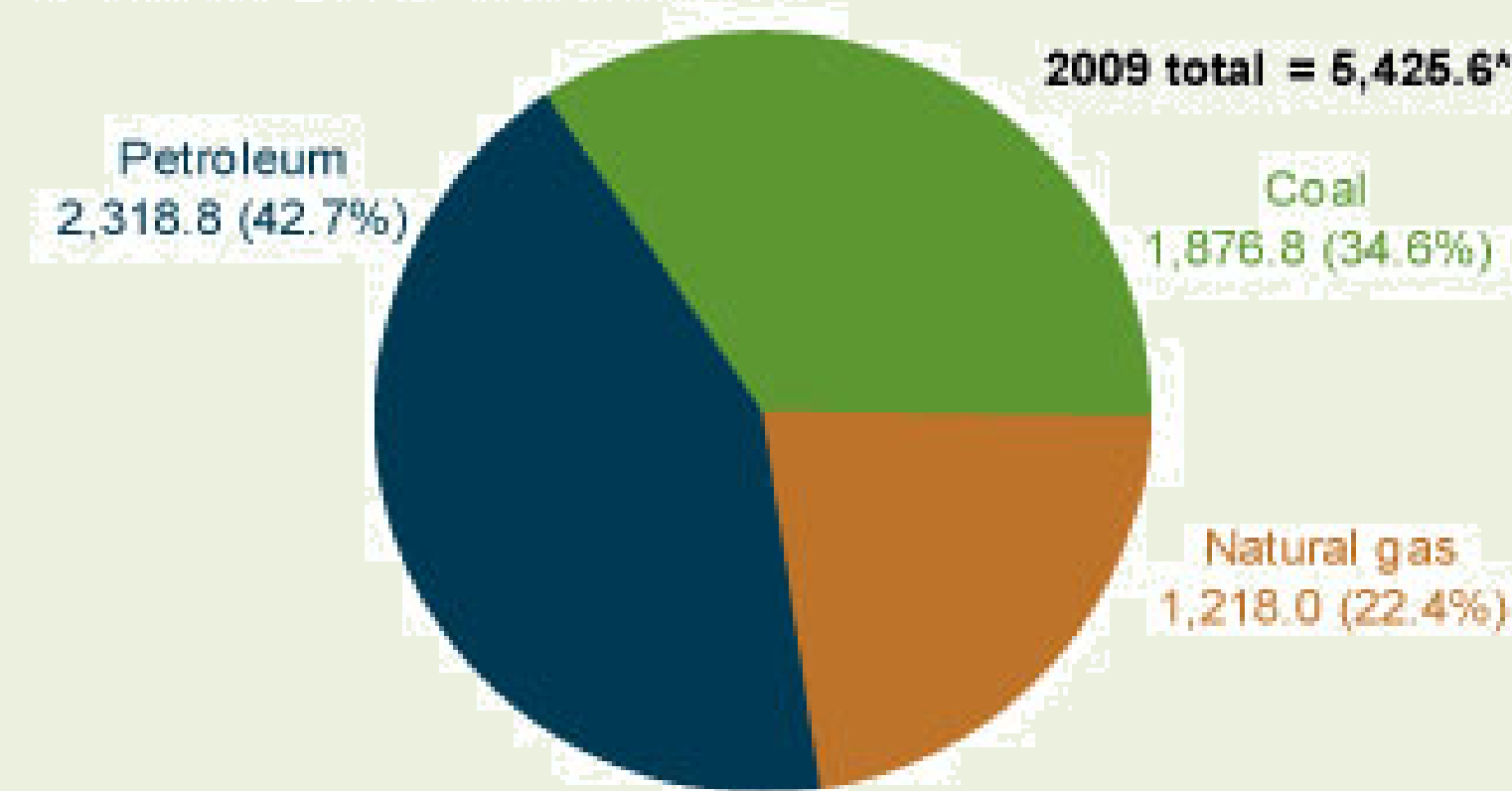
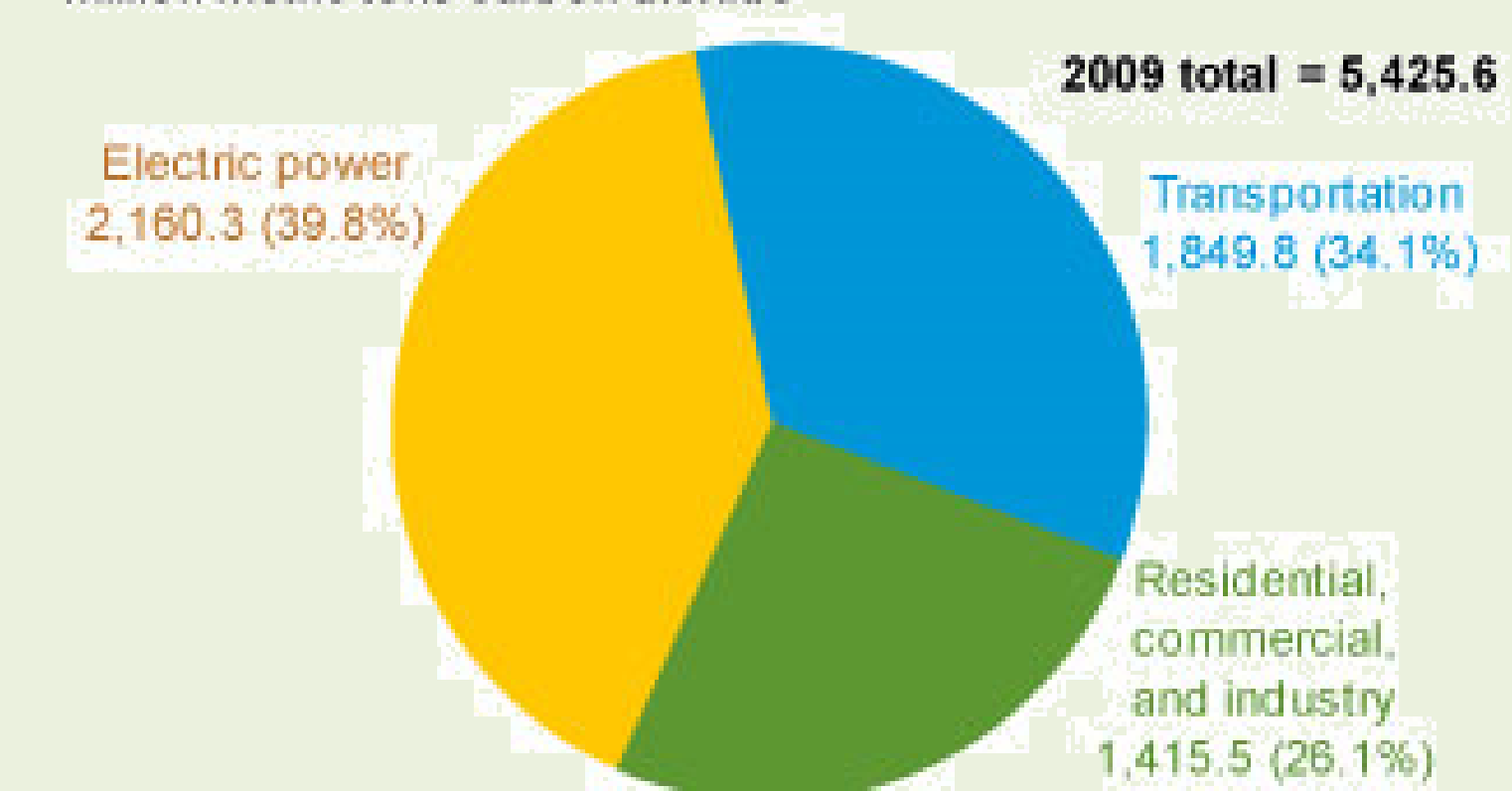


