The Big Picture: Energy

UNIVERSITY OF CALIFORNIA, BERKELEY
CONTEXT-BASED RESEARCH EXPERIENCES FOR COMMUNITY COLLEGE TEACHERS

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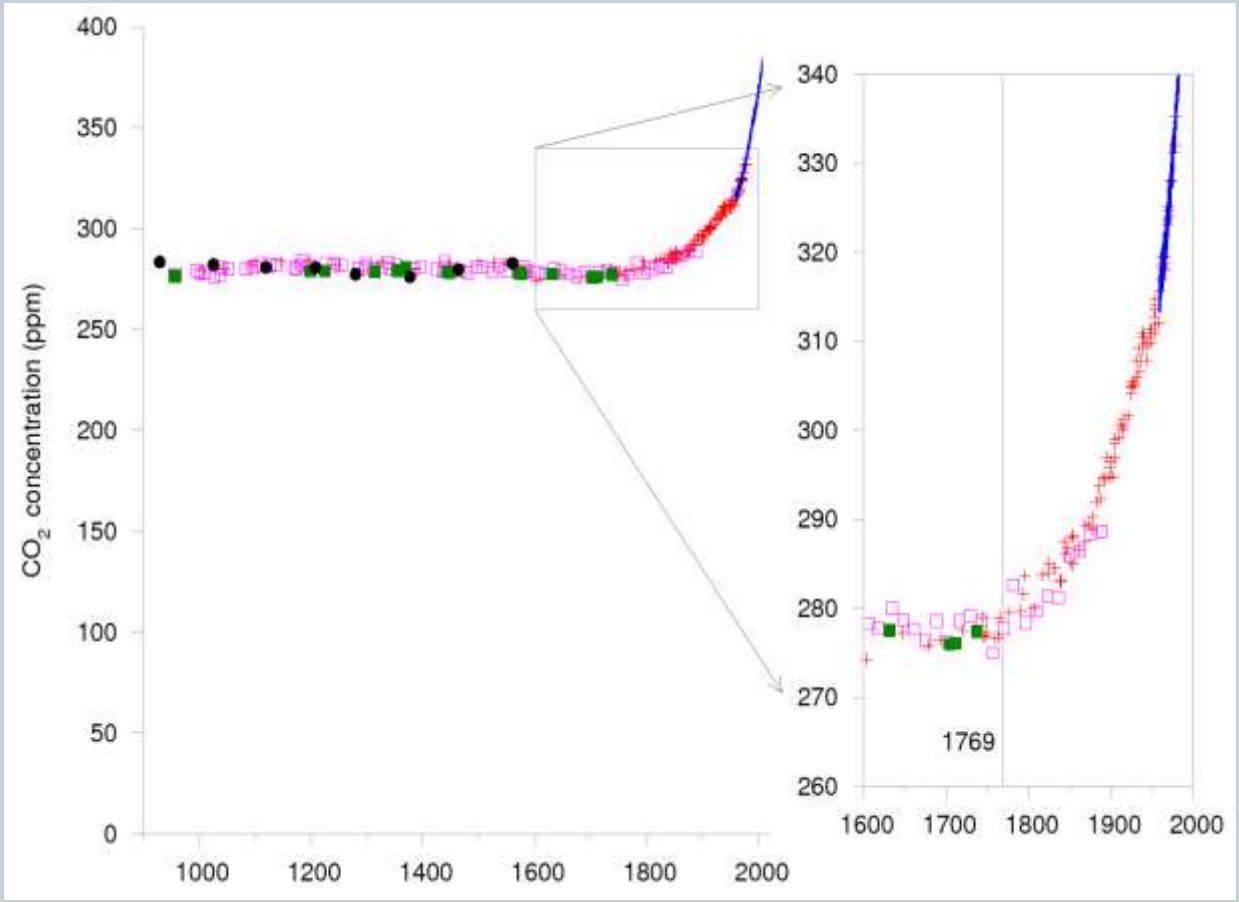
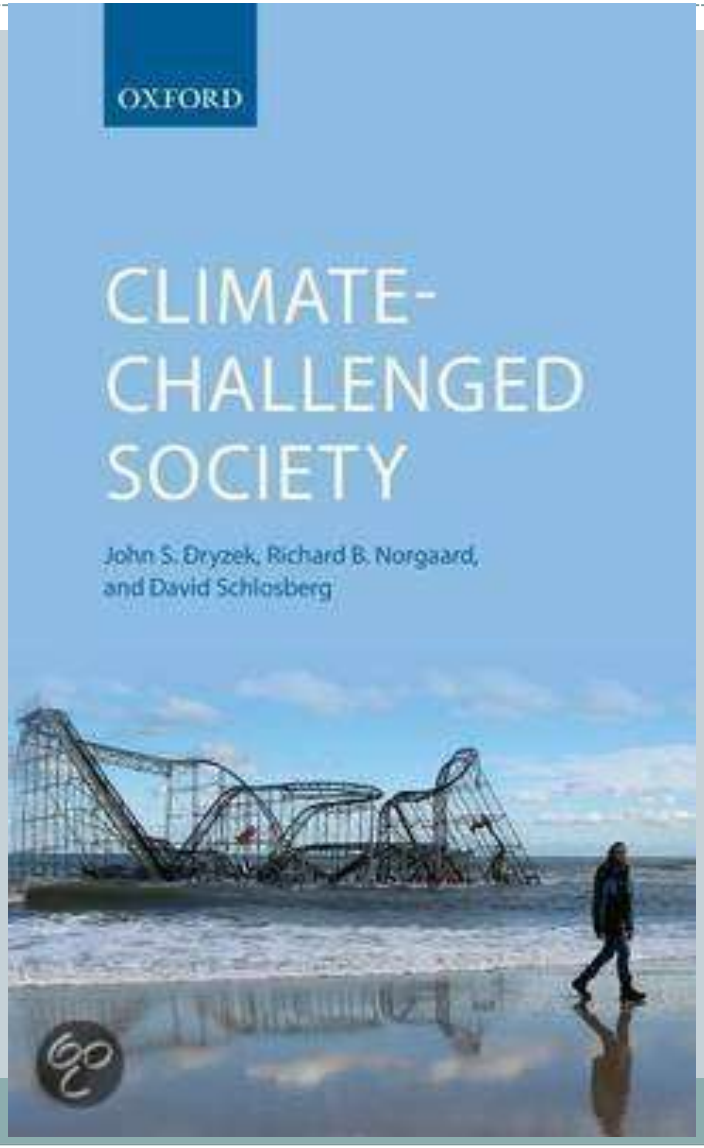
CO_2 and Climate Change



