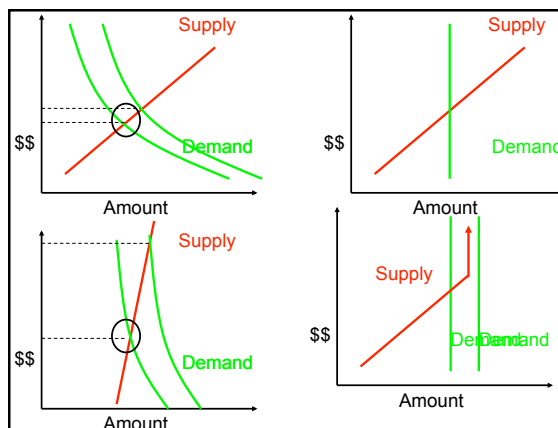
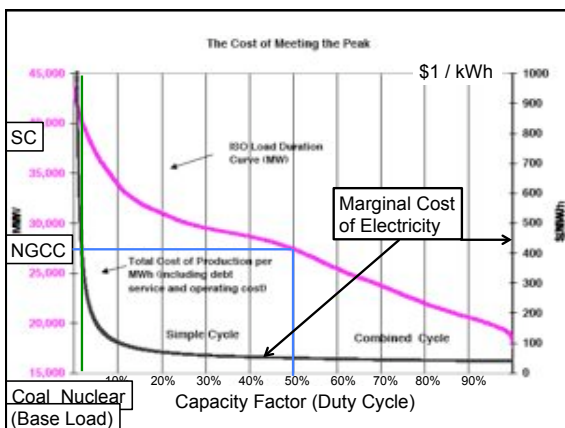
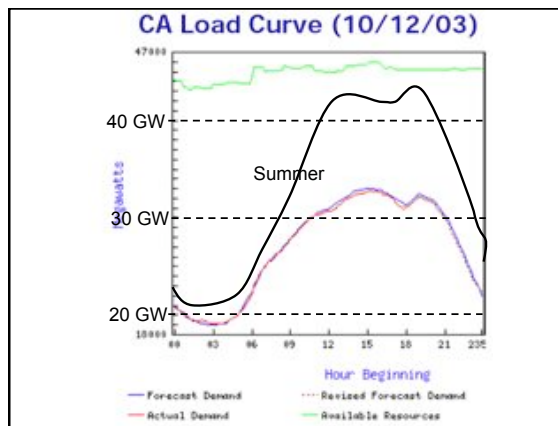


Transmission and profits

- Load Factor = $\frac{\text{average demand}}{\text{peak demand}}$ → revenues
→ costs
- Load factor increases with:
 - Number of consumers
 - Load diversity
- Helps explain why transmission systems tend to be large
- Costs: Generation (45%), Transmission (22%), Distribution (34%)



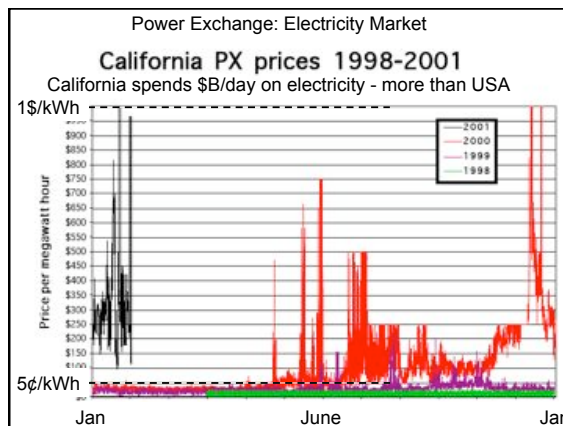
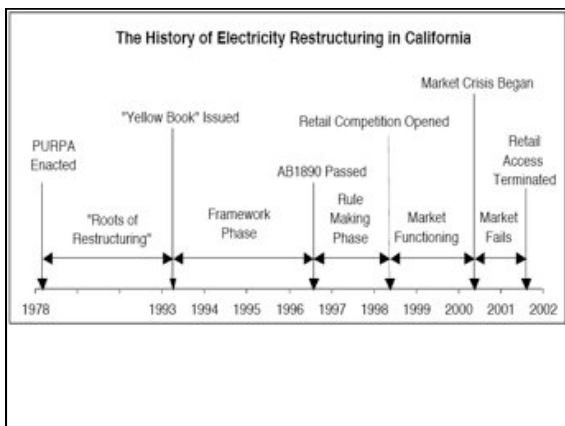
California Energy Crisis