Figure 3. U.S. energy-related carbon dioxide emissions by sector, 2009
million metric tons carbon dioxide

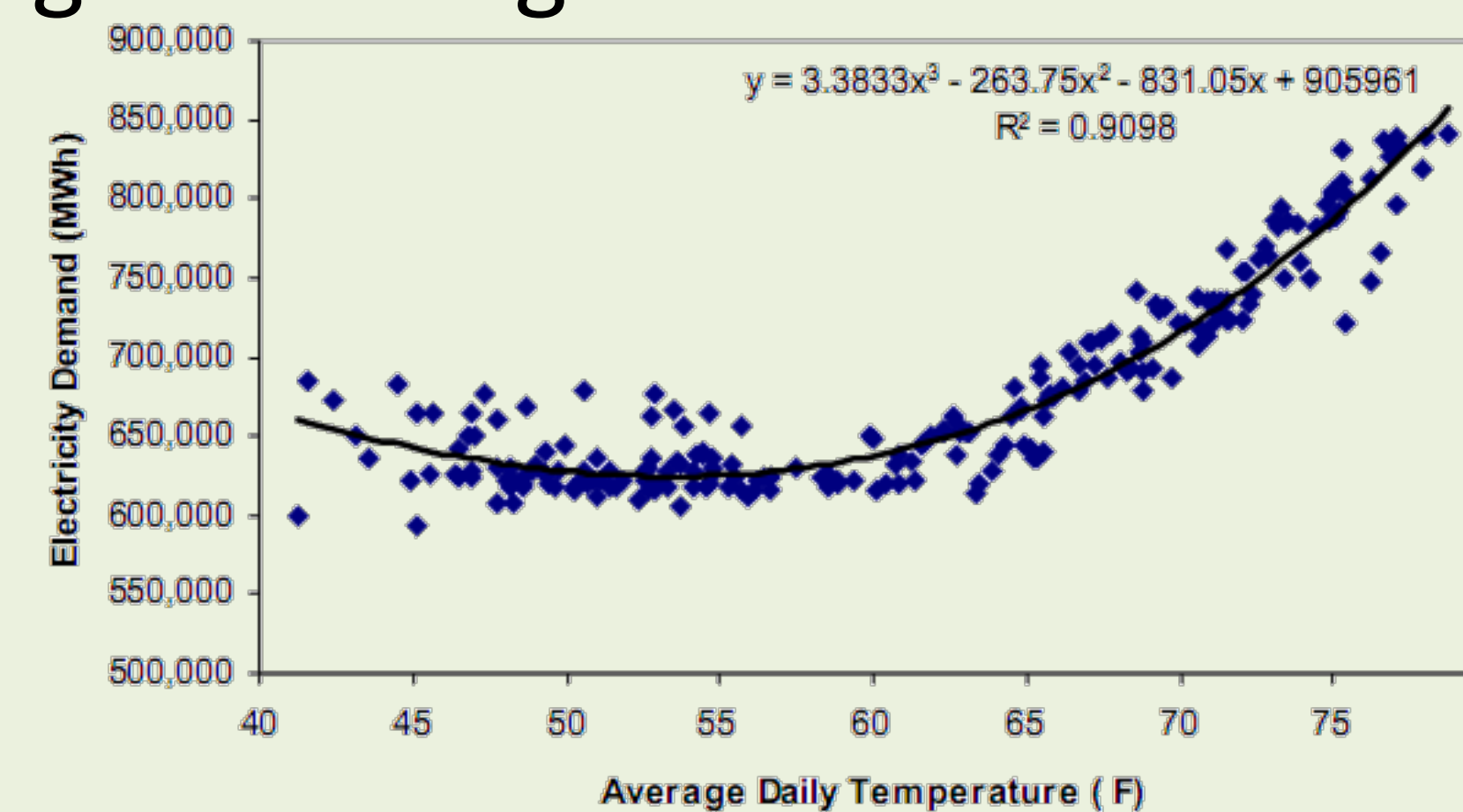


Coal: 205-225 lb CO₂/Mbtu
Gas : 117-139 lb CO₂/Mbtu

Energy Information Administration, US Department of Energy.
www.eia.doe.gov/environment/emissions/ghg_report/ghg_overview.cfm

