



CALIFORNIA ISO

California Independent
System Operator

Teaching Electric Power Deregulation In Academia (*Panel*)

Chris Mensah-Bonsu, Ph.D.

California ISO

Folsom, California

Panel Session: Teaching Deregulation

IEEE Power Engineering Society 2002 Summer Meeting

Chicago, Illinois

Created By: C. Mensah-Bonsu www.caiso.com

July 23, 2002



Overview

- Motivation for power industry restructuring
- Electricity deregulation and requirements
- Key participants and sectors of deregulation
- Market design components of deregulation
- Proposed “new” power engineering program
- Research and career opportunities
- Issues and benefits of deregulation
- Educational resources and information
- Conclusion



Motivation

- Reduce prices
- Improve services
- Foster innovation through competition
- Increase efficiency
- Foster customer choice
- Promote transmission open access
- Ensure competitiveness in generation



Electricity Industry Restructuring and Milestone

Introduces competition by decoupling electricity generation and transmission businesses, and removes external price setting agencies

- **10/1/1977**-FERC replaces the Federal Power Commission
- **1978**-Public Utilities Regulatory Policy Act (PURPA) initiates deregulation process, allowing Non-Utility Generators to enter wholesale power market
- **1992**-Energy Policy Act (EPACT) lays foundation for wholesale electricity deregulation, and ordered FERC to facilitate the transition
- **4/1996**-FERC Orders 888/889 to eliminate monopoly through equal and open transmission access. Order 889 for OASIS
- **12/1999**-FERC Order 2000 reforms the transmission operation practices, gave birth to the RTO/LCA concept



Electricity Deregulation

Deregulation -“Process” of removing restrictions and regulations to achieve competitive wholesale prices without compromising adequacy, system reliability and security

Requirements: **100% Deregulation**

- Good operations, planning and market design engineers
- Sufficient supply and fuel diversity
- Sufficient transmission infrastructure
- Efficient demand side responsiveness and management
- Provision of right incentives and good price signals
- Hedging instruments that enhance wholesale competitiveness
- Environmental desires and electric power needs trade-offs
- Seams management



Key Participants, Sectors and Their Roles in Deregulation

- Deregulations requires **mutual satisfaction** of all participants
- Federal Energy Regulatory Commission-**Compliance**
- NERC- **Compliance**
- WECC- **Minimum operating reliability criteria**
- ISOs/RTOs-**Reliability and economics through markets**
- Public Utility Commissions-**End user and environment**
- Electricity Oversight Boards-**Advisory and market monitoring**
- Legal and state regulators- **Compliance and protection**
- Other stakeholders: IPPs, IOUs, municipalities, marketers, public interest groups, and end users
- Engineering implementation trade-offs



CALIFORNIA ISO

California Independent
System Operator

Typical Organizational Structure-CA ISO

Facilitate transparent markets and mitigate emergencies without compromising system reliability and security

● Key departments

- Market Services (Operations, Quality, Client Relations, Settlements, and Contracts & Special Projects)
- Grid Operations (Operations, Planning, Scheduling, Engineering & Maintenance, Support and Training, Regional Coordination)
- Information Services (Operation Systems, Infrastructure Engineering)
- General Counsel (Federal/State/Regional Affairs, Market Analysis, Compliance, and Regulatory)
- Finance
- Corporate and Strategic Development (Human Resources, Communication etc.,)

Created By: C. Mensah-Bonsu

www.aiso.com

July 23, 2002



Market Design Components

- Robust and accurate load forecasting tools
- Ancillary services and operating reserves
- Efficient hedging instruments
 - Existing transmission rights
 - Firm transmission rights
- Congestion management by optimal power flow
- Forward markets and scheduling processes
- Real time (spot) markets and protocols
- Incentives for supply and transmission investments
- Robust power system network models
- Tariffs
- Market monitoring
- Market power mitigation
- Market simulators – Agent based modeling
- Competency in interfacing policy, engineering and economics



Ancillary Services

- Ancillary services are needed to fine tune system energy needs – **Rely firmly on them for Reliability**
- Market competition
 - Regulation up and down
 - Spinning reserve
 - Non-spinning reserve
 - Replacement reserves
- Bilateral contracts
 - Voltage support
 - Black start



Congestion Management By OPF

Minimize

$$\mathbf{obj}(\mathbf{u}, \mathbf{x})$$

Subject constraints:

$$\mathbf{f}(\mathbf{u}, \mathbf{x}) = \mathbf{0}$$

$$\mathbf{g}(\mathbf{u}, \mathbf{x}) \leq \mathbf{0}$$

where:

U - Set of control variables

X - Set of dependent variables

obj(u,x) - Scalar objective function

f(u,x) - Represents power flow constraints, occasionally augmented by a few special equality constraints

g(u,x) - Consists of limits of the control variables and operating limits of the power system

