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American Nuclear Society Young Members Group

Electricity Markets

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- The Path to Electricity Markets
- How Electricity Markets Work



The Path to Electricity Markets

Vertically Integrated Utilities





Source: Adapted from National Energy Education Development Project (public domain)

Regulated Utilities



- Electricity service is a natural monopoly monopolies require government regulation
- Regulatory compact
 - Obligation to serve
 - Companies can have a monopoly but the cannot set prices

Regulated Utility Business Model

Paid for the cost to provide service

- Provided a return on investment
 - Prudent
 - Used and useful

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Public Utility Commissions



- Regulate utilities
- Determine prudency of costs
- Set a reasonable rate of return for investments
- Review Integrated Resource Plans
 - Projections of future demand (15 years)
 - Resource mix needed to provide service

Economist View of Regulated Utilities

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- Monopolies are bad
 - No consumer choice
 - No competition to drive innovation
 - Incentives are not quite right
- Push to deregulate many industries in 1970s
- Nuclear overruns helped to make the case

Push for Electricity Competition



- Encourage efficiency! Incentive to reduce costs rather than build more.
- Is electricity generation really a monopoly?
- Varying enthusiasm across states
 - Northeast, Midwest, Texas, California
 - Other states on the bandwagon
 - California Electricity Crisis throws wrench in the gears

State Electricity Policies





Regional Electricity Markets





Nuclear Reactors Map





Two-thirds of reactors in some form of market

KEY





How Electricity Markets Work

Finding a Market Price





Energy Market Design



Solve two (related) problems:

1. Which power plants should be used to meet demand?

2. How much should they be paid for their electricity?

Challenge for Electricity Markets

- Need it everywhere
- Every minute of the day
- As much as demanded
- Can't store it
- No substitute

Other markets aren't really like this

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Based on short-run marginal cost

"Short-run" – only concerned with the immediate future

"Marginal" – providing the next bit of electricity

Short-run marginal cost = fuel cost (+ a little)



Have plant owners provide bids to provide power

Grid Operator



"Hey power plant owner! How much do you need to be paid to provide power to Chicago at 7pm?"



"How Much Extra Would It Cost Me to Run the Plant?"



"I need to buy more coal. Maybe bring in a couple of workers. \$20 per MWh is worth it for me to generate power."



"My natural gas supplier says he can provide it to me for \$4/mmBTU. I'm not the most efficient plant, but I'm pretty good. I can cover my costs at \$32 per MWh"



"I'm not in an outage so I am running no matter what. Let the other generators set the market. I am a price taker."



"I get a tax credit as long as I sell my generation. I can bid negative \$20/MWh and still come out ahead."









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Declining Wholesale Electricity Prices





Cost Trends

Mike Kramer, Exelon





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Nuclear's Role Today

Nuclear Power Plant Cost Structure



2018 U.S. Nuclear Power Plant Costs (\$/MWh)



2018 costs compared to 2017:

- Total generating costs decreased by \$2.44/MWh (7.1% reduction)
- Fuel costs decreased by
 \$0.62/MWh (9.3% reduction)
- Capital costs decreased by
 \$0.59/MWh (8.7% reduction)
- Operations costs decreased by \$1.23/MWh (5.9% reduction)

Source: Electric Utility Cost Group Updated: July 2019 ŊÉI

Progress Being Made...





Source: Electric Utility Cost Group Updated: July 2019 In 2018 dollars

2018 U.S. Nuclear Power Plant Cost Breakdown



Category	Plants / Sites	Generation (Million MWh)	Fuel (\$/MWh)	Capital (\$/MWh)	Operations (\$/MWh)	Total Generating (\$/MWh)
All U.S.	60	810,210	\$5.98	\$6.21	\$19.69	\$31.88
Plant Size						
Single-Unit	24	175,658	\$5.84	\$8.34	\$27.82	\$42.00
Multi-Unit	36	634,552	\$6.01	\$5.62	\$17.44	\$29.07
Operator						
One Plant	12	178,670	\$6.47	\$6.65	\$20.40	\$33.52
Multiple Plants	48	631,540	\$5.84	\$6.08	\$19.49	\$31.41

2018 U.S. Nuclear Power Plant Cost Breakdown



Plants / Sites	Generation (Million MWh)	Fuel (\$/MWh)	Capital (\$/MWh)	Operations (\$/MWh)	Total Generating (\$/MWh)
60	810,210	\$5.98	\$6.21	\$19.69	\$31.88
ale 30	390,551	\$5.05	\$4.26	\$20.03	\$29.34
ed 30	419,659	\$6.83	\$8.02	\$19.38	\$34.24
VR 23	274,166	\$5.93	\$6.45	\$21.10	\$33.48
VR 37	536,044	\$6.00	\$6.08	\$18.97	\$31.06
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U.S. Nuclear Power Plant Costs (\$/MWh, in 2018 dollars)



Year	Fuel	Capital	Operating	Total Generating
2002	6.07	4.16	19.72	29.95
2004	5.60	5.99	19.66	31.25
2007	5.44	6.49	20.22	32.15
2010	7.17	9.71	21.89	38.76
2011	7.53	10.67	23.21	41.41
2012	7.96	11.48	22.91	42.36
2015	7.28	8.44	22.09	37.81
2016	7.07	7.05	21.38	35.50
2017	6.59	6.80	20.92	34.32
2018	5.98	6.21	19.69	31.88
2012 – 2018 Change	-25%	-46%	-14%	-25%

Capital Costs – Historical Perspective



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Operations Costs – Historical Perspective



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Premature Closures and Announced Shutdowns





Plants Saved: nearly <u>twice</u> the electricity generation from all U.S. utility-scale solar in 2018





Questions?





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