Climate change adaptation

Higher average air and water temperatures



Guido Franco and Alan H. Sanstad,
Climate Change and Electricity Demand
in California, California Climate Change
Center, CCC-2005-201-SF,
February 2006

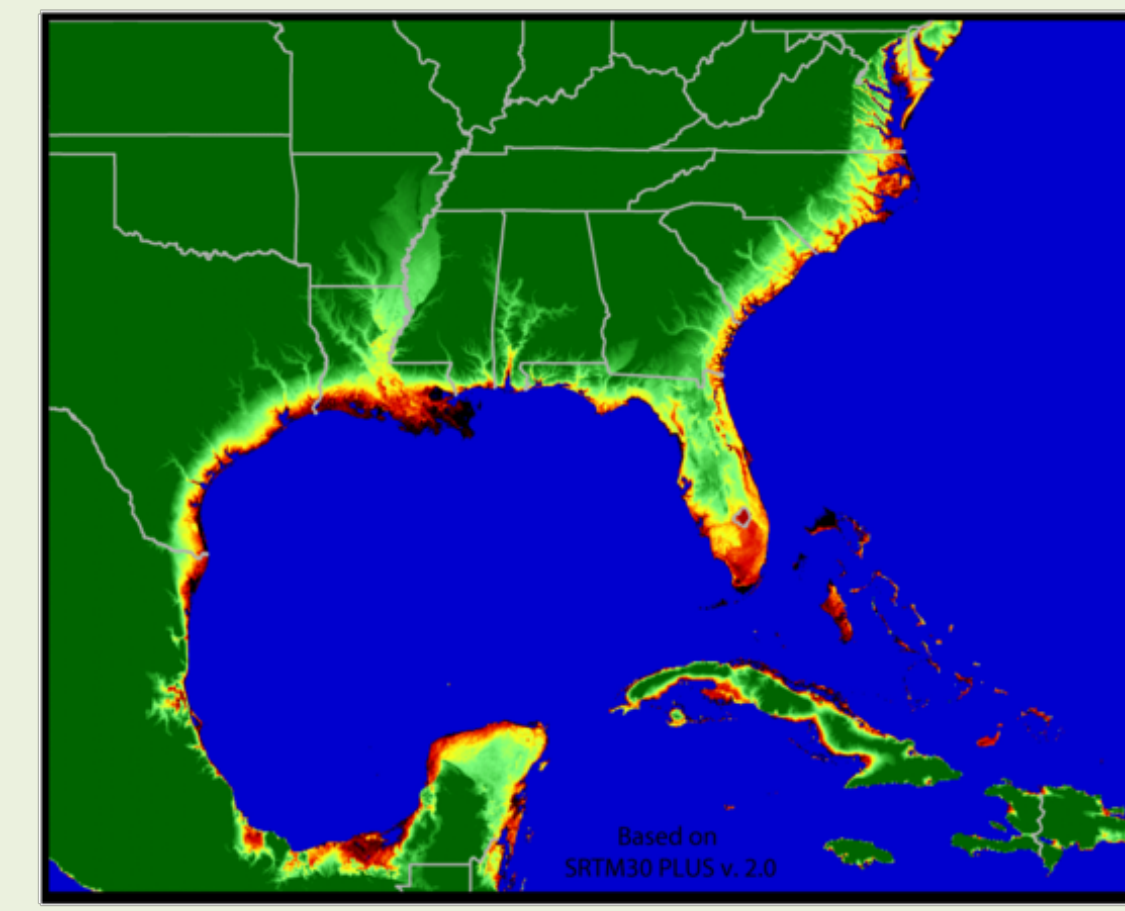
