EEPS 517
Energy Crises

(and the World of Energy)

Lecture 5 – California and Enron : Crisis of markets

Barış Sanlı
Bilkent University – EEPS Program

Week 5

Week 1 – Overview and Course outline

Week 2 – Coal transition in UK & Timber crises in US

Week 3 – Oil Crisis of 1973-74

Week 4 – Oil Crisis of 1979-1980

Week 5 – California electricity crisis & Enron

Week 6 – German Energiewende

Week 7 – Australian Energy Crisis: Blackouts, Renewables and Storage systems* (may shift)

Week 8 - Chernobyl to Fukushima: Nuclear accidents and their aftermath

Week 9 - Natural gas disruptions and European experience

Week 10 - Forces of Nature: Hurricanes, Pandemics, Volcano Eruptions, Sun

Week 11- Climate Change

Week 12 - Turkey’s energy crises and shaping of present energy system

Week 13 - Analytical methods : Building up scenarios, structured analysis and crisis management

Week 14 – Making of the next crisis

Reading List and Resources

Reading:

Great Expectations (Electricity Restructuring in the United States: Markets and Policy from the 1978 Energy Act to Present, Steve Isser, 2015)
Darkness, Darkness (Electricity Restructuring in the United States: Markets and Policy from the 1978 Energy Act to Present, Steve Isser, 2015)
California and Market Power (Electricity Restructuring in the United States: Markets and Policy from the 1978 Energy Act to Present, Steve Isser, 2015)
Stresses (From Edison to Enron, Richard Munson, 2005,Chapter 6. Stresses)
Chapter 8. Energy Trading Strategies in California: Market Manipulation? (Obtaining the Best from Regulation and Competition, Editors: Michel A. Crew, Michael A. Crew, Menahem Spiegel, Michael DeCesaris, Gregory Leonard, J. Douglas Zona)

Supplementary:

Powering The Past: A Look Back , https://americanhistory.si.edu/powering/backpast.htm

Energy Society Environment http://sharedcurriculum.peteschwartz.net/energy-society-environment/

Dieter Helm Talks http://www.dieterhelm.co.uk/helm-talks/

Overview

- A bit of review
- History
- What electricity markets are?
- Terms
  - Pricing
  - Market power
- What are the lessons?
- Student presentations (not included)
- Quiz (as usual)

Why?

- Electricity is the future
- Electricity markets are different
- California Energy Crisis is a game changer
- There are lessons to be learned
- About market design failures leading to crisis

2001 and recently

PG&E Files for Bankruptcy / $9 billion in debt, firm abandons bailout talks with state

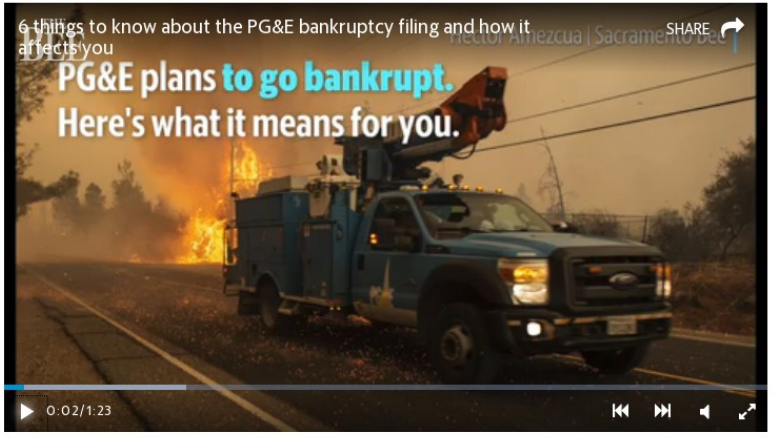
David Lazarus, Chronicle Staff Writer Published 4:00 am PDT, Saturday, April 7, 2001

Pacific Gas and Electric Co., its debts increasing by $300 million a month, filed for bankruptcy in San Francisco yesterday after deciding that bailout talks with Gov. **Gray Davis** were on the verge of collapse.

> The bankruptcy filing -- the third-largest in U.S. history -- does not affect the utility's parent company, PG&E Corp., or any other PG&E division.

PG&E is going bankrupt. What that means for ratepayers, wildfire survivors

BY DALE KASLER, TONY BIZJAK, SOPHIA BOLLAG, AND ALEXEI KOSEFF
JANUARY 15, 2019 03:00 AM, UPDATED JANUARY 15, 2019 08:09 AM



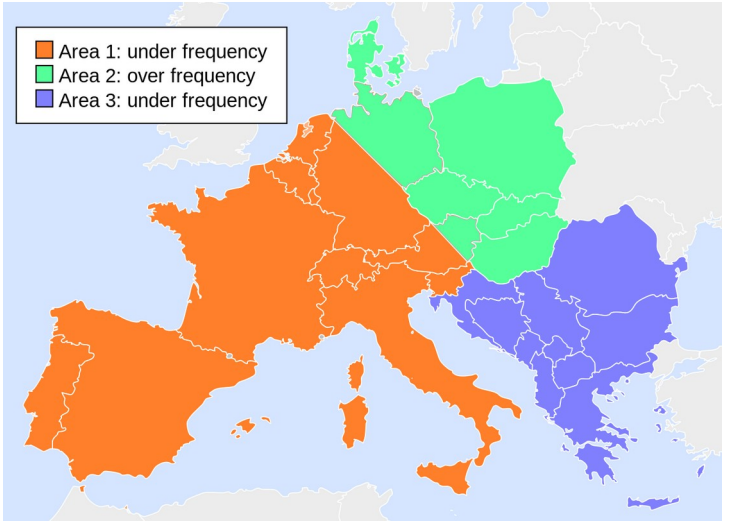
PG&E is about to go bankrupt. Will the troubled utility keep the lights on as it finds a resolution of the billions of dollars it faces in potential liabilities from the Camp Fire and the wine country wildfires.
BY DAVID CARACCIO | HECTOR AMEZCUA

In a dramatic but not unexpected move, PG&E revealed on Monday it will file for bankruptcy in a desperate bid to sort out the estimated $30 billion in claims it's facing from Northern California's wildfires. The Chapter 11 filing will begin years of uncertainty for millions of Californians, from ratepayers all the way up to new Gov. Gavin Newsom.

https://www.sacbee.com/news/business/article224525395.html

Blackouts happen

- India – 2012 – 700 million people (30-31 July)
- Europe – 2006 – (4 November)



Indian states

Affected 2 days by the power outages (on 30 and 31 July)

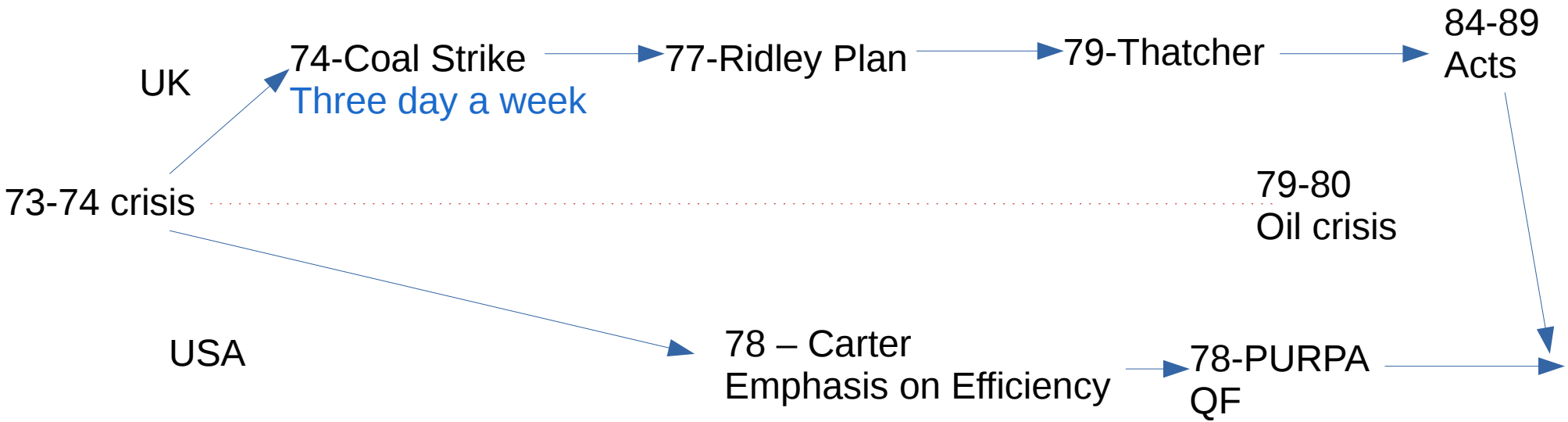
Affected 1 day by the power outages (on 31 July)

