Session 5
Designing Network Markets: the Case of Californian Electricity

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Outline

• Networks: by accident or design?
• What is the nature of the electricity market?
• General principles of market design
• The design of the Californian electricity market
• The Californian Power Crisis of 2000
• Lessons for market design
The Electricity Industry

Electricity travels from the generators, who create electricity, along high-voltage transmission lines – and then through a lower voltage local distribution system – to the domestic and business customers.

Source: OfGEM website

The Current Market in E&W

NETA (New Electricity Trading Arrangements) is a new wholesale market, comprising trading between generators and suppliers of electricity in England and Wales.

Under NETA, bulk electricity will be traded forward through bilateral contracts and on one or more power exchanges.

NETA also provides central mechanisms which do two things. They help NGC to ensure that demand meets supply, second by second, and they sort out who owes what to whom for any surpluses or shortfalls.

It is estimated that some 90% of power traded in NETA will take place in the forward contracts markets. It is expected only small volumes of electricity traded will be subject to arrangements in the central mechanisms.

The Balancing and Settlement Code, which sets down the rules for central mechanisms and governance, is managed by a separate company called ELEXON. All participants have to sign up to it.

Source: Ofgem website
A Competitive Electricity Market

Elements of an Electricity Market

- Generators
- Transmission Owners
- Independent System Operator (ISO)
- Power Exchange (energy market)
- Balancing Market
- Ancilliary Services
- Distribution Companies
- Power Retailers
- Regulators e.g. CPUC and FERC
Economics of a Competitive Electricity Market (Hogan, 1998)

- Short-Run market
- Transmission congestion
- Long-run market contracts
- Scheduling and balancing
- Long term investment
- Access fees to recover embedded costs
- Security concerns and capacity reserves

The US Electricity Industry

- A number of regulators
  - State Public Utility Commissions
  - FERC
- A number of ownership forms
  - IOUs (Investor owned utilities)
  - Federal Power Projects
  - Municipals
- Regulation
  - Rate of return based
  - Financially guaranteed
  - Changes negotiated
Supply and Demand for Electricity

Source: Hogan (2001)

Transmission Constraint Costs

<table>
<thead>
<tr>
<th>Power Flows and Locational Prices</th>
<th>Alternative Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link Capacity A to B (MW)</td>
<td>400   300   200   100</td>
</tr>
<tr>
<td>Total Load at B (MW)</td>
<td>600   600   600   600</td>
</tr>
<tr>
<td>Price at A (cents/kWh)</td>
<td>4.5   3.5   3.0   2.0</td>
</tr>
<tr>
<td>Price at B (cents/kWh)</td>
<td>4.5   5.0   6.0   7.0</td>
</tr>
<tr>
<td>Transmission Price (cents/kWh)</td>
<td>8.0   1.5   3.0   5.0</td>
</tr>
<tr>
<td>Pool Generation at A (MW)</td>
<td>200   150   100   0</td>
</tr>
<tr>
<td>Pool Generation at B (MW)</td>
<td>200   300   400   500</td>
</tr>
<tr>
<td>Blue Bilateral Input at A (MW)</td>
<td>100   50    0     0</td>
</tr>
<tr>
<td>Red Bilateral Input at A (MW)</td>
<td>100   100   100   100</td>
</tr>
</tbody>
</table>

Source: Hogan (2001)
Issues in the design of markets
(Chao and Huntington, 1998)

• Markets are not an accident!
• Primary motivation is to promote long-run efficiency gains through competition that stimulates technical innovation and efficient investment.
• Requires unbundling and new institutions, this will add transaction costs.
• Efficient short run price signals are essential for long run efficiency.
• Market design should exhibit compatibility across regions and consistency across market segments.