Changing precipitation patterns

Changing vegetation

Changes to insect and animal population

Rising sea levels/ land subsidence

Sea Level Risks - US East Coast

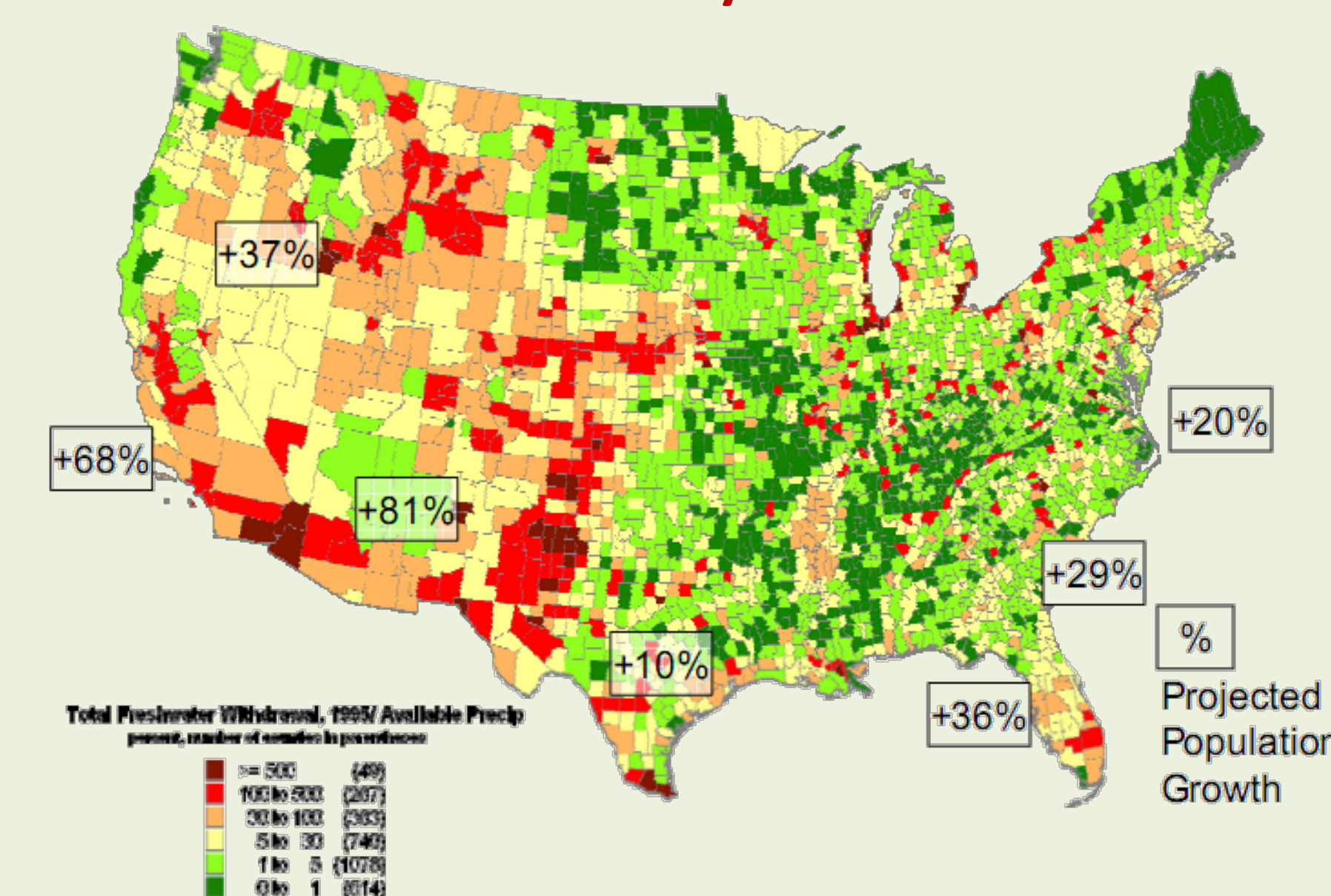


