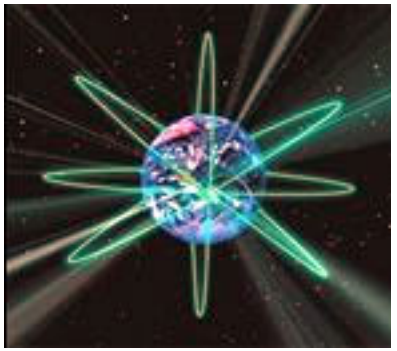
Nuclear Energy: Beyond 2001

(Part 2)

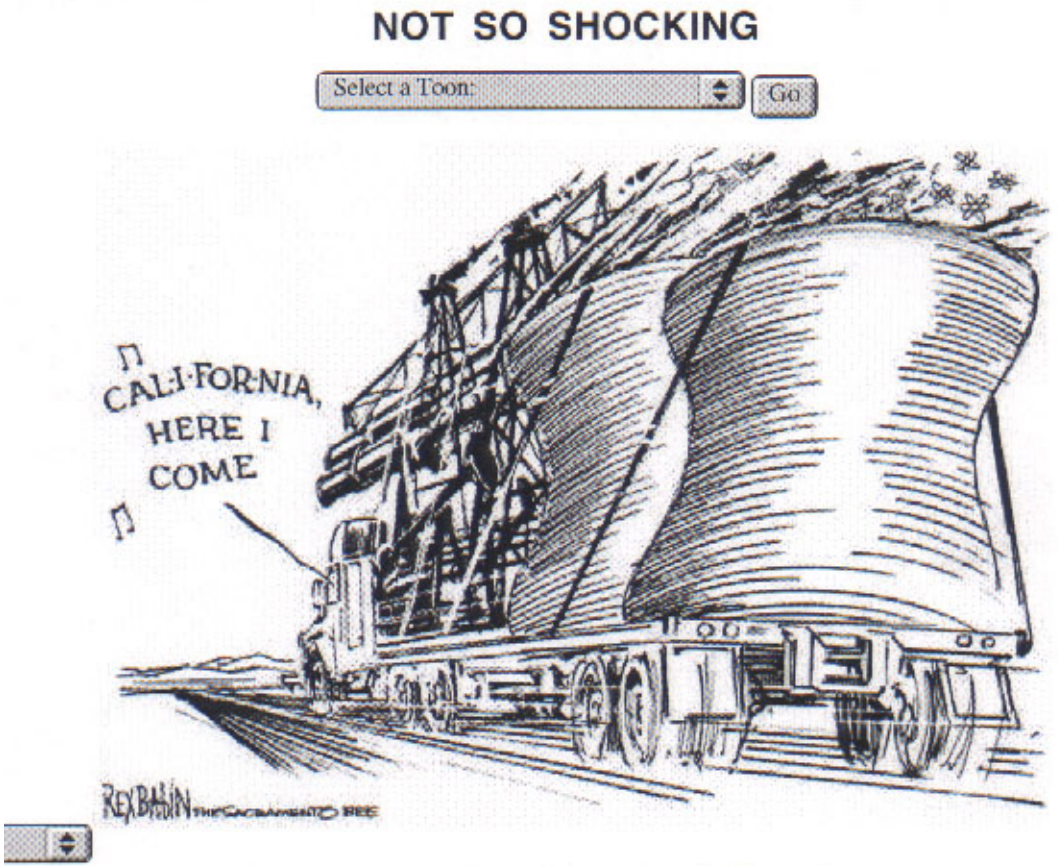


Jasmina Vujic
Associate Professor

Department of Nuclear Engineering
University of California, Berkeley

May 16, 2001

Energy Crisis: What Happened in California?



Energy Crisis: What Happened in California?