Issues in the design of markets

• Policy markers tend to undervalue the importance of customer choice and product diversity in achieving long run welfare maximisation.
• Some long-run decisions will require public intervention because they involve important externalities.
• Informed public policy requires impartial evaluation and frequent monitoring of market performance under different rules and institutions.
Key things to be decided

- Which elements of the industry will be vertically unbundled?
- How much horizontal unbundling will be undertaken? (in generation?)
- Where will competition be introduced? (in retailing?)
- What trades will be banned or regulated? (e.g. voluntary or compulsory trading in pool)
- What protection will consumers (especially domestic) receive? (e.g. price cap tariff with local distributor)
- By what mechanism will market be cleared? (day ahead, real time?)
- Who will oversee the operation of the market and who be responsible for revisions? (governance of ISO or Power Exchange)

The Californian Electricity Market

- California - world’s 5th largest economy
- Californian electricity industry $23bn p.a., 45MW peak demand, 44MW available capacity in CA
- US political trend setter
- Leading state for environmental development
- Overly democratic: frequent public ballot initiatives
- Three large utilities: PG&E, SCE, SDG&E; (R=9.6,7.9,2bn)
- No new base load capacity between 1987-00
- Capacity additions came from expensive IPPs
California’s Electricity Market

The Background to the Reform

• Early 1990s recession in California, GSP declined for three years.
• Power prices 50% higher than neighbours and twice the average for the US.
• In 1993 California Public Utilities Commission (CPUC) proposes reform.
• April 1994 CPUC after hearings and forums with the industry, environmentalists and consumers formally opts to pursue full-scale reform.
The Debate about Market Design

- Debate dominated by arguments about stranded costs and unwillingness of consumers to pay for bad past investments.
- Design options emerged:
  - 1. Pool Model with strong ISO
  - 2. Bilateral Transactions with constraints on the ISOs ability to intervene in dispatch.
- May 1995 review of 120 strong working group leads CPUC to adopt Option 1.

A Compromise Proposal for Market Design

- However the major utilities, large users and IPPs were unhappy with this and secured a Memorandum of Understanding (MOU) with the Governor which made Pool participation voluntary. This effectively implied a hybrid of Options 1 and 2.
- December 1995 the PUC accepts this framework as an optimal compromise.
- Customers were to be given three options:
  - Stay with their traditional utility
  - Engage in hedge contracts
  - Direct access through bilateral contracts
The new institutions of the market

• The Californian Power Exchange (PX)
  – Conduct day ahead and day of markets wholesale auction for generation and sale of electricity. Prices set hourly, PX price was to be paid to all generators in a given auction.

• Independent System Operator (ISO)
  – Manage the transmission facilities, co-ordinate the flow of PX power as purchased in the day ahead market and the bilateral contract market, charged with maintaining reserves, but PX not allowed to provide it with information for economic dispatch.

The Governance of the new institutions

• On the PX Board, only two of 25 current members represent residential consumer interests.

• On the ISO Board, only two of 27 current members represent residential consumer interests.
On to the Legislature

• PG+E were still concerned about stranded costs, thus they proposed a rate freeze for three years to recover stranded costs as they believed prices would fall after deregulation.
• Legislature gives itself 2 months to manage the process.
• Reopens process, unleashing lobbying exp. of $4.3m + $1m in campaign contributions.

The Legislation

• Assembly Bill (AB) 1890
  – 10% rate reduction and 5 year rate freeze to 2002
  – Subsidies to renewable energy
  – Stranded costs to be recovered via a competitive transition charge (CTC) if wholesale price below retail price. This implied that there would be no retail competition in the interim.
• Bill passed both houses without a single dissenting voice on Sept 23, 1996. Governor Pete Wilson said ‘we have pulled the plug on another outdated monopoly and replaced it with a new era of competition’.
The CPUC’s final adjustments

- Utilities encouraged to divest generation assets in return for higher allowed return on wires businesses.
- Incumbent utilities barred from signing bilateral contracts or hedging contracts to prevent foreclosure.
- Retail rate freeze would end in March 2002 or after the utilities had paid off their stranded assets.
- ISO empowered to run a real-time spot market to secure generation for reliability with no limit on the prices it would pay. This was an additional market which the generators could sell into in competition with the PX.