Date	02:48, 30 July 2012 (+05:30)- 20:30, 31 July 2012 (+05:30)
Location	North, East and Northeast India

https://en.wikipedia.org/wiki/2012_India_blackouts

https://www.power-technology.com/features/featurethe-10-worst-blackouts-in-the-last-50-years-4486990/

Historical notes



UK - Coal Strikes

- High oil prices → high inflation
- Wages ???
- Three day a week (1 Jan 1974-7 March 1974)

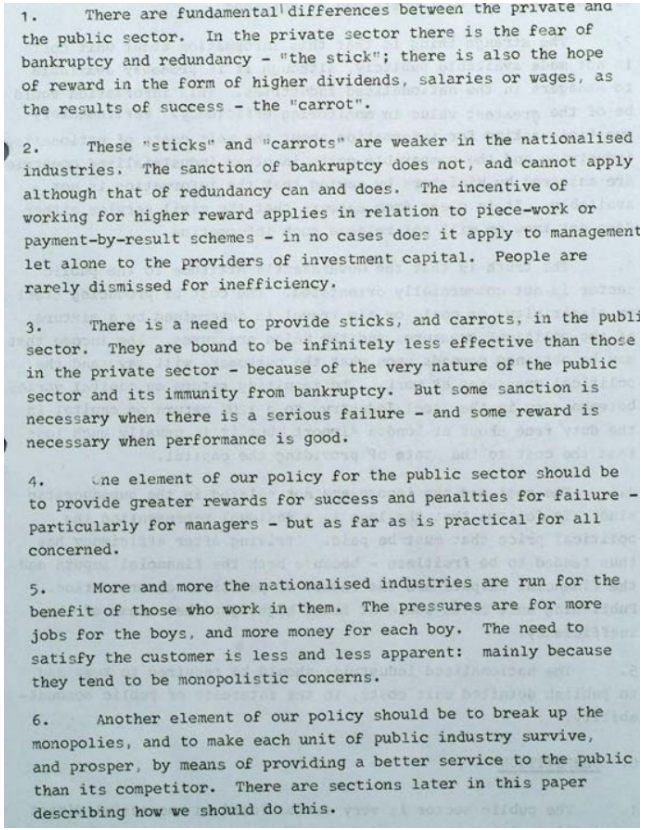
UK – Before oil crisis

- British Gas from 1972
- Electricity: in England and Wales, the Central Electricity Generating Board (for generation and transmission) and 12 area Boards (for transmission) from 1957
- Water: from 1973, in England and Wales, 10 water authorities
- Telecommunications: the Post Office before 1981 and BT (BritishTelecommunications) from 1981

Mark Thatcher (1998) Institutions, regulation, and change: New regulatory agencies in the British privatised utilities, West European Politics, 21:1, 120-147, DOI: 10.1080/01402389808425235

1977 – Ridley Plan

- Report of Nationalised Industries Policy Group (leaked Ridley report)



1. There are fundamental differences between the private and the public sector. In the private sector there is the fear of bankruptcy and redundancy - "the stick"; there is also the hope of reward in the form of higher dividends, salaries or wages, as the results of success - the "carrot".

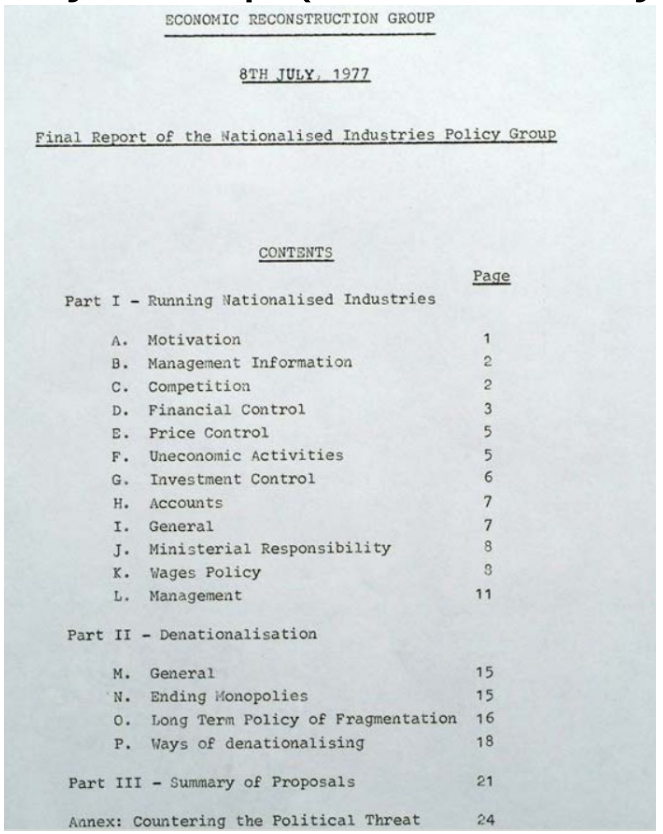
2. These "sticks" and "carrots" are weaker in the nationalised industries. The sanction of bankruptcy does not, and cannot apply although that of redundancy can and does. The incentive of working for higher reward applies in relation to piece-work or payment-by-result schemes - in no cases does it apply to management let alone to the providers of investment capital. People are rarely dismissed for inefficiency.

3. There is a need to provide sticks, and carrots, in the publi sector. They are bound to be infinitely less effective than those in the private sector - because of the very nature of the public sector and its immunity from bankruptcy. But some sanction is necessary when there is a serious failure - and some reward is necessary when performance is good.

4. One element of our policy for the public sector should be to provide greater rewards for success and penalties for failure - particularly for managers - but as far as is practical for all concerned.

5. More and more the nationalised industries are run for the benefit of those who work in them. The pressures are for more jobs for the boys, and more money for each boy. The need to satisfy the customer is less and less apparent: mainly because they tend to be monopolistic concerns.

6. Another element of our policy should be to break up the monopolies, and to make each unit of public industry survive, and prosper, by means of providing a better service to the public than its competitor. There are sections later in this paper describing how we should do this.