- **Many factors converged to produce this crisis:**
- **Partly because of very stringent restrictions on the construction of new generating plants, there were no SIGNIFICANT additions to generating capacity in over a DECADE!**
- **California's population and demand for electricity continued to grow: Current demand >> available supply.**
- **Given its mild warm climate and scarcity of energy production facilities, California uses more energy than any other economy on Earth, but Texas.**
- **In residential, commercial and transportation sectors, California uses more energy than Texas!**
- **Per capita, CA ranks 48th in energy use in the US - Alaska holds the first place.**
- **Aging electrical grid complicates long distance transfer of electricity.**

Energy Crisis: What Happened in California?

- **Two primary fuels drive California's energy system: petroleum and natural gas**
- **CA produces about 16% of the natural gas it uses.**
  - **California has made a far-reaching transition into the natural gas fired power stations, counting on its cheap price and clean-burning characteristics.**
- **CA produces about 53% of the petroleum it uses.**
- **CA produces roughly HALF of its peak electricity demand!**
- **In 1999, about 32.3% of the state's 259,365 GWh of electricity production was produced by renewable sources.**
- **Out of that, 23.5% was generated by hydroelectric power plants and 9% by all other (geothermal, wind, solar, and biomass).**
- **California now has 40% of the world's geothermal power plants, 20% of the installed wind capacity and 70-80% solar.**

Sources of Electricity in California (1999)

Fuel Type	GWh	%
Coal	51,460	19.8
Large Hydro	52,082	20.1
Natural Gas	80,497	31.0
Nuclear	42,030	16.2
Other (Oil,Diesel)	1,671	0.6
Eligible Renewables	31,625	12.2
Geothermal	12,786	4.9
Solar	954	0.4
Wind	3,850	1.5
Total	259,365	100

Electricity from NPPs in California

Name of Plant	Capacity (MW)	In Service	Owner
Diablo Canyon			
Unit 1	1,073	1985	PG&E
Unit 2	1,087	1986	PG&E
San Onofre			
Unit 1	436	1968-92	SCE/SDG&E
Unit 2	1,070	1983	Same
Unit 3	1,080	1984	Same
Humbolt Bay			
Unit 3	65	1963-76	PG&E
Rancho Seco	913	1975-89	SMUD
Vallecitos	30	1957-67	PG&E/GE

Electricity from NPPs in California

- **The last nuclear reactor in California was commissioned 15 years ago, and there are no plans for new reactors.**
- **California law PROHIBITS construction of new NPPs unless the technology for permanent waste disposal is demonstrated!**
- **Well meaning people deceive themselves into believing that new solar and wind power will suffice to run the sixth or seventh biggest economy in the world.**
- **New NPP can be constructed in less then 4 years!**
- **Spent fuel is being held in temporary storage at NPP sites until a permanent long-term waste disposal becomes available.**

- **Just to replace coal as the dirtiest fuel to generate electricity with nuclear power in the world, it would require building one NPP every three days for the next hundrid years!**

Energy Crisis: What Happened in California?

- **California instituted a deregulation plan in 1996.**
- **The plan required investor-owned electrical utilities to divest of much of their generating capacity and to sell the power to the California Power Exchange (CPE).**
- **Any additional power needed for distribution would be purchased through CPE.**
- **The theory:**
  - **the plan would increase competition and reduce prices for electricity.**
  - **Outside companies would be interested in selling power on a "wholesale" basis to the "retail" power providers.**