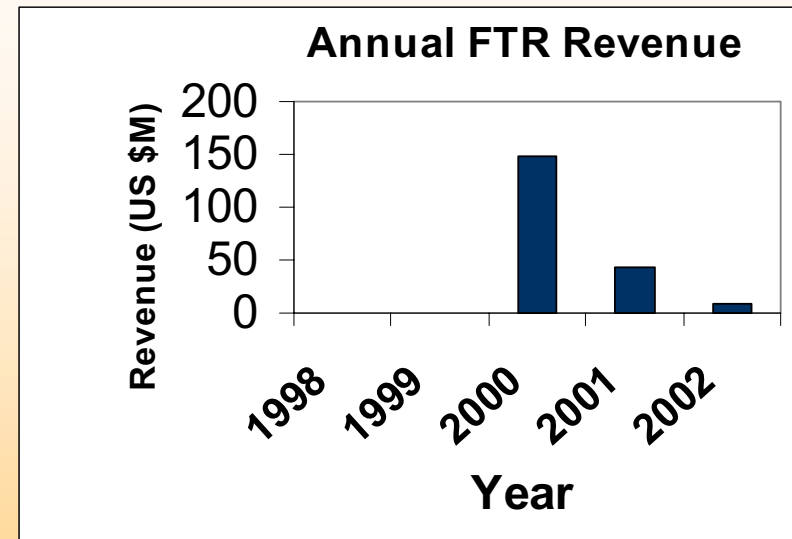
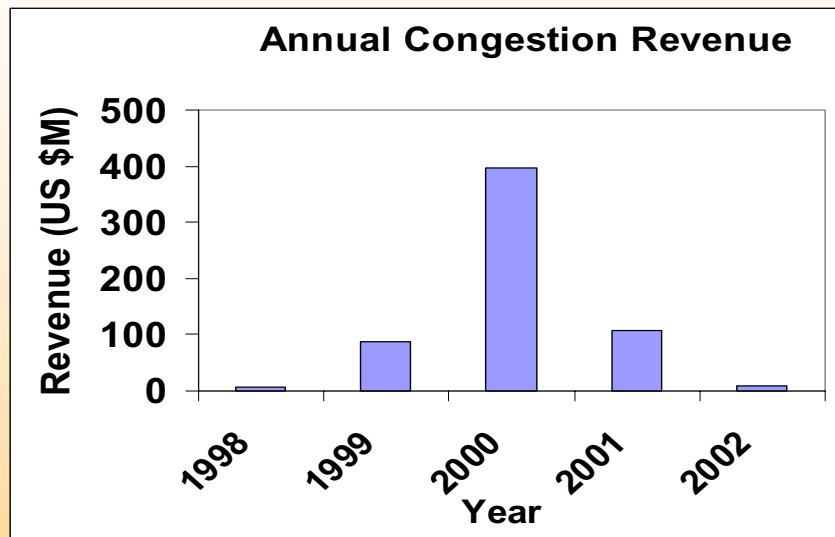


Firm Transmission Rights

- Features of transmission rights
 - Network service using adjustment bids
 - Contract paths - Physical transmission link
 - Point-to-point - No explicit reference to links
 - Flow gates - Physical link required for a transaction
- Types of transmission rights
 - Financial - Entitlement or obligation to receive or pay congestion rent
 - Physical - Entitlement to use transmission



Effective FTR and Congestion Management Design, and Revenue Impact



● Total FTR revenue

US \$199, 025, 984.00

● PTO TO Debit

US \$408, 831, 822.00

● Total congestion revenue

US \$607, 857, 806.00



Proposed “New” Power Engineering Program

Complement the “traditional” **power engineering** programs with innovative courses that strengthen **economic evaluations**, ensure equitable rate of return, improve adequacy, **system reliability and security**

- Effective across discipline communication skills
- Economics (Microeconomics)
- Finance (risk management)
- Legal and regulatory policies that address emerging utility industry issues
- Power generation, transmission and the environment
- Software applications for mega control areas and interfaces
- Collaboration with business college department



Career and Research Opportunities

- Recent **California ISO hiring** statistics and elsewhere
- Historical utility hiring freeze due to downsizing
- Pre-start up recruitment of experienced utility engineers for immediate ISO start up operation
- Bridging the industro-academic divide
- Promote innovative technologies to address deregulation needs
- Design innovative software interfaces to handle larger control areas and their operational challenges



Issues And Benefits of Deregulation

- ✿ Survival of the fittest - Efficient units live, others perish
- ✿ System investment responsibility is uncertain
- ✿ Lack of sufficient resource command and control that existed in the “old” paradigm
- ✿ End user price volatility adaptation
- ✿ Stricter environmental requirements
- Cheaper electricity through competition and innovation
- Improved generation and planning efficiency and economy
- Revitalization of the power engineering profession means increased job and challenging opportunities



CALIFORNIA ISO

California Independent
System Operator

Educational Resources

- Invite industry guest speakers - ISOs/RTOs, FERC
- Organize IEEE tutorials on the subject matter
- Encourage internships/co-ops - **California ISO** example
- Organize excursions to operational ISOs
- National websites
 - California ISO (www.caiso.com)
 - Pennsylvania Jersey Maryland Interconnections (www.pjm.com)
 - ISO New England (www.iso-ne.com)
 - New York ISO (www.nyiso.com)
 - MISO (www.miso.com)
 - FERC (www.ferc.gov)
- International (UK, Norway, Australia, Brazil, Chile, etc.,)



Conclusion

Reliability and “fair” electricity prices through innovative technologies, economics and competition

- **RELIABILITY** is too important to leave it to the Economists **ALONE**
- Deregulation requires active involvement from power engineers
- Deregulation offers substantial opportunities to power engineers