ECONOMIC RECONSTRUCTION GROUP

8TH JULY, 1977

Final Report of the Nationalised Industries Policy Group

CONTENTS

https://www.margaretthatcher.org/document/110795

Thatcher era

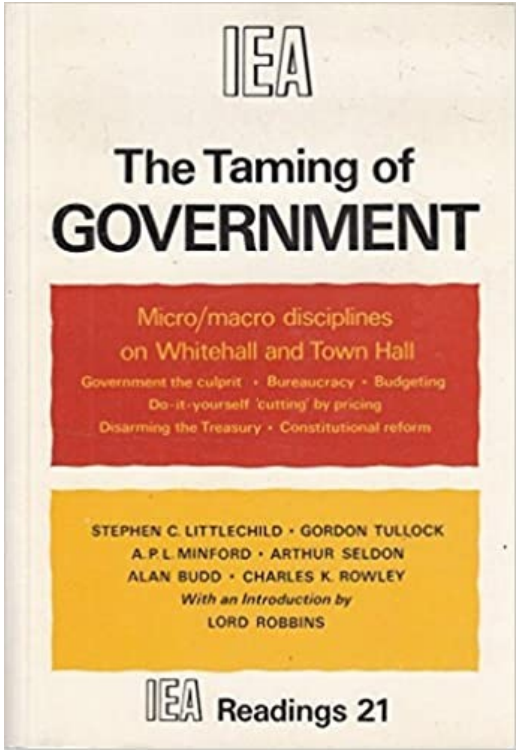
- 84-85 Coal strike
- Ridley plan
  - The government should if possible choose the field of battle.
  - Industries were grouped by the likelihood of winning a strike; the coal industry was in the 'middle' of three groups of industries mentioned.
  - Coal stocks should be built up at power stations.
  - Plans should be made to import coal from non-union foreign ports.
  - Non-union lorry drivers to be recruited by haulage companies.
  - Dual coal-oil firing generators to be installed, at extra cost.

New Acts and Institutions

the Telecommunications Act 1984;
the Gas Act 1986;
the Electricity Act 1989;
the Water Act 1989;
the Water Industry Act 1991;
the Water Resources Act 1991;
the Competition and Service (Utilities) Act 1992;
the Environment Act 1995;
the Gas Act 1995.

- Telecommunications: the Director General of Telecommunications (DGT) heading **Oftel** (the Office of Telecommunications);
- Gas: the Director General of Gas Supply (DGGS), heading **Ofgas** (the Office of Gas Supply);
- Electricity: the Director General of Electricity Supply (DGES), heading **Offer** (the Office of Electricity Regulation);
- Water: the Director General of Water Services (DGWS) heading **Ofwat** (the Office of Water Services).

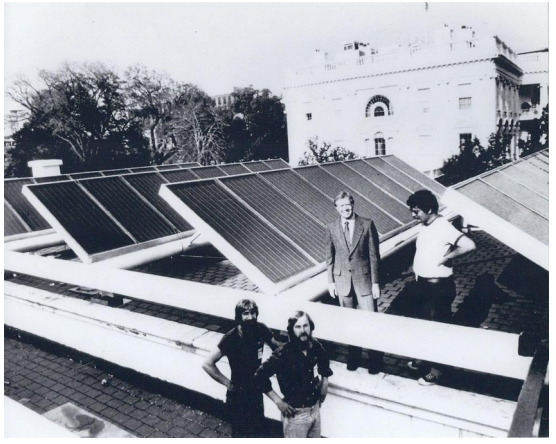
Stephen Littlechild



https://www.eprg.group.cam.ac.uk/tag/s-littlechild/

US

- After Nixon and Ford → 1977 Jimmy Carter
  - “energy independence”
  - Promotional rate structures (Demand + , rate ---)
- November 1978, the Public Utility Regulatory Policies Act (PURPA)

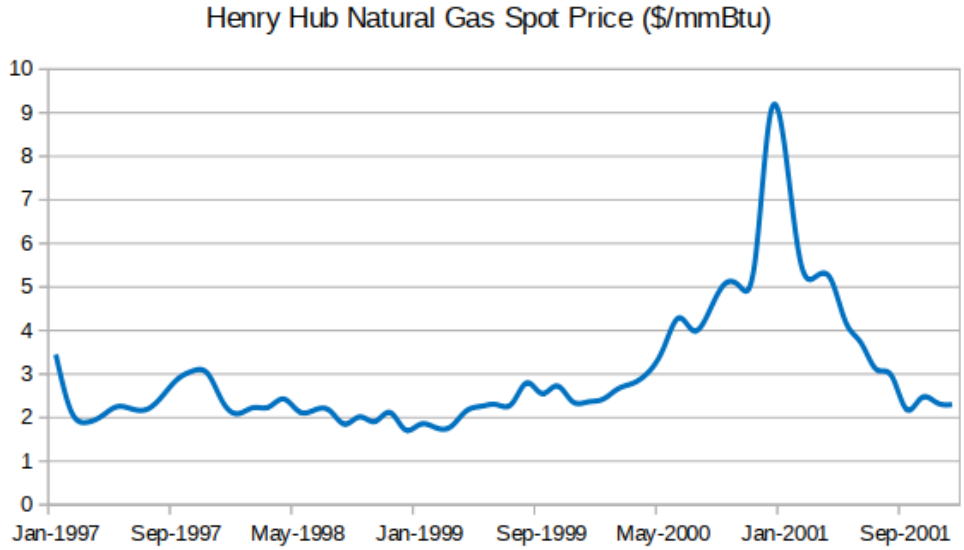


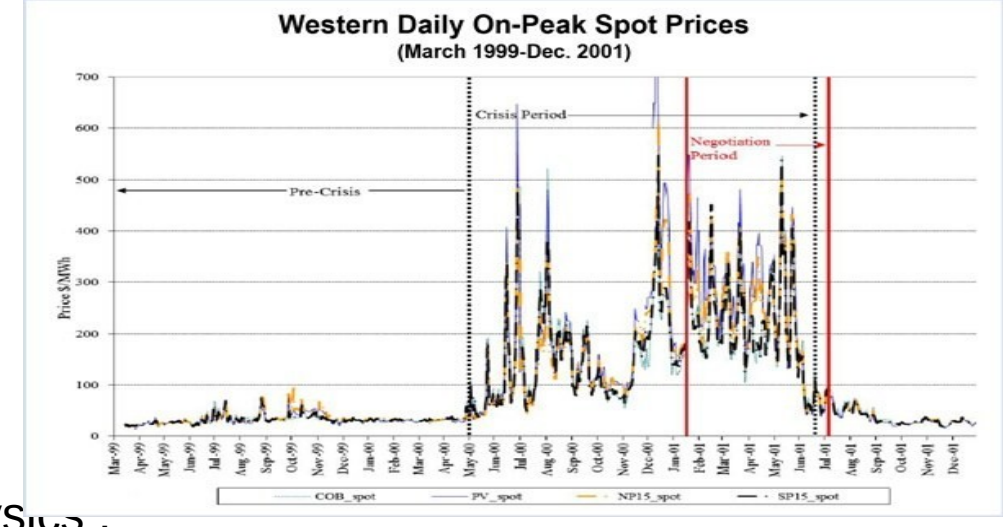
PURPA

- Public Utility Regulatory Policies Act – 1978
- Aftermath of 1973-1974 oil crisis
- QF: Qualifying Facility
  - Small power production facility (limited size <80 MW)
  - Cogeneration facilities

https://www.ferc.gov/industries/electric/gen-info/qual-fac/benefits.asp

WEC from 3 Perspectives

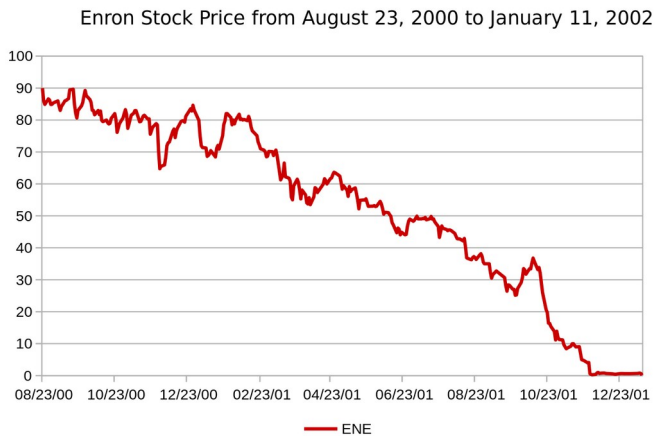




9b California Energy Crisis; Schwartz Cal Poly Physics ;
https://www.youtube.com/watch?v=SC5mAZg2SN4

Enron

- 1985 – Houston Natural gas + Internorth
- FERC 1985->1986->1988 deregulated gas pricing