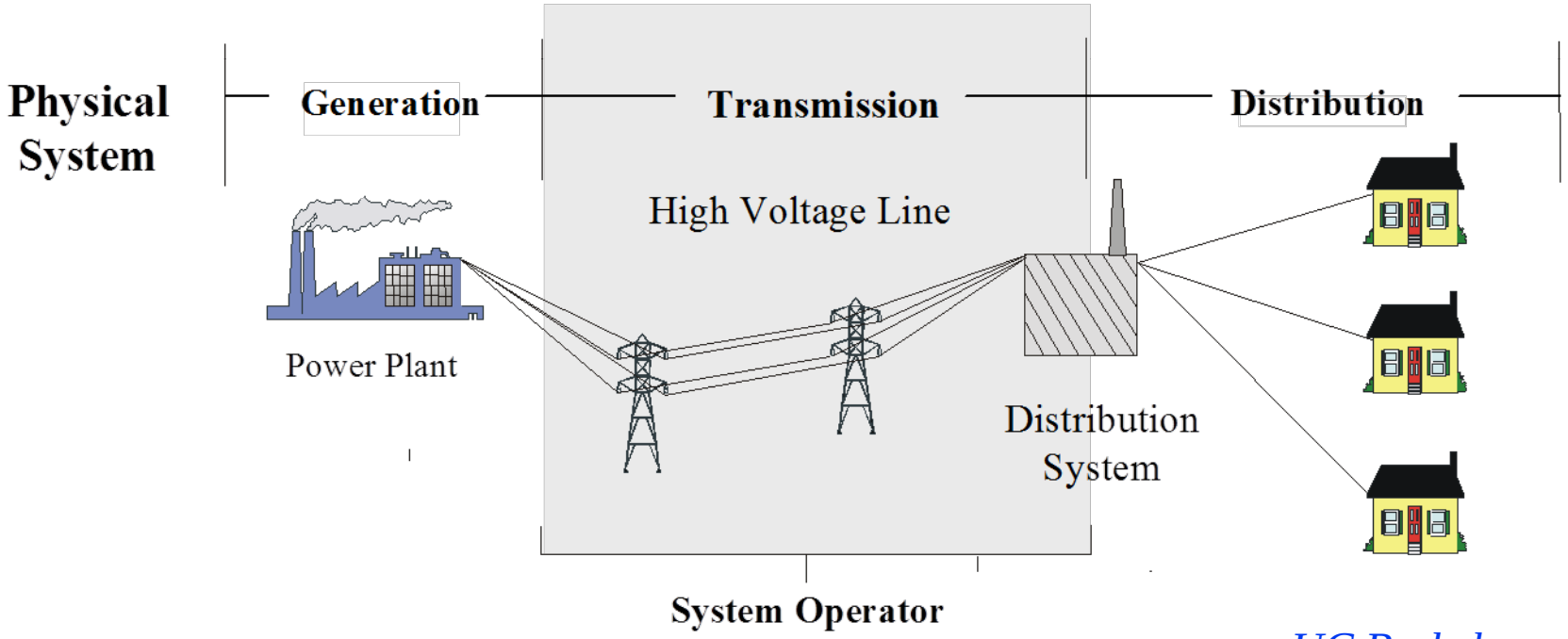
Energy Crisis: What Happened in California?