PURPA: (1978) Public Utility Regulatory Policy Act
Deregulation: AB1890, unanimous vote 1996
IOU: Investor Owned Utility, PG&E, SCE
IPP: Independent Power Provider
QF: (Usually IPP) Qualified Facility (ENRON, Reliant)
ISO: Independent System Operator
FERC: Federal Energy Regulatory Commission
CEC: California Energy Commission
PX: Power Exchange, Electricity Market (Now Defunct)
Stranded Assets: past, bad investments that need to be dumped (Diablo)

Market: The capitalist market of free trade
 "The market is strong", "The market works": Society is served
Gaming: Making money by NOT serving society, without breaking the law.
Collusion: Cooperating to undermine society. Getting Caught

PURPA: (1978) Public Utility Regulatory Policy Act
 •Part of the National Energy Act
 •Meant to increase renewable energy use
 •**IOUs (Independently Owned Utilities, Like PG&E) are required to purchase power from a Qualified Facility at avoided cost (marginal cost - next bit of electricity you would produce).**
 •Avoided cost – "Marginal Cost of Electricity"
 • "long run avoided cost" - involves new capital.
 •30% of Cal's electricity was from (~500) QFs. Wind, Diesel, etc.

Deregulation: AB1890, unanimous vote 1996
 •Stranded Costs: \$30-\$60 Billion in Bad Investments
 •**IOU required to sell their power production facilities. LA refused**
 •Frees Utilities from thinking about Power Production
 •**10% discount on retail electricity.** Freezing price below market.

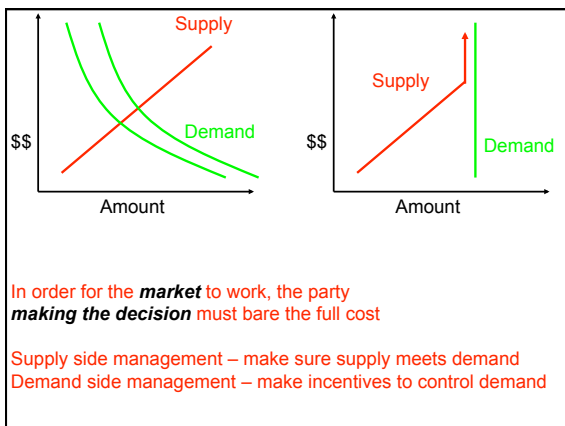


Up to 1994 10% power down for maintenance
 Winter 2001, 38% power down: Collusion.
 Every power producer gets paid the maximum price.
 Producers take turns having "maintenance outages".
 Governor Davis decides that we are GOING to not have blackouts. We will buy the energy. Allowed crisis to continue.

Blackouts in the Winter!
 Duane: Seize power producers by eminent domain.
 FERC - didn't stop this, trying to help us recover money.
 ENRON - not the only gougers.
 LA!!!

The Smoking Gun:
All from ENRON internal documents

- Death Star:** Enron would overschedule its expected power transmissions to create the illusion that the state's grid would be overloaded, then receive state payment for "relieving" the congestion. The beauty of this con, the company's memos noted, is that "Enron gets paid for moving energy to relieve congestion without actually moving any energy or relieving any congestion."
- Fat Boy:** This scam (aka "Inc-ing") also involved over-scheduling power transmission -- for example, to a company subsidiary that didn't really need all of it. Then Enron would sell the "excess" power to the state at a premium.
- Ricochet:** Also called "megawatt laundering". Ricochet was the power equivalent of a real-estate land flip: buy in-state power cheaply, flip it out-of-state to an intermediary, then re-sell it to California at a highly inflated "imported" price.



People were asked to voluntarily decrease power use.
 20/20: 20% reduction for 20% rebate.

Reduction in Monthly 2001 Electricity Use									
	Jan.	Feb.	March	April	May	June	July	August	Sept.
Expected (MW)	33,743	32,195	32,233	31,888	34,657	39,637	41,599	42,528	39,480
Actual (below expected) (MW)	-2,091	-2,578	-2,967	-2,866	-3,595	-5,570	-4,455	-3,796	-3,163
Decrease (%)	-6.2	-8.0	-9.2	-9.0	-10.4	-14.1	-10.7	-8.9	-8.0

Flex your POWER It Only Takes a Little Energy to Save A Lot

http://www.energy.ca.gov/electricity/peak_demand_reduction.html

Will Americans learn to love 'smart grid'?
By PHIL DANCO, Greenwire
 Published: February 27, 2008

General Electric Co. splurged on a \$3 million Super Bowl ad this year to promote "smart grid" technology in hopes that a singing scarecrow bouncing around a high-voltage transmission tower might get viewers away from the beer and dip to think for just 30 seconds about electricity.