ARTHUR ANDERSEN

ENRON

QF

- Avoided cost

  "QFs generally have the option of selling to a utility either at the utility's avoided cost or at a negotiated rate"

- Stranded costs
  - From utility side
- retail wheeling

  - "means the process of moving third party electricity from a point of generation across the distribution systems of the municipality and selling it to a customer"

  https://www.lawinsider.com/dictionary/retail-wheeling

Theoretical Part

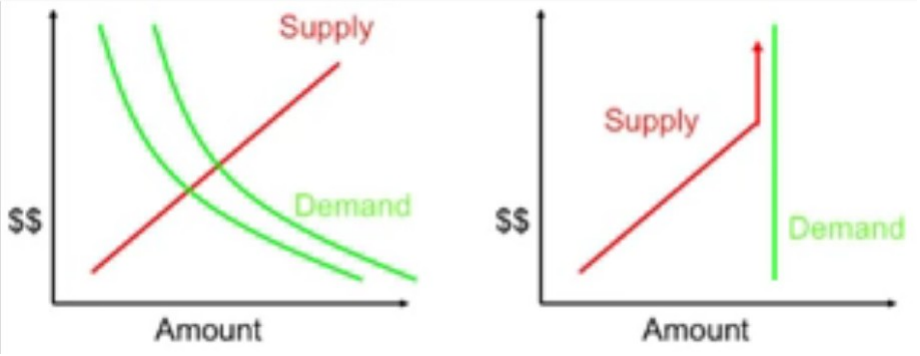
Basic Rules

- Markets are social institutions
- Electricity markets are social constructs with physical links
- Electricity markets do not just happen overnight, they are made in years

“A crisis of a social construct?”

Problems with Electricity

- Had to be Real Time
  - Based on frequency
- Storage not common
  - Pumped hydro
- Super-interlinked
  - Momentarily impact of linkages
    - Wind, solar, lines, demand
- Demand not flexible
  - Real time price signal ~

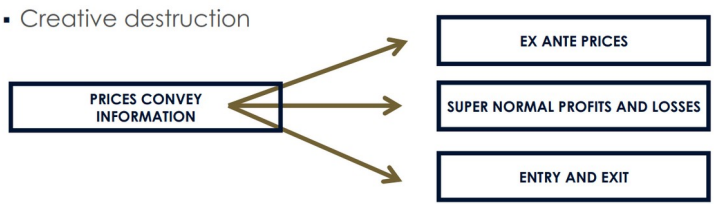


What is the normative view?

- Like a bazaar
- Buyers & sellers meet and exchanges happen
- Find the price from survey?
- Hourly tomato prices?
  - Hourly volume of sales
  - Closing exchanges
  - Price discovery

Philosophy

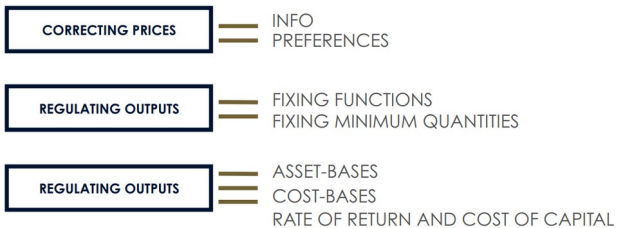
- Neoclassical (“Market failure)
  - Perfectly competitive market
- Austrian
  - Competition is dead in PCM
  - No supply and demand function to be drawn
  - Trial&error – “Creative destruction”
- Asset based & systems
  - Core infrastructure
  - Non-marginal analysis

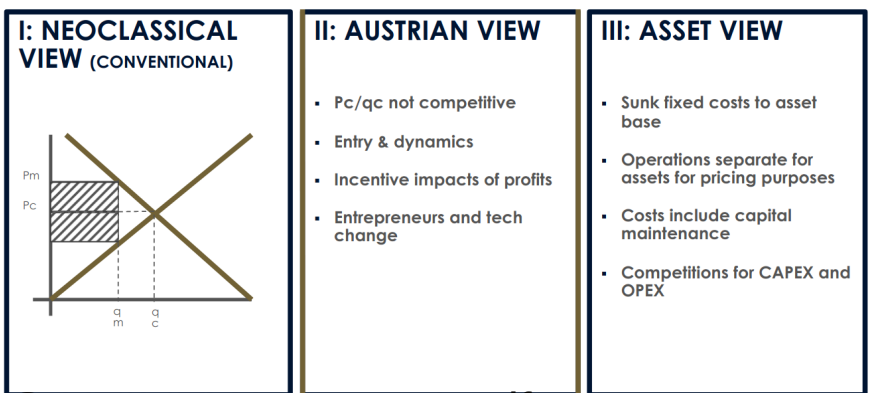


http://www.dieterhelm.co.uk/helm-talks/utilities/

Problems and corrections

- Time inconsistency
- Monopoly&Market Power
- Externatilites and Env Impacts
- Informational failures





http://www.dieterhelm.co.uk/assets/Uploads/HELM-TALKS-UTILITY-Lecture-1.pdf

Pricing in electricity markets

- Cost / Price/ Value different
- Rates
  - Price/Revenue cap, Rate of return, WACC, RPI-X, RIIO
- Wholesale (~ auction)
  - Pay-as-bid, marginal price, uniform price
- Willingness to Pay/Willingness to Accept
  - Asymmetric

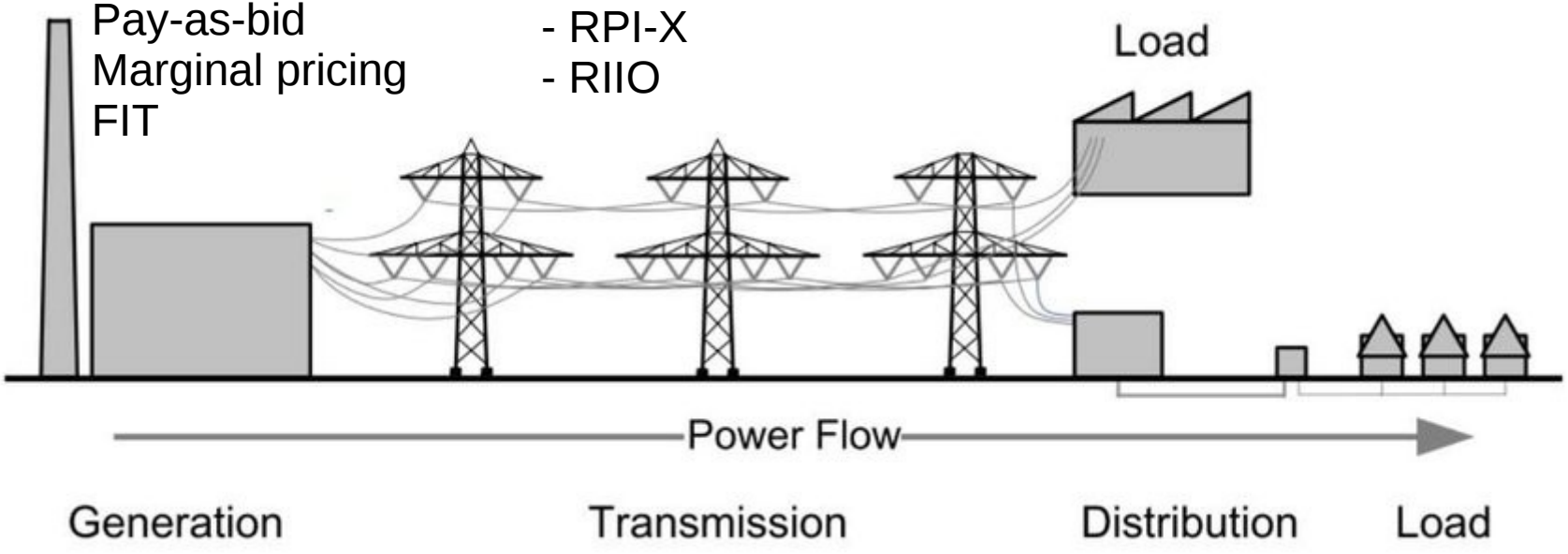
RIIO (Revenue=Incentives+Innovation+Outputs)