- Pre-industrial level
  - 280 ppm
- Current level (June 2015)
  - 403.7 ppm
- 1769: Humans master *fire* for industry.
- Fossil fuel usage increases atmospheric CO2 level
- Causes climate change

Image From *Sustainable Energy, Without the Hot Air* by David MacKay, (http://www.withouthotair.com)

Expensive Climate Change Consequences



- Weather shifts
  - Longer droughts -> agriculture and social impacts
  - More severe and destructive storms
  - Construction season impacted
- Biodiversity loss
  - Modern medicine relies on nature
  - Tropical diseases become more prevalent
- Sea level rise
  - Coastal real estate devalued or destroyed

Climate ~~Change~~ Challenge

Global Energy Use by Fuel (2014)

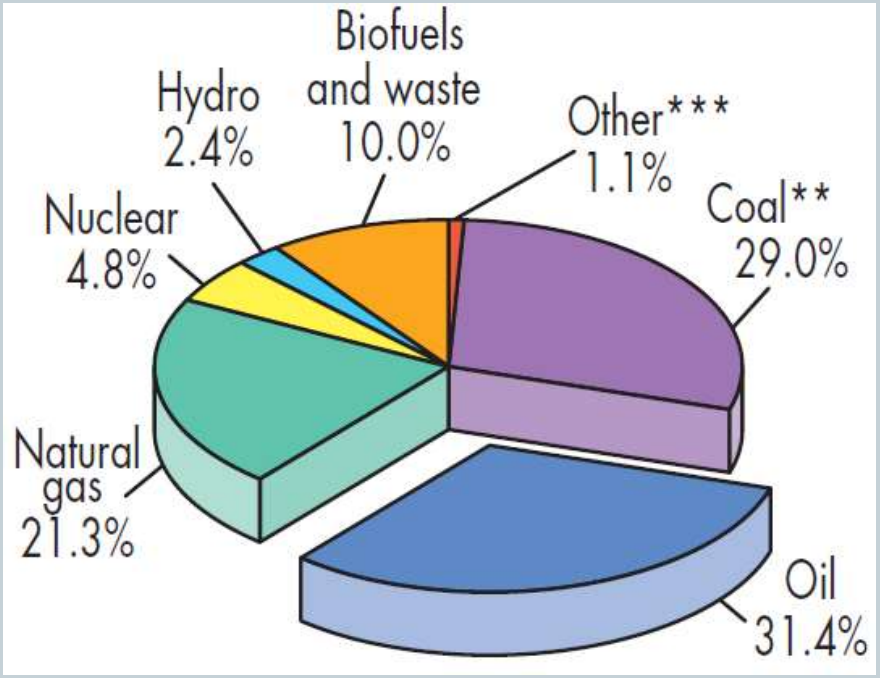


Image From *Key World Energy Statistics, 2014.* International Energy Agency. (http://www.iea.org)

- More than 90% of current energy use emits carbon
- Most of this is from fossil fuels (*or fire)*
  - Electricity – coal & natural gas
  - Transportation – oil
- The challenge is to replace these old energy sources with new technologies