globalwarmingart.com/wiki/File:Eastern_USA_Sea_Level_Risks.png

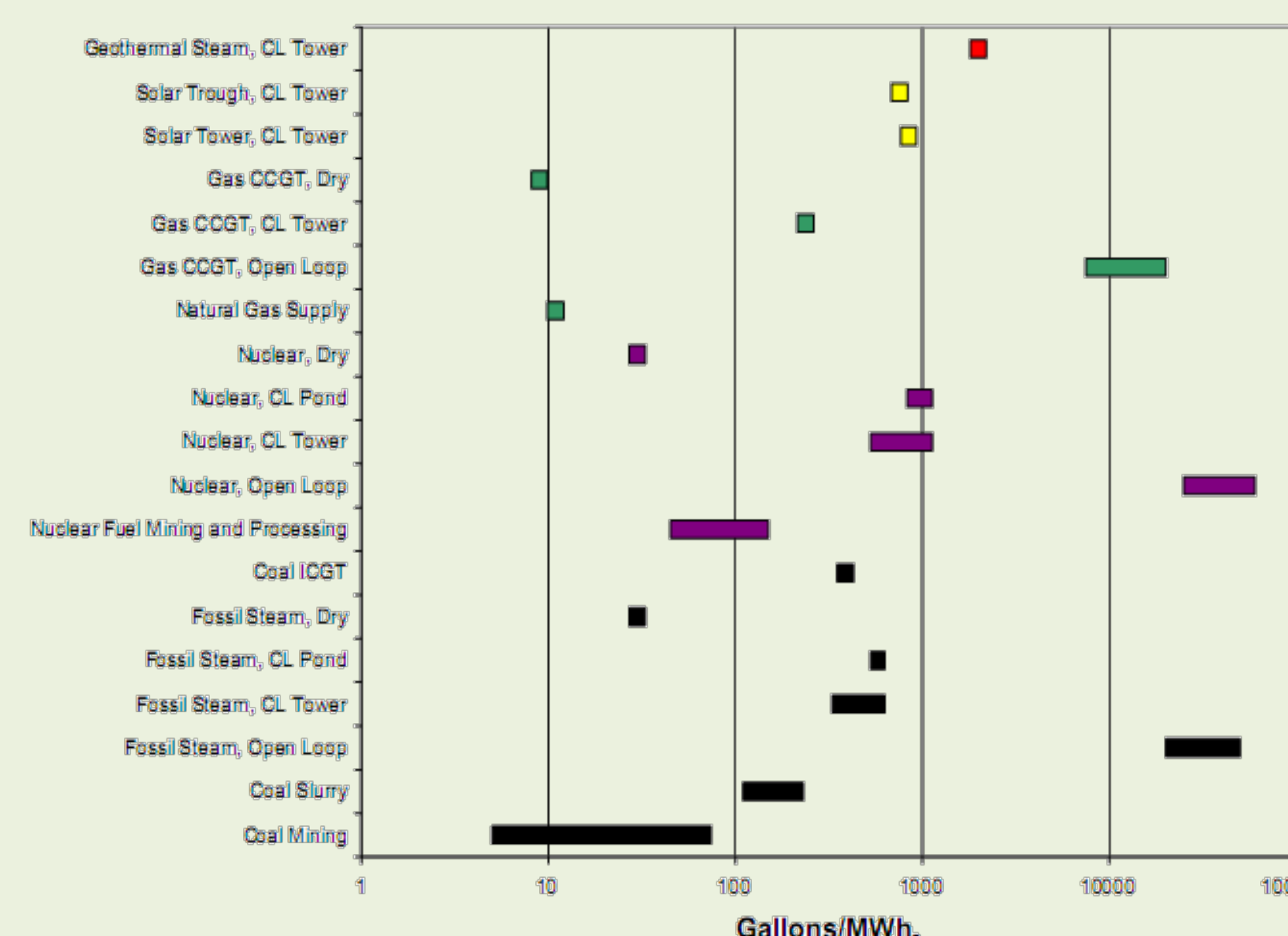
Severe weather



Availability of water



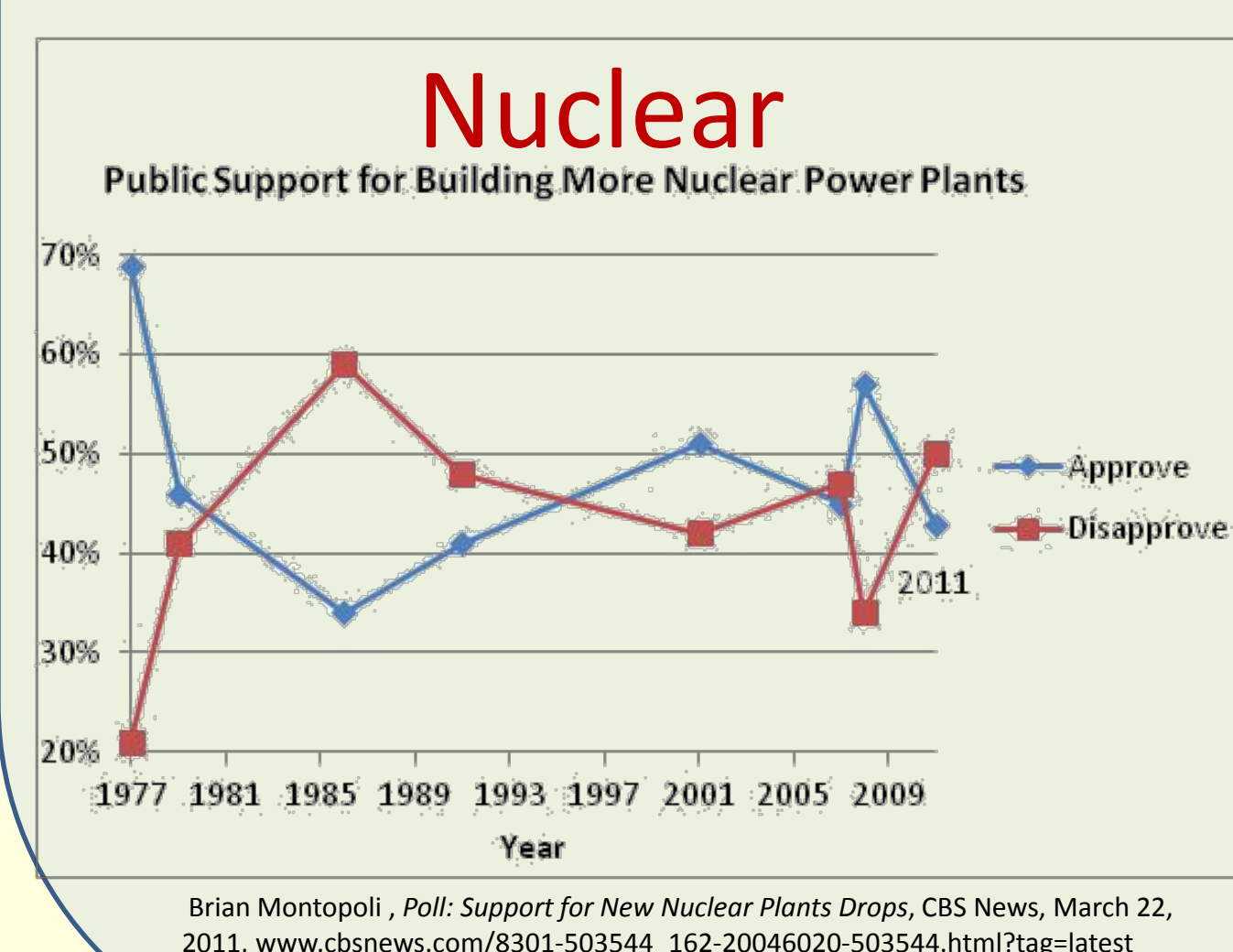
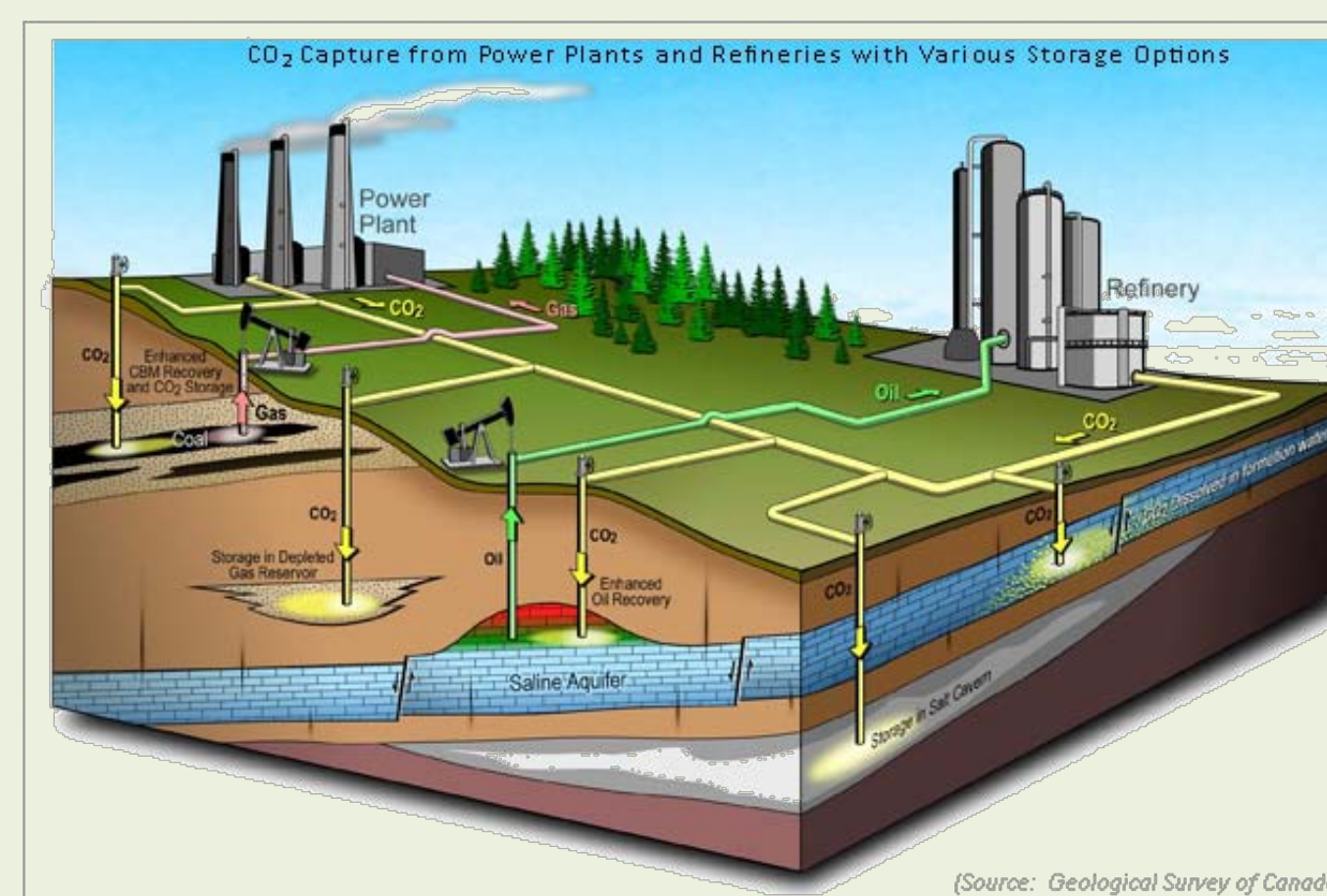
Water Consumption
Water Withdrawal