Traditional System view

Rate
- Price/Revenue cap
- Rate of return
- RPI-X
- RIIO

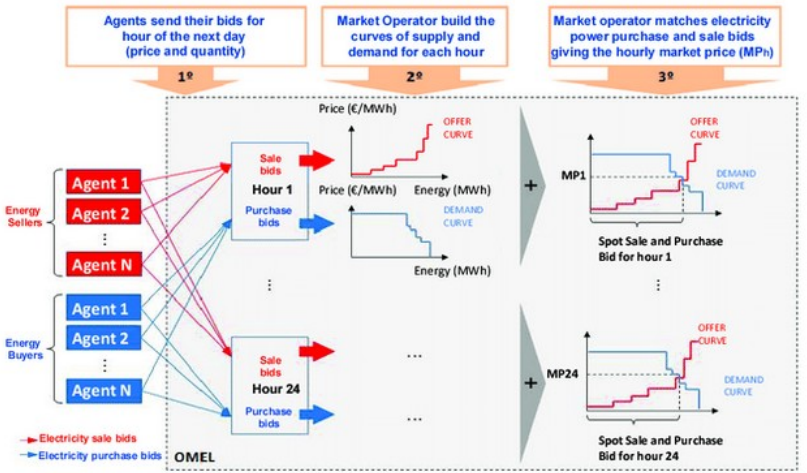
Rate:
- Retail / tax / network charges

Pay-as-bid
Marginal pricing
FIT



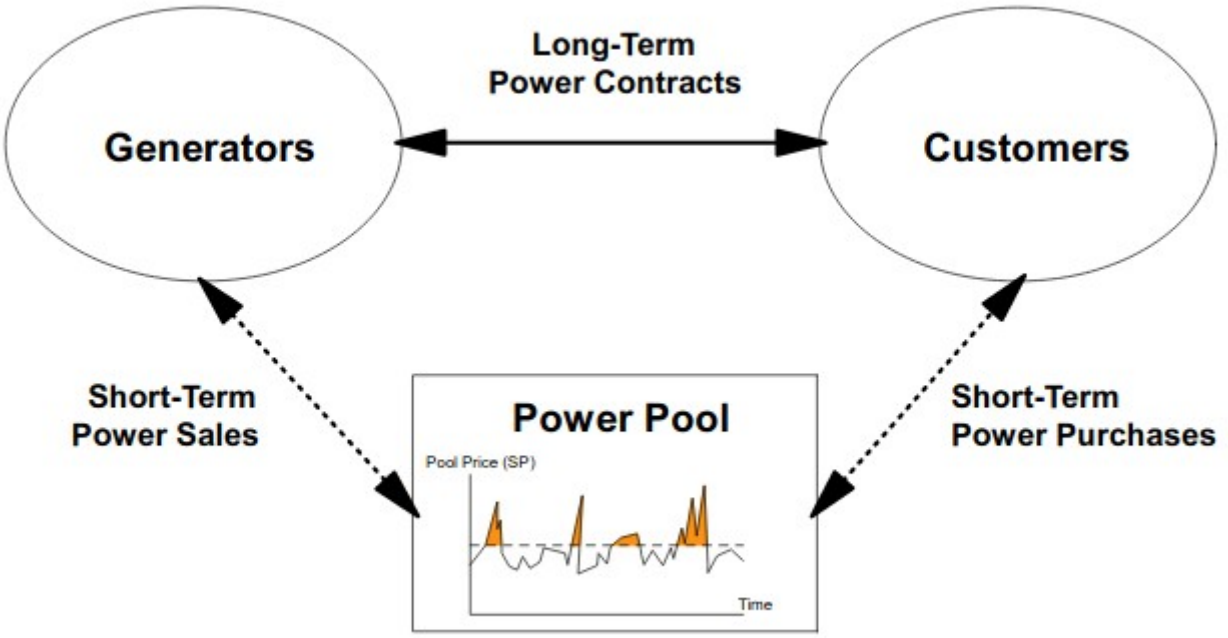
Different prices

- Classical model
  - Day ahead price
  - System Marginal Price
  - Ancillary services
  - Congestion charges
  - Capacity prices



https://www.researchgate.net/figure/Locational-marginal-price-formation-in-the-day-Ahead-spot-market_fig17_291757206

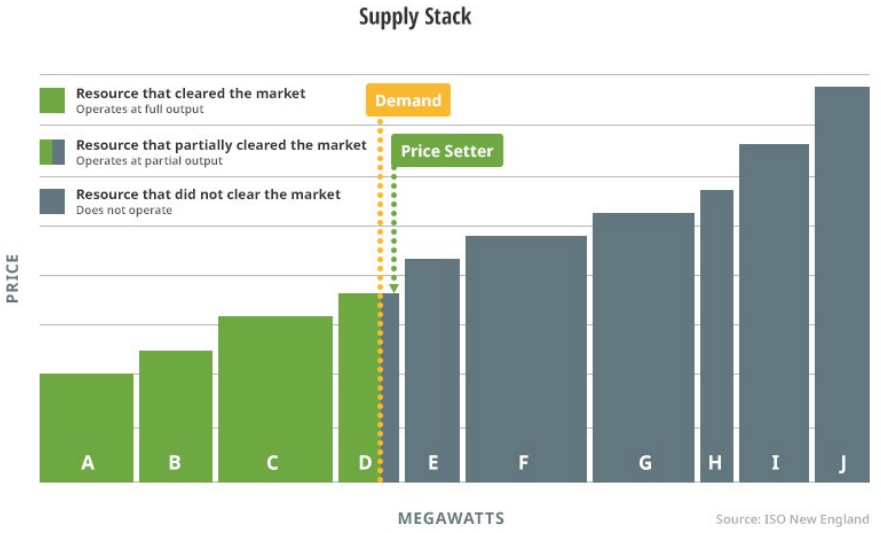
Different contract lengths



https://media.rff.org/documents/170914_PowerMarkets_WilliamHogan.pdf

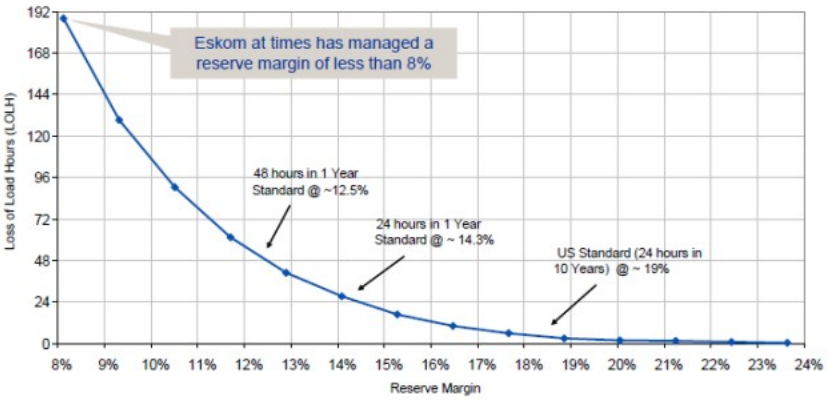
Marginal price

- Price at the margin
- 3 generators
  - 10 MW each
  - Bids (costs): 5, 7, 8 c/kWh
- What is the market price?
  - 4 MW
  - 14 MW
  - 29 MW



Pool pricing in the UK (very old)

- Pool input price
- Pool output price
- pip = energy + capacity adjustment
- SMP : System Marginal Price
- Loss of Load Probability
- VLL : Value of loss load (100xaverage price)
- pip = SMP + LOLP (VLL - SMP)