The Challenge: To Reinvent Fire. Transitioning to a Low Carbon Future

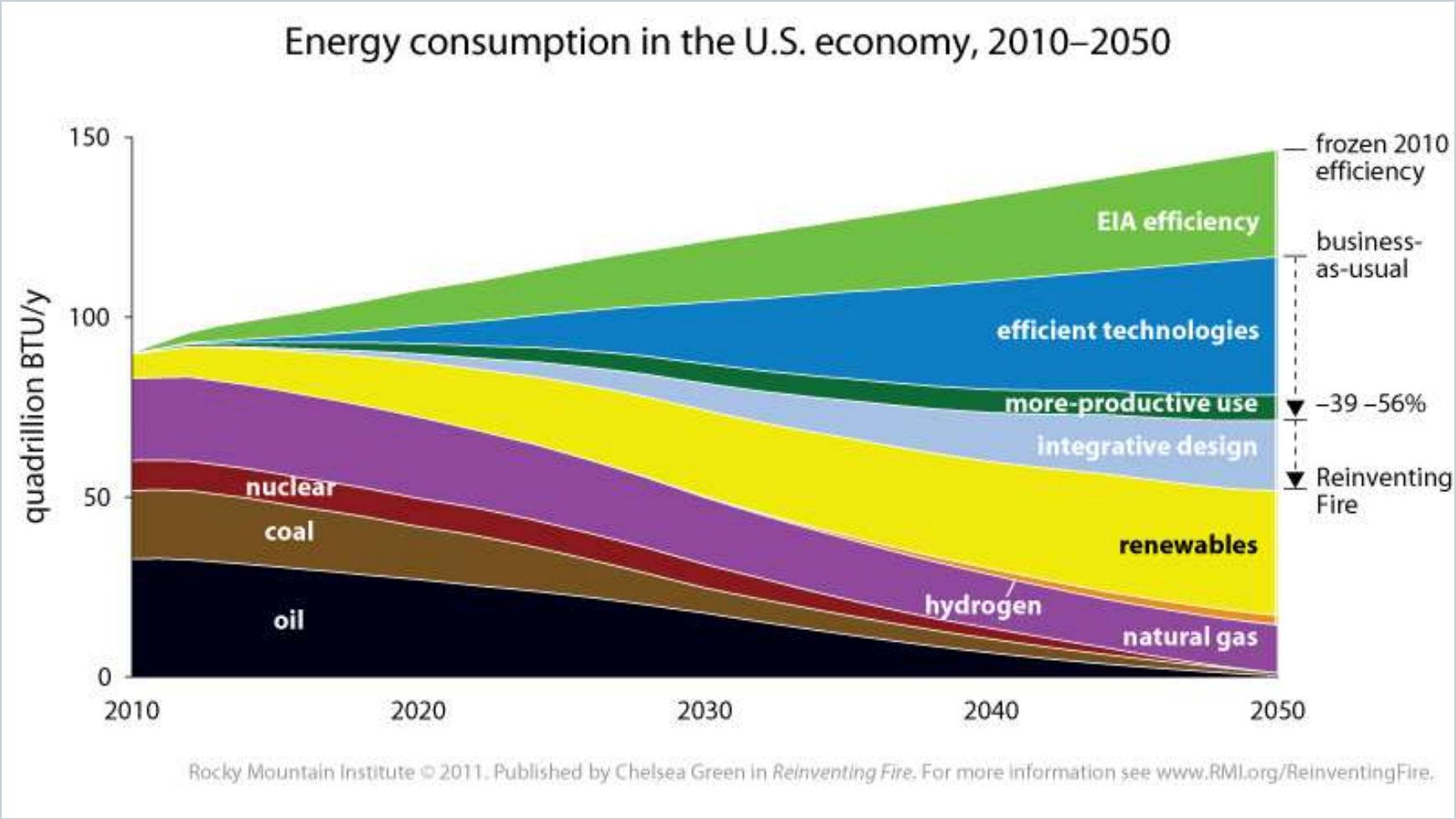