Energy Demands on Water Resources. Report to Congress on the Interdependency of Energy and Water. U.S. Department of Energy (December, 2006).

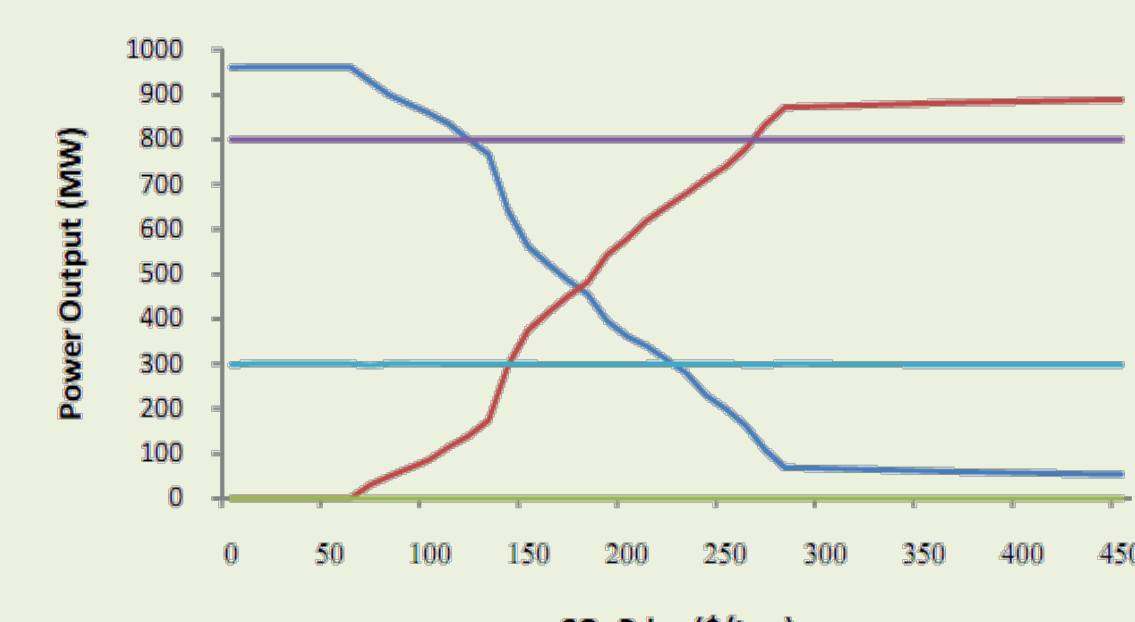
The Technologies

Carbon Capture and Storage



Brian Montopoli, "Poll: Support for New Nuclear Plants Drops," CBS News, March 22, 2011, www.cbsnews.com/8301-503544_162-20046020-503544.html?tag=latest