- **In reality:**

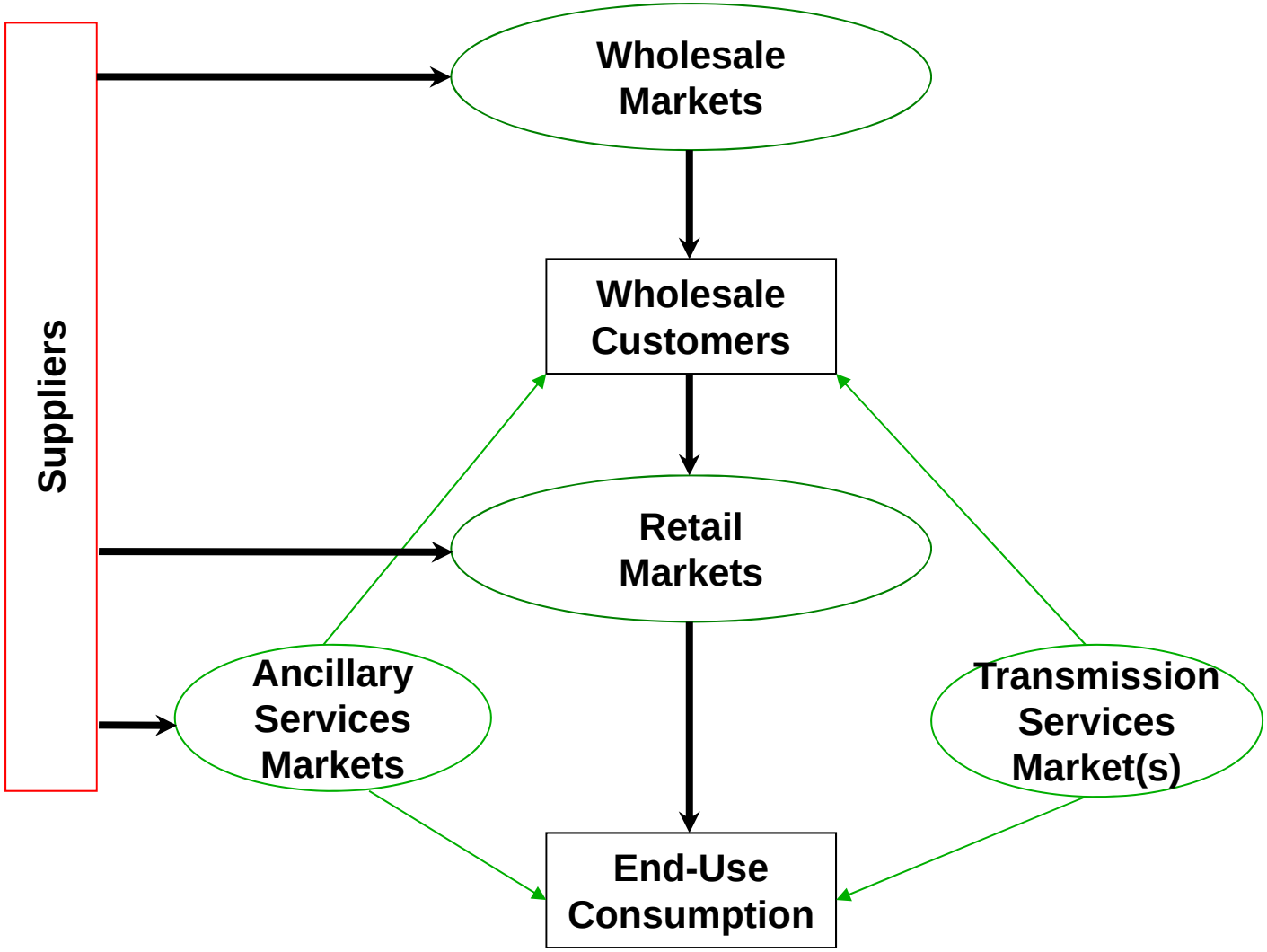
- **Rates charged to consumers were “FIXED”.**
- **There was no “cap” on what utilities would have to pay on the”wholesale” market.**
- **Utilities were forced to purchase power on a daily “spot” market.**
- **The plan did not allow any long-term contracts between electrical “retailers” and the “wholesalers” who generated the power.**
- **Increased demand and limited supply raised wholesale “spot” prices DRAMATICALLY!**
- **The tab for electricity sold in CA soared to $27.1 billion in 2000, nearly quadruple the 1999 total of $7.4 billion, shocking consumers and pushing PG&E into bankruptcy!**