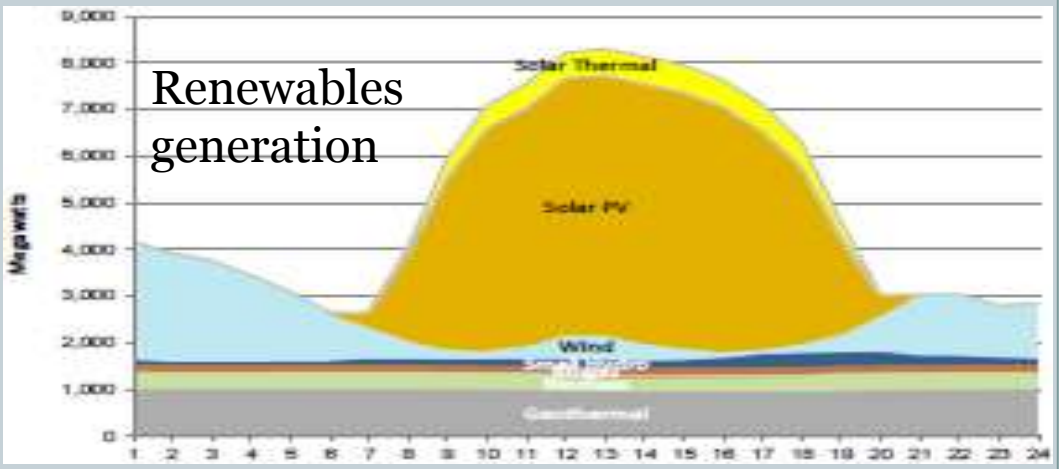
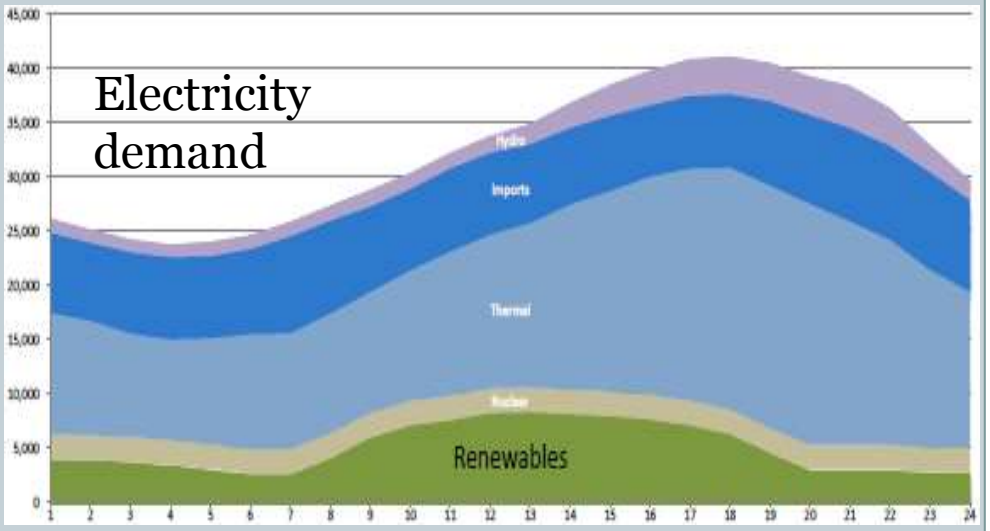