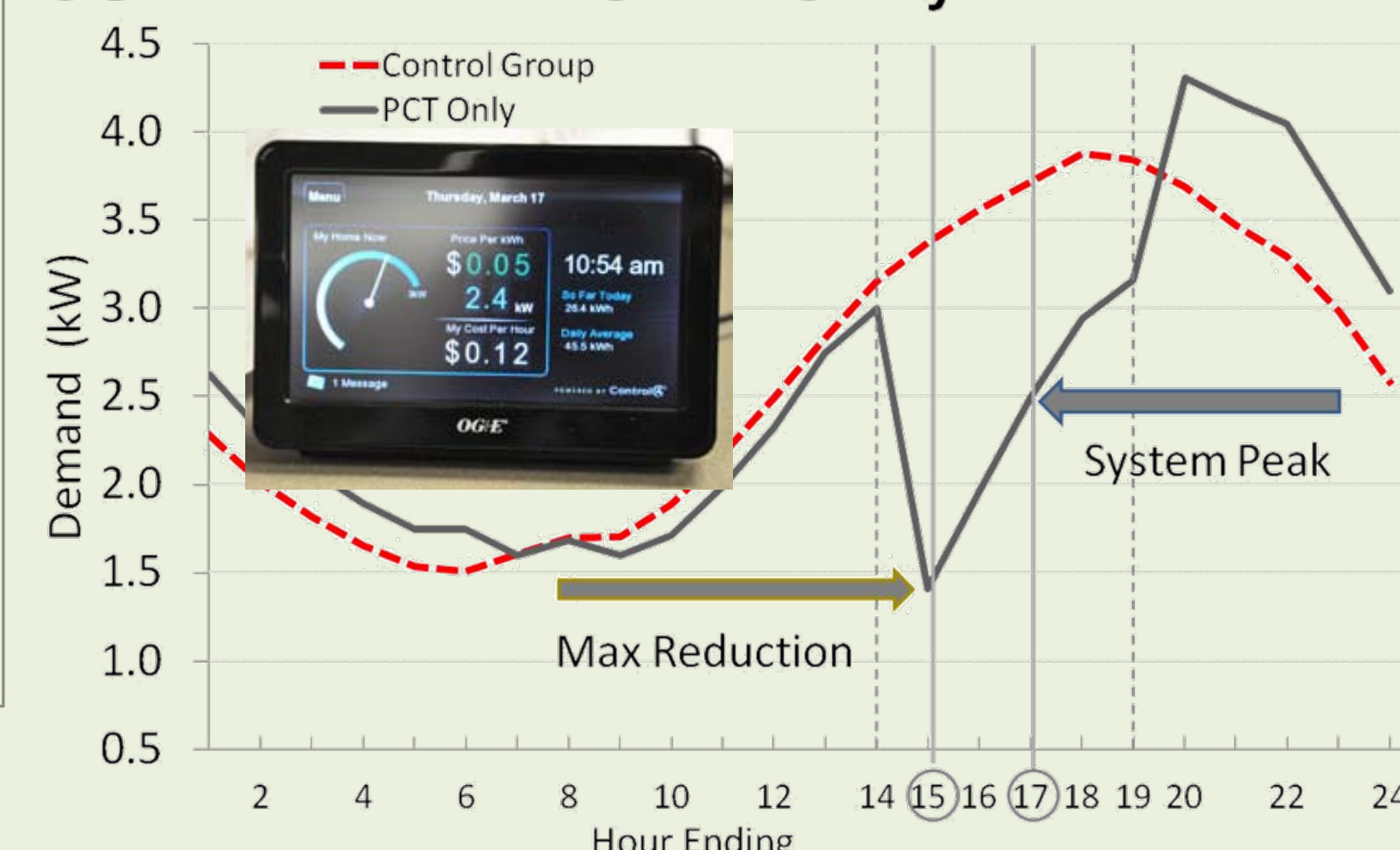
Fuel Switching



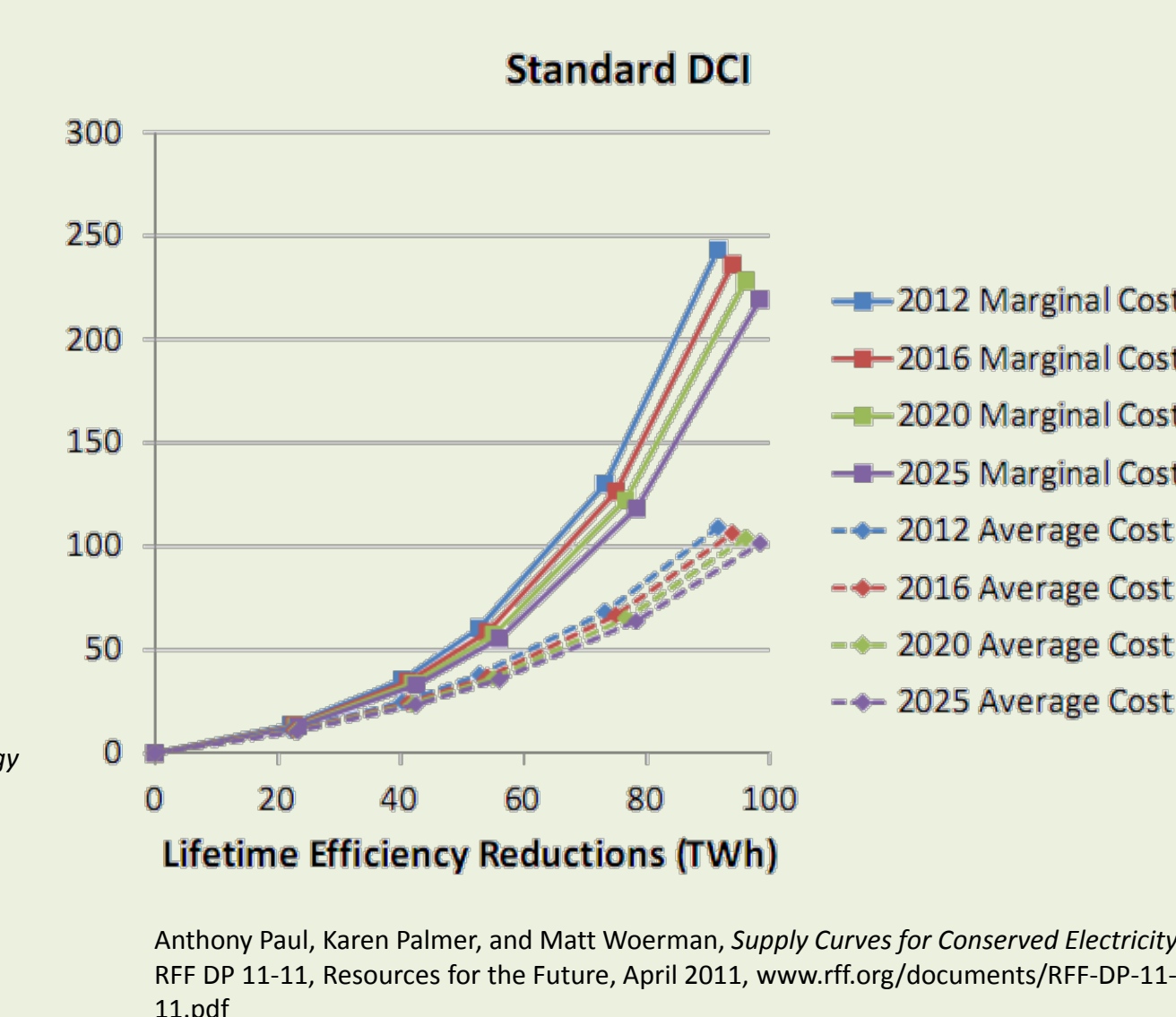
Miaoli Shao, Ward Jewell, "CO₂ Emission-Incorporated AC Optimal Power Flow and Its Primary Impacts on Power System Dispatch and Operations," 2010 IEEE Power and Energy Society General Meeting, Minneapolis, July 2010, pp. 1-8.