Comparing Pre- and Post-restructuring

<table>
<thead>
<tr>
<th></th>
<th>Pre AB 1890</th>
<th>Post AB 1890</th>
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<tbody>
<tr>
<td><strong>Generation</strong></td>
<td>Utility owned plant</td>
<td>PG&amp;E, SCE and SDG&amp;E retain nuclear plant and renewable contracts. Duke, AES/Williams, Dynergy, Reliant, Southern buy divested plant. Prices set in PX Large users buy power from generators</td>
</tr>
<tr>
<td></td>
<td>Utility purchases</td>
<td></td>
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<tr>
<td><strong>Transmission</strong></td>
<td>Utility operated system Prices set by FERC</td>
<td>ISO controlled system Prices set by FERC</td>
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<tr>
<td><strong>Distribution</strong></td>
<td>Utility operated system Prices set by CPUC</td>
<td>Utility operated system Prices set by CPUC</td>
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New market becomes effective on 1 April 1998
The Anatomy of a Crisis

- The new market initially functions well: April 98 - April 00.
  - Prices in PX low and PG&E and SCE collect $10bn towards stranded costs. However redesign was contemplated.
- In the summer of 2000 a number of shocks occurred accompanied by unusually hot weather and transmission lines overheating:
  - Hydro-power shortages (8% of statewide demand)
  - Natural gas shortages (prices rise up to 1600%)
  - Emission controls (electricity demand drove price of NOx permits)
  - Demand growth (5%+)
  - Plant outages (up to 10MW)
  - Grid problems (old and unreliable)

<table>
<thead>
<tr>
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<th>1998</th>
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<tr>
<td>January</td>
<td>-</td>
<td>21.6</td>
<td>31.8</td>
<td>260.2</td>
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<tr>
<td>February</td>
<td>-</td>
<td>19.6</td>
<td>18.8</td>
<td>363.0 (ISO RT)</td>
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<tr>
<td>March</td>
<td>-</td>
<td>24.0</td>
<td>29.3</td>
<td>313.5 (ISO RT)</td>
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<tr>
<td>April</td>
<td>23.3</td>
<td>24.7</td>
<td>27.4</td>
<td>370.0 (ISO RT)</td>
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<tr>
<td>May</td>
<td>12.5</td>
<td>24.7</td>
<td>50.4</td>
<td>274.7 (ISO RT)</td>
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<tr>
<td>June</td>
<td>13.3</td>
<td>25.8</td>
<td>132.4</td>
<td>103.8 (ISO RT)</td>
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<tr>
<td>July</td>
<td>35.6</td>
<td>31.5</td>
<td>115.3</td>
<td>62.6 (ISO RT)</td>
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<tr>
<td>August</td>
<td>43.4</td>
<td>34.7</td>
<td>175.2</td>
<td>45.2 (ISO RT)</td>
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<tr>
<td>September</td>
<td>37.0</td>
<td>35.2</td>
<td>119.6</td>
<td>35.0 (EST)</td>
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<tr>
<td>October</td>
<td>27.3</td>
<td>49.0</td>
<td>103.2</td>
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<td>November</td>
<td>26.5</td>
<td>38.3</td>
<td>179.4</td>
<td></td>
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<td>December</td>
<td>30.0</td>
<td>30.2</td>
<td>385.6</td>
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<tr>
<td>AVERAGE</td>
<td>30.0</td>
<td>30.0</td>
<td>115.0</td>
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Source: Joskow (2001)
Figure 4.11: Energy Emergencies and Blackouts in California