Image From *Reinventing Fire,* Rocky Mountain Institute. (http://www.rmi.org/RFGraph-Energy_consumption_in_US_economy)

Renewables Generation and Demand

- Are the peaks aligned in time? Why/Not?
- How can we schedule renewable resources to meet demand?
- What about carbon reduction?

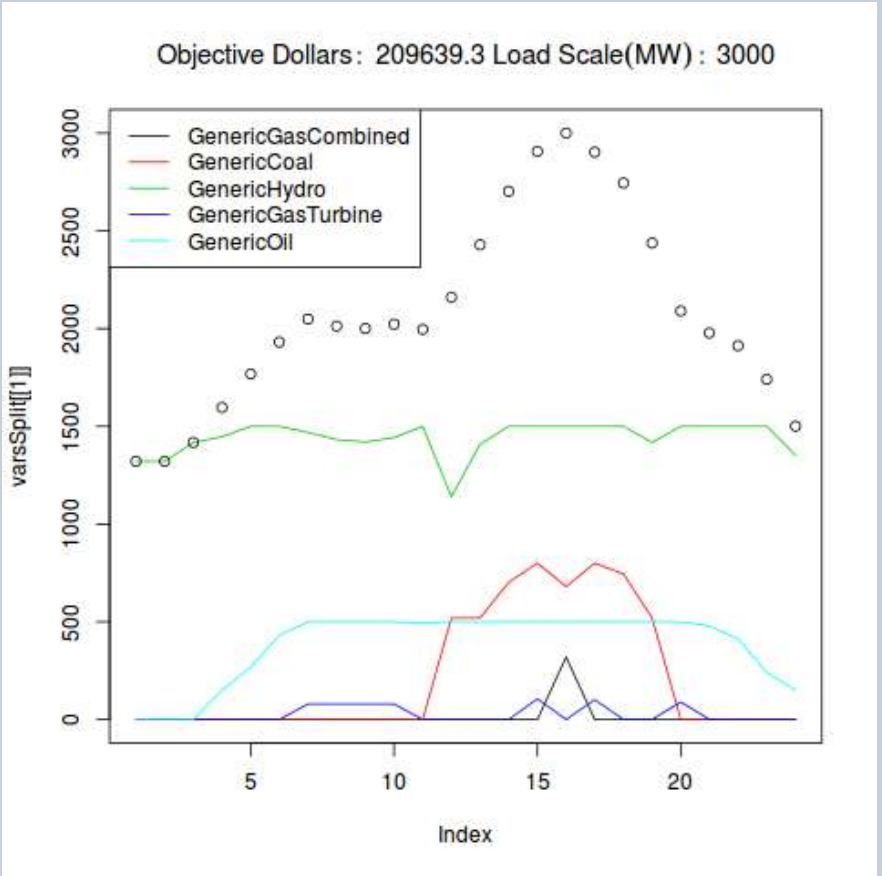




Data for July 28, 2015, from Cal ISO:
http://www.caiso.com/Pages/TodaysOutlook.aspx