Inelastic demand

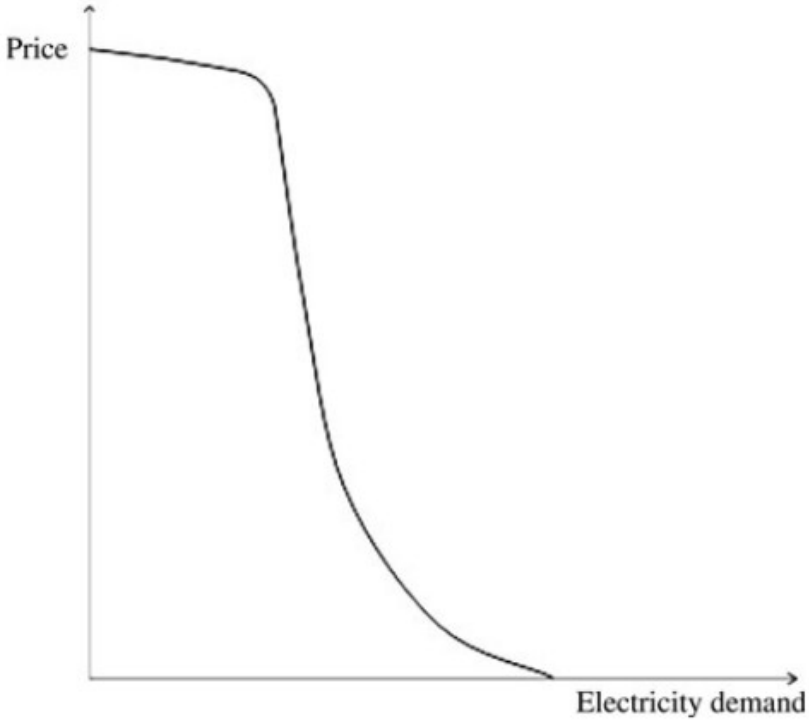


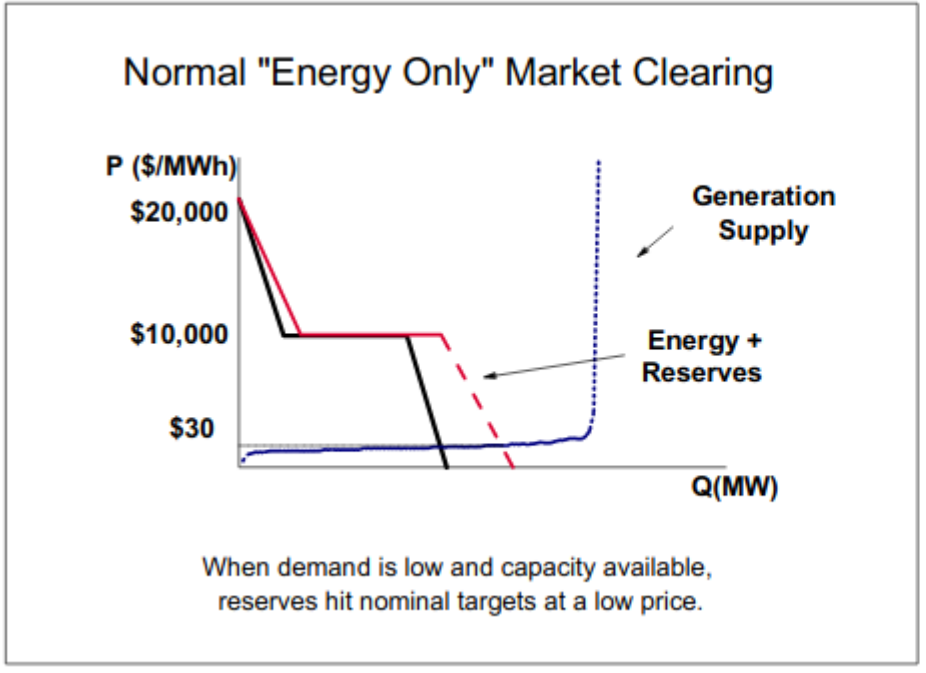
Table 2.1 Summary of price elasticity estimates (adapted from USDOE [9])

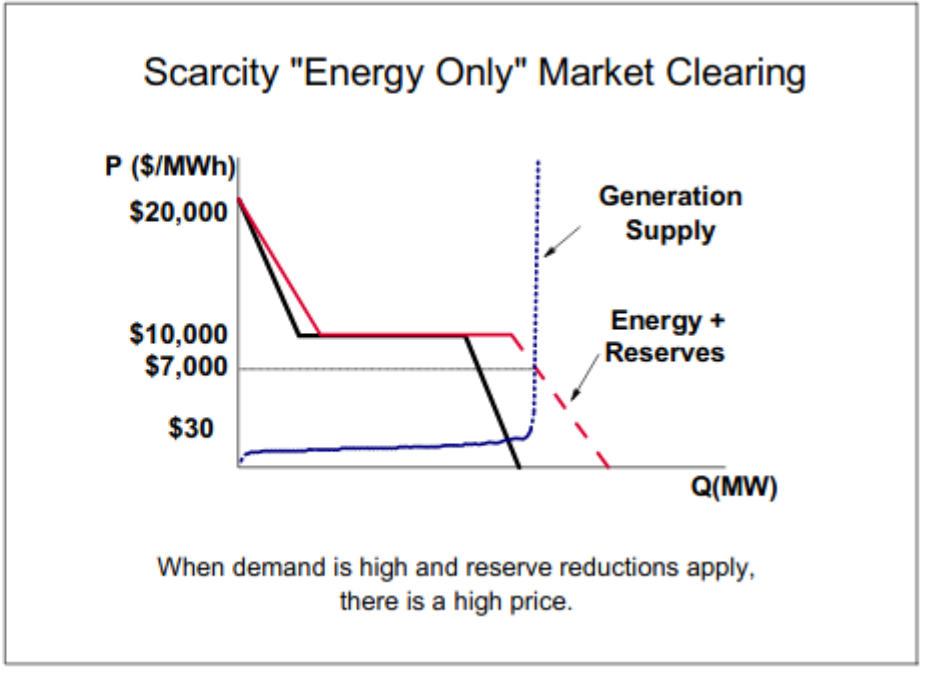
Target customers	Type of programme	Own price elasticity	Elasticity of substitution	Region
Residential (and small commercial)	TOU		0.07 to 0.21 (0.14 average)	US
	TOU/CPP	−0.1 to −0.8 (−0.3 average)		US-international
	CPP		0.04 to 0.13 (0.09 average)	California
	RTP	−0.05 to −0.12 (average −0.08)		Illinois
Medium or large commercial and industrial		−0.01 to −0.28		Georgia
		−0.01 to −0.27		UK
		<−0.01 to −0.38		N–S Carolina
			0.10 to 0.27	Southwest US
			0.02 to 0.16 (0.11 average)	New York

Regulation of the Power Sector, Ignacio J. Pérez-Arriaga(Editor)

Missing money

- ‘Early market designs presumed a significant demand response. Absent this demand participation most markets implemented inadequate pricing rules equating prices to marginal costs even when capacity is constrained. This produces a “missing money” problem.’ (Joskow, 2008)