Source: Sweeney, 2002

<table>
<thead>
<tr>
<th>MONTH</th>
<th>1999</th>
<th>2000</th>
<th>CHANGE %</th>
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<tr>
<td>JANUARY</td>
<td>24,013</td>
<td>25,516</td>
<td>6.3</td>
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<td>FEBRUARY</td>
<td>24,194</td>
<td>25,515</td>
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<td>MARCH</td>
<td>24,469</td>
<td>25,533</td>
<td>4.3</td>
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<tr>
<td>APRIL</td>
<td>24,166</td>
<td>25,329</td>
<td>4.8</td>
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<tr>
<td>MAY</td>
<td>24,271</td>
<td>26,813</td>
<td>10.8</td>
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<tr>
<td>JUNE</td>
<td>26,890</td>
<td>20,981</td>
<td>22.7</td>
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<tr>
<td>JULY</td>
<td>28,878</td>
<td>29,591</td>
<td>2.2</td>
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<tr>
<td>AUGUST</td>
<td>29,015</td>
<td>31,104</td>
<td>7.1</td>
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<td>SEPTEMBER</td>
<td>27,070</td>
<td>28,619</td>
<td>5.5</td>
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<tr>
<td>OCTOBER</td>
<td>20,822</td>
<td>29,125</td>
<td>-2.6</td>
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<tr>
<td>NOVEMBER</td>
<td>25,144</td>
<td>25,912</td>
<td>3.1</td>
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<tr>
<td>DECEMBER</td>
<td>25,919</td>
<td>26,691</td>
<td>0.7</td>
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</table>

Source: Joskow (2001)
35% of total capacity unavailable

Reported Capacity Outages (1999 vs. 2000)

The Anatomy of a Crisis

- Retail rates were frozen, SDG+E rates did rise but large rises in July 2000 caused re-imposition of rate freeze by Sept 2000.
- There was arbitrage between the PX and ISO markets as generators preferred to go into the ISO emergency market and leave the PX.
- In December 2000 FERC declared that IOUs did not have to buy all their power in the PX, the market declined. FERC imposed soft price caps of $150/MWh.
Some ongoing problems

- Rolling blackouts in January 2001 affecting 380,000 customers and costing $2.3bn as storm reduces capacity at a nuclear PG+E plant.
- Paying for new supplies - prices raised 1 June 2001, state has been buying power via CDWR.
- Deferred costs - PG+E bankrupt March 2001
- Overcharging by generators and MW laundering
- Decreasing consumption - minus 11% May 2001 compared with May 2000 due to weather/suasion

Source: Sweeney, 2002
To quote...

“California is one of several states that adopted electricity restructuring. However, only California's restructuring caused severe price hikes and energy shortages. It is time to learn from other successful restructurings enacted by Texas, the New England states, and the Mid-Atlantic States of Pennsylvania, New Jersey and Maryland. In addition, California should also look to the standard market design created by FERC.”

A.Schwarzenegger (2003)

Lessons

• When markets are complex ‘design by committee’ allowed interest group politics, rhetoric to supercede common sense, technical realities and international experience.
• Spot markets work badly when supplies are tight: high prices and market power problems.
• Regulators needed to move more quickly and more sensibly when problems become clear in summer 2000.
• Consumers should be allowed to face wholesale prices and/or their suppliers should be able to sign long term contracts or financially hedge.
Lessons

- Spare capacity is a public good in an interconnected system and it should be adequately remunerated.
- Where markets overlap, rules should be standardised as much as possible across them (e.g. ‘MW laundering’).
- Allowing efficient investment is critical as this is likely to be one of the biggest benefits of reform. Bushnell makes the point that California is planning once again to make wasteful generation investments.
- Mid-course corrections to market design need to be built into the market re-design process to take account of learning.

Lessons for Napster

- Markets are designed and do not exist by accident.
- Incumbents have undue influence.
- Incumbents getting may get it wrong for themselves.
- Governments bad at technicalities.
- Ensuring worthwhile investment crucial.
- Trading collapses if market is badly designed. This has enormous costs.