Demand response

OG&E 2020 Plan – Smart Study Results



Energy efficiency



Also to be considered

Secondary effects

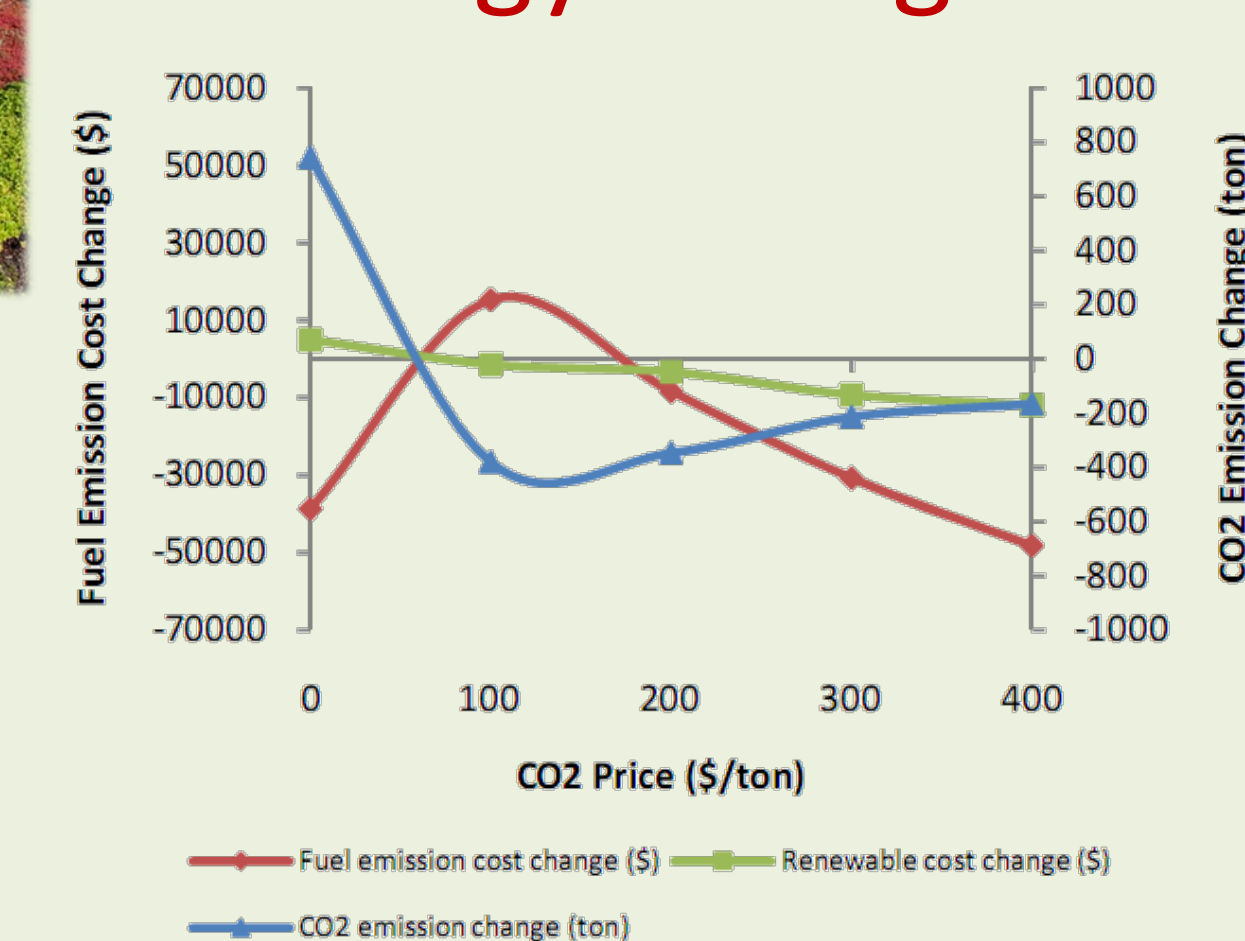
Interactions among regulations:

Electric Vehicles

Renewables



Energy Storage



Zhouxing Hu, Ward T. Jewell, Optimal Power Flow Analysis of Energy Storage for Congestion Relief, Emissions Reduction, and Cost Savings, 2011 Power Systems Conference and Exhibition, Phoenix, March 2011.