The grid of the future: dynamic and optimized

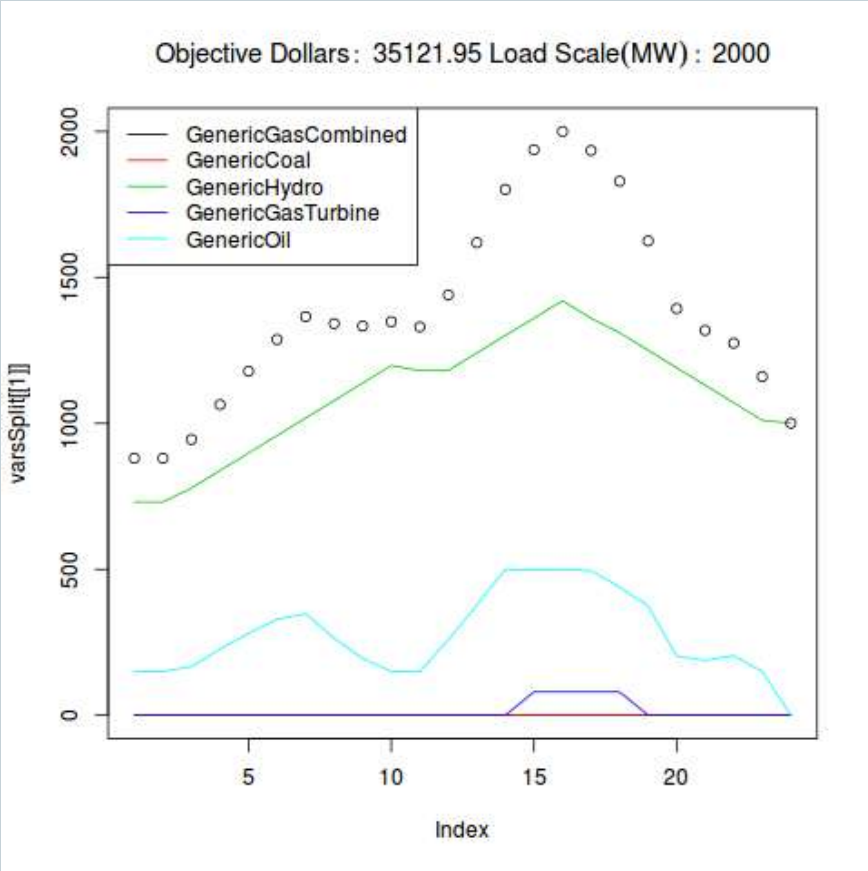
- Improved renewable availability prediction (*day ahead forecast*)
- Dynamic resource dispatch
- Rapid resource curtailment
- Rapid resource ramping
- Carbon and cost aware



Plot using lpsolve in R, dispatch simulation based on Griddle game parameters. – Soneji (2015)

In Griddle: Electricity Simulation Game

- Power plant physical limitations
  - Minimum Output, Maximum Output, Ramping Rates
- Fuel Cost
- Carbon Emissions & Carbon Price



Plot using lpsolve in R, dispatch simulation based on Griddle game parameters. – Soneji (2015)

“Smart” nanomaterials reduce demand

Thin films allow flexible PV solar panel designs for ease of installation

Smart color-changing windows may improve building energy efficiency.

Computers consume large amounts of electricity. Smaller nanodevices of the future may help reduce demand for electricity.

What does the future hold?

- Business as usual vs. technology solutions
- Smart materials development
  - Enable energy efficiency
  - Enable low carbon technologies
- Changes in energy demand
  - Through smarter design and control of everything
  - Dynamic, just-in-time management of energy generation & use
- The challenges are exciting and reinforce the need for engineers and scientists to work with policy makers to help ***reinvent fire****

*The Rocky Mountain Institute cleverly casted this title for the challenge ahead.