Structure of a Power System

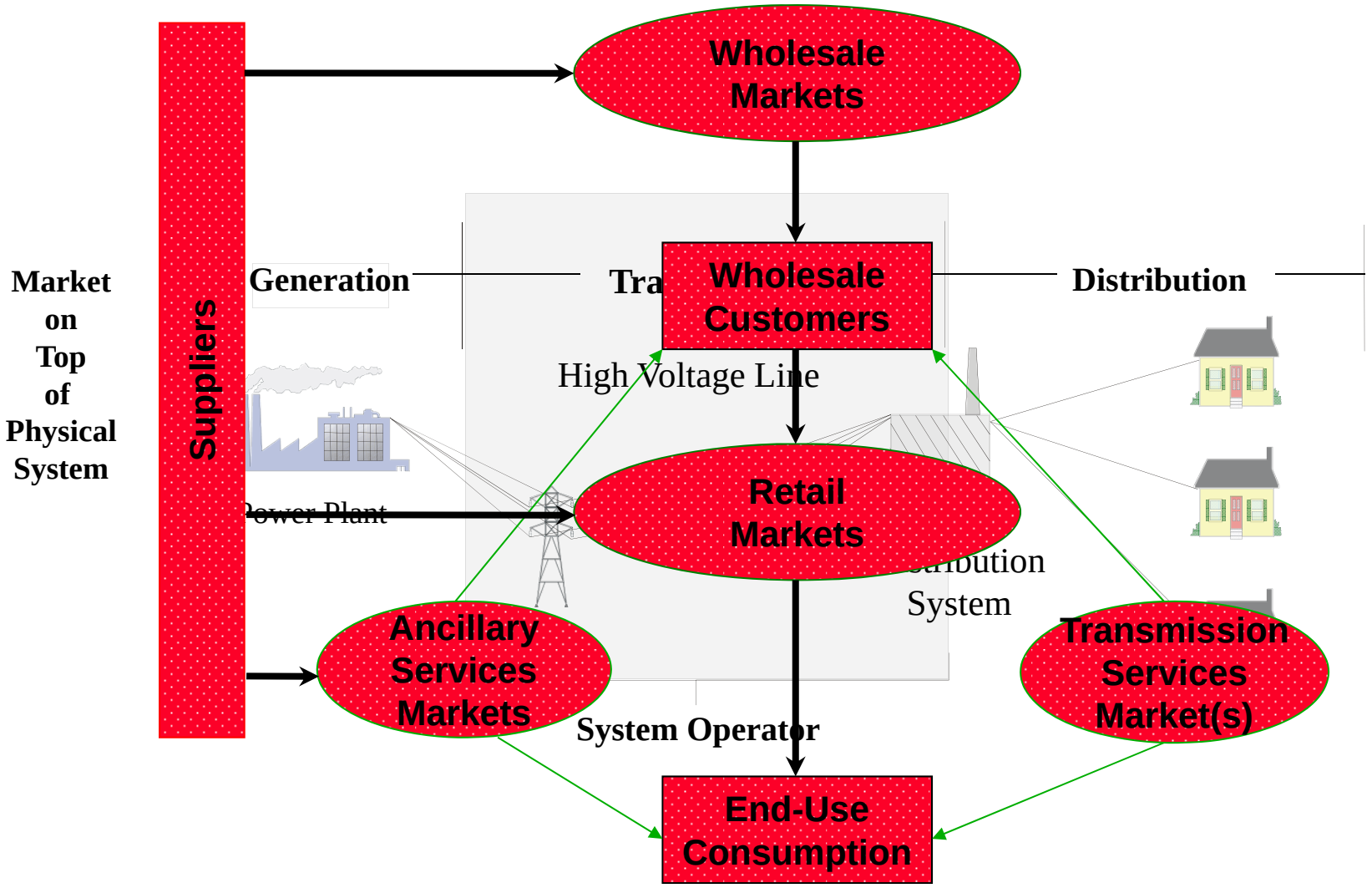
- Traditional Utility: Generation, Transmission, Load and System Operator



Regional Electric Markets - DOE Conceptual Design



Regional Electric Markets - DOE Conceptual Design



Design, Operation and Control of Power System (California)

- **Objective: Produce, Deliver and Consume Electricity Reliably under Normal Operating Conditions with Possible Occurrence of Plausible Contingency**
- **Continual Balance of Supply and Demand**
  - **Lack of Practical Means of Storage**
  - **Long Distance Transmission**
  - **Uncertainties in Load and Equipment**