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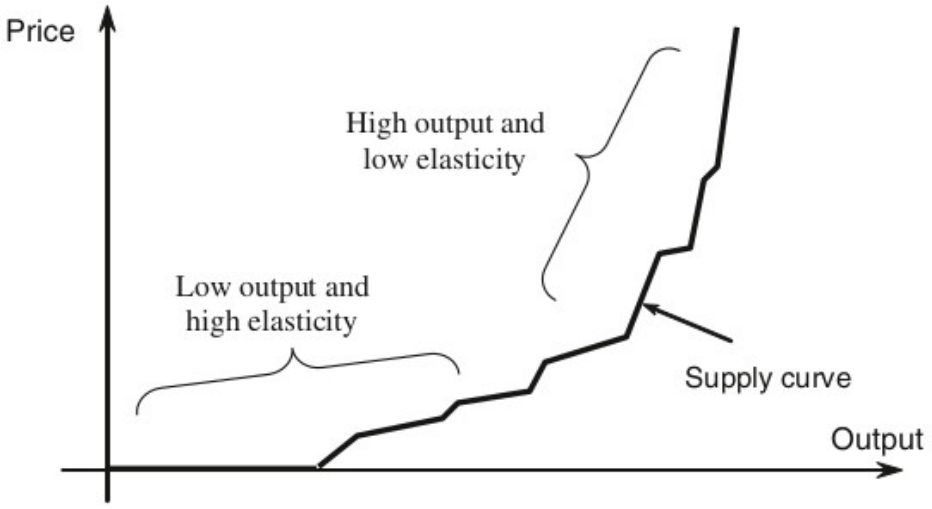
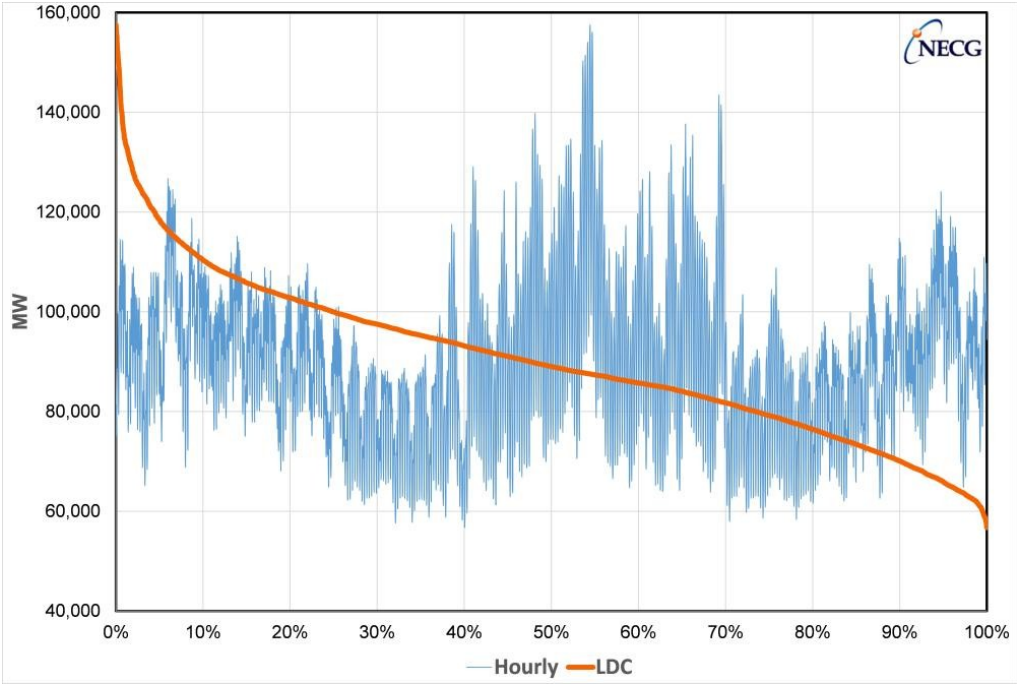
Supply

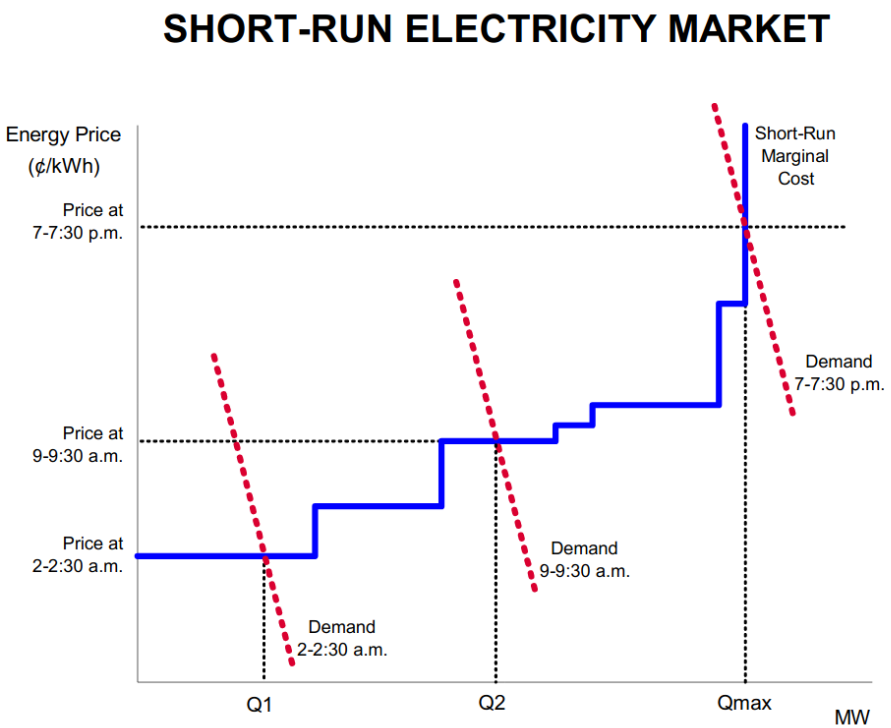


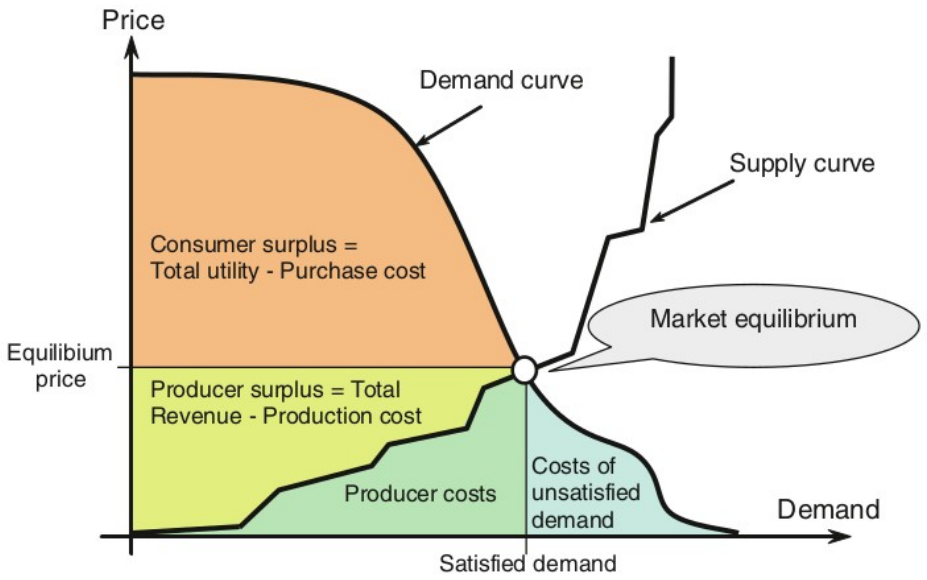
Typical electricity supply curve in the short term



Regulation of the Power Sector, Ignacio J. Pérez-Arriaga(Editor)

Supply & Demand





Equilibrium between electricity supply and demand in the short term

Regulation of the Power Sector, Ignacio J. Pérez-Arriaga(Editor),
https://media.rff.org/documents/170914_PowerMarkets_WilliamHogan.pdf

Market power – Different Definitions

- OECD: "Market power refers to the ability of a firm (or group of firms) to raise and maintain price above the level that would prevail under competition is referred to as market or monopoly power. The exercise of market power leads to reduced output and loss of economic welfare. "
- US FTC : "market power as the ability of a single or several competing firms to set prices above their competitive level or consistently withhold supply to raise prices for their own benefit for a given period of time"
- EU : "dominant position", "'a position of economic strength enjoyed by an undertaking which enables it to prevent effective competition being maintained on the relevant market by giving it the power to behave to an appreciable extent independently of its competitors, customers and ultimately of its consumers'

Gaming, manipulation, fraud

- Gaming: "behaviour that circumvents or takes unfair advantage of Market Rules or conditions in a deceptive manner that harms the proper functioning of the market and potentially other market participants and consumers" (FERC)
- Fraud: Fraud is a question of fact and is defined generally “to include any action, transaction, or conspiracy for the purpose of impairing, obstructing or defeating a well-functioning market.”