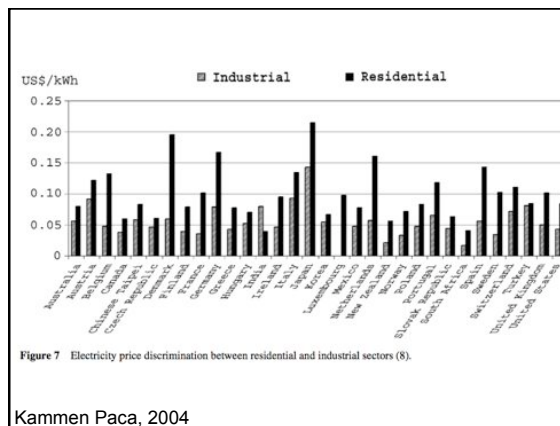
The commercial was the energy

Smart Grid = real time pricing + two way communication + Control DR: Demand Response – Demand Side Management
 Shifting Load, Shedding Load
 ISO can turn on facilities, can turn off consumers (with agreement)

Green Inc.
 A blog about energy, the environment and

The party making the decision must knowingly bare the full cost in order for the market to work

Smart grid is considered crucial for utilities, environmentalists and government officials embarking on what they hope will be a revolution in energy generation and distribution. With the new federal stimulus law packing \$11 billion for smart grid technology, including \$4.5 billion for smart-technology matching grants, the revolution is about to begin.



In order for the market to work, the party making the decision must bare the full cost

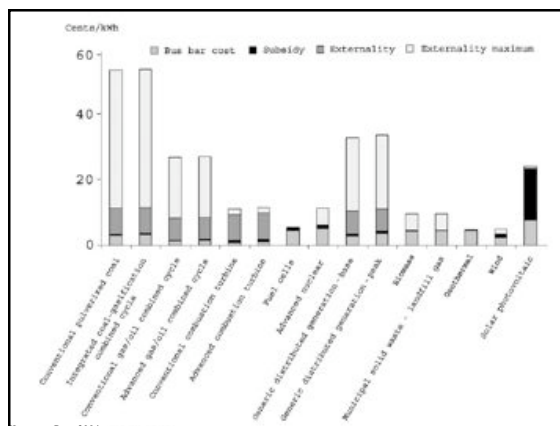
Actions undermining the free market: Subsidies, External Costs
 The decision maker (the consumer) don't bare the full costs.

External Costs: Costs not paid by the consumer, and are often invisible...

- 1) Pollution,
- 2) Opportunity Costs,
- 3) Loss of "Carrying Capacity", or "Ecosystem Services"

"Why am I paying you to turn my daughter's petroleum into CO₂ and criteria pollutants in her atmosphere?"

Full Societal Costs of petroleum... ~ \$15 / gallon?



Price distortions - subsidies

- Most recently, the federal government has contributed nearly \$3 billion to the development of new coal-burning technologies through the Clean Coal Technology Program.
- Renewable energy industry is today fighting to maintain a \$300 million annual federal R&D budget for all renewable energy technologies combined⁽³⁾
- Another recent analysis, estimates that ratepayers nationwide will incur costs of \$14.8 billion because of above-market, long-term coal contracts between electric utilities and coal producers⁽⁴⁾

(3) U.S. Energy Information Administration, Annual Energy Outlook 1997 with Projections to 2010, DOE/EIA-0263(96), January 1997.
 (4) North American Electric Reliability Council, Generating Cost Statistics 1990-1994, June 1995.
http://www.nerc.gov/energy/annual_prices/need.html

Lecture 9: Energy Markets, Crisis, Smart Grid
 Pete Schwartz, Cal Poly Physics

- 1) How did companies (especially Enron) "game" the state of California (to the tune of \$40 B) in 2001?
- 2) How did the government make the energy crisis possible?
- 3) What is "Dynamic Electricity Pricing"? How might this have prevented the crisis?
- 4) What are the challenges in introducing Dynamic Electricity Pricing?