§1c.2 Prohibition of electric energy market manipulation.

(a) It shall be unlawful for any entity, directly or indirectly, in connection with the purchase or sale of electric energy or the purchase or sale of transmission services subject to the jurisdiction of the Commission,

(1) To use or employ any device, scheme, or artifice to defraud,

(2) To make any untrue statement of a material fact or to omit to state a material fact necessary in order to make the statements made, in the light of the circumstances under which they were made, not misleading, or

(3) To engage in any act, practice, or course of business that operates or would operate as a fraud or deceit upon any entity.

(b) Nothing in this section shall be construed to create a private right of action.

https://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=5526e11f6adf72bcb980bf480b29c88e&rgn=div5&view=text&node=18:1.0.1.1.3&idno=18

Indices

m-firm concentration ratio

$$C_m = \sum_{f=1}^{f=m} \alpha_f$$

α_f represents company f's market share.

- Aggregate share of m largest companies
- Generally m~4
- Or number of companies representing 95%

Hirschman-Herfindahl Index

- R_H or HHI

$$R_H = \sum_f \alpha_f^2$$

- %100 = 10000
- 2500 upper limit for reasonably efficient
- 1000-1800
- Anti-trust policy
- ? 1x30% , 10*7% ? HHI 1390

Pivotal Supplier Indicator

- PSI
- A company is pivotal if
  - All other producers can not cover market demand
- PSI is binary
  - Pivotal or not

Residual supply index

- The ratio between the total capacity of all a company's competitors to total demand

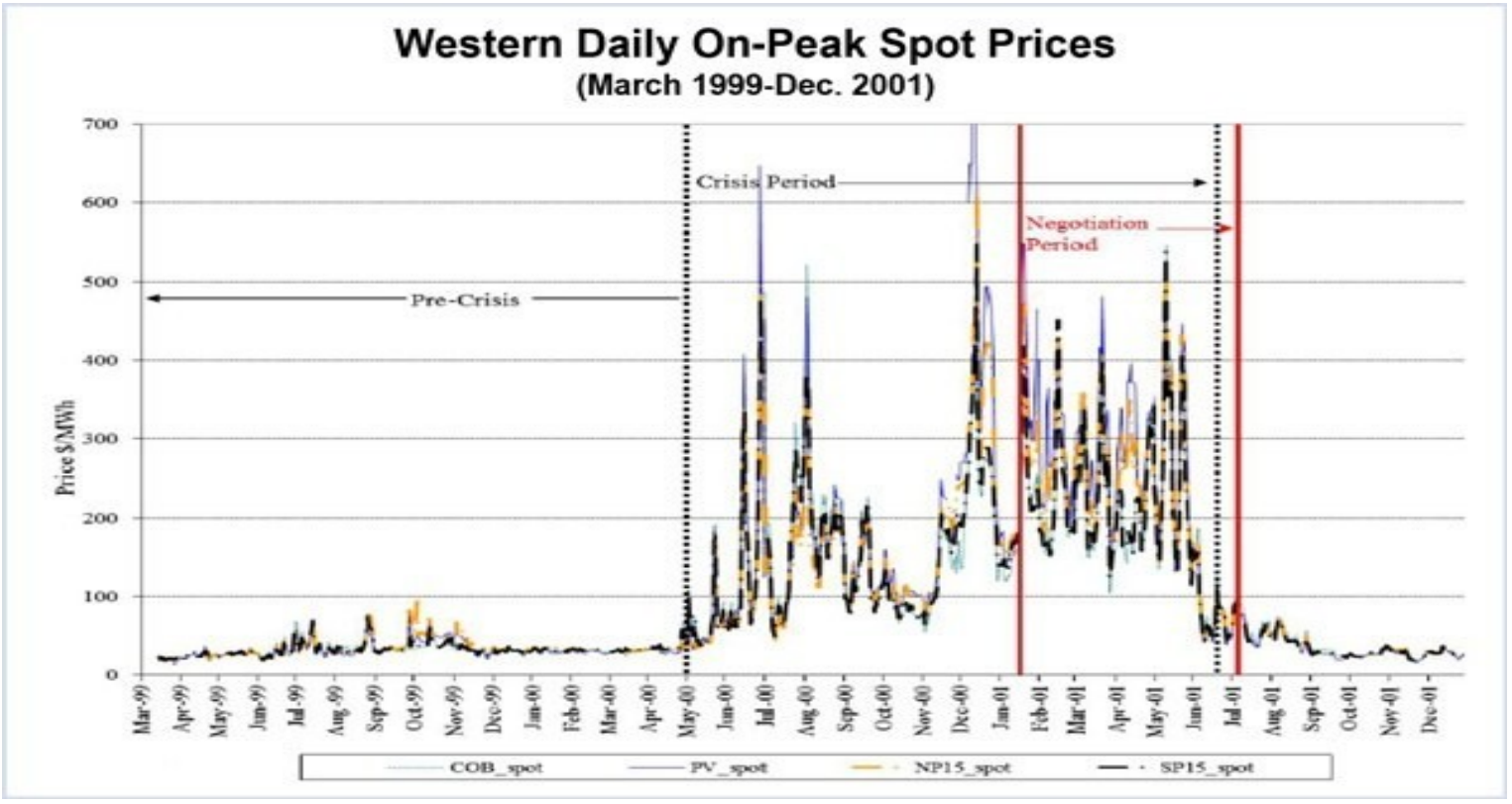
$$\begin{aligned} \text{RSI}_f &= \frac{\text{Company } f\text{'s residual supply}}{\text{Total demand}} \\ &= \frac{\text{Total supply capacity} - \text{Company } f\text{'s supply capacity}}{\text{Total demand}} \end{aligned}$$

Lerner index

- A behavioural index that measures market imperfection as overpricing with respect to a perfect market

$$L_I = \frac{p_{\text{realmarket}} - p_{\text{perfectmarket}}}{p_{\text{realmarket}}}$$

Western(California) Energy Crisis



https://www.rtoinsider.com/ferc-western-energy-crisis-pricing-umbrella-36591/

Trading Strategies (!) - Enron Era

Strategy	Category	Discussed in Enron Memos	Discussed in ISO DMA Reports	Discussed in FERC Staff Final Report
Export of CA Power	Energy market trading	✓	✓	✓
Ricochet (Megawatt Laundering)	Energy market trading	✓	✓	✓
Underscheduling by Utilities	Energy market trading	✓	✓	✓
Fat Boy ("Inc-ing" Load)	Energy market trading	✓	✓	✓
Load Shift	Congestion relief	✓	✓	✓
Death Star (Circular Schedules)	Congestion relief	✓	✓	✓
Wheel Out	Congestion relief	✓	✓	✓
Non-Firm Export	Congestion relief	✓	✓	✓
Scheduling to Collect Congestion Charges	Congestion relief	✓	✓	
Get Shorty	Ancillary services	✓	✓	✓
Selling Non-Firm as Firm	Ancillary services	✓	✓	✓

Energy Trading Strategies in California, Market Manipulation? *
https://link.springer.com/chapter/10.1007%2F0-387-23196-X_8

Lessons learned

- When demand/supply close to 1
  - Anyone may exercise market power
- The lag in cash flow creates imbalances
- Markets are highly affected by tech change
- Since price is constructed – flaws are inevitable
- Electricity market is not plug&play (grid maybe)

End of Lecture 5