

Nuclear Power and Power Market Reform: Some Lessons from the U.S. and Europe

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Summary

- No new nuclear power plant has ever competed successfully in a genuine, all source competitive power procurement anywhere in the world;
- Because of their long construction times, large initial costs and need to recover costs and profit, new reactors tend to foreclose major commitments to energy efficiency and renewable energy;
- Today in the U.S. even some existing reactors are have difficulty competing and are requesting market changes to assure that they receive higher payments and, in some cases, to reduce payments to renewable sources;
- New market reforms are encouraging changes in the utility industry that may undermine the vertically integrated model on which much nuclear investment depends.

Impact of competition on operating reactors

- Five U.S. reactor closings were announced in the last 15 months. These were the first such closings in 15 years.
 - Three involved reactors facing expensive repairs.
 - Two involved reactors facing strong economic competition.
- Two reactor owners have announced that more closings are possible if market changes favoring nuclear power are not made soon.

Threats to traditional utilities now transcend the nuclear sector

- States with aggressive policies promoting renewables sometimes reduce utility sales faster than they reduce utility costs.
- As more control passes into customer hands electricity grids face some of the challenges of the telephone systems of two decades ago, when technological change moved the intelligence of the communications out of the switching centers and into the end use devices.
- Many utilities are resisting these changes. They have some success where the issues are primarily political, but they cannot win for long when the technological and economic fundamentals work against them, as they are doing with new nuclear reactors.

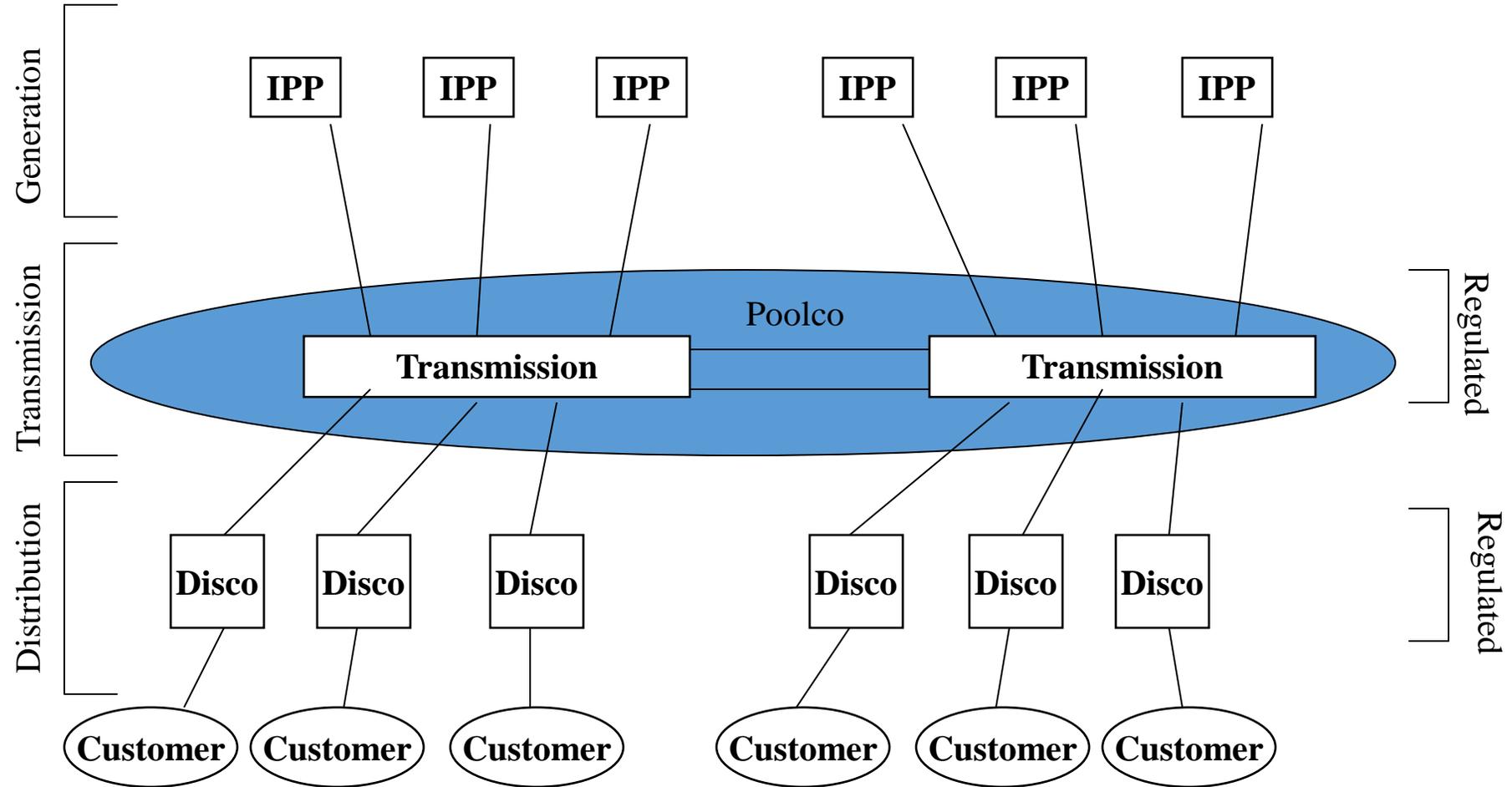
Effects of resistance to change by traditional utilities

- Each commitment to a new reactor necessarily forecloses commitments to very large amounts of energy efficiency and renewable energy.
 - “All of the above” energy strategies are a substitute for serious thought.
 - No nation has enough money to meet the same energy needs several different ways.
 - No electric system will eliminate the demand for thousands of nuclear megawatts that it has decided to build.
 - This is clear in the policies of the states committed to new nuclear in the U.S.
 - And will be clear in Britain if the Hinckley Point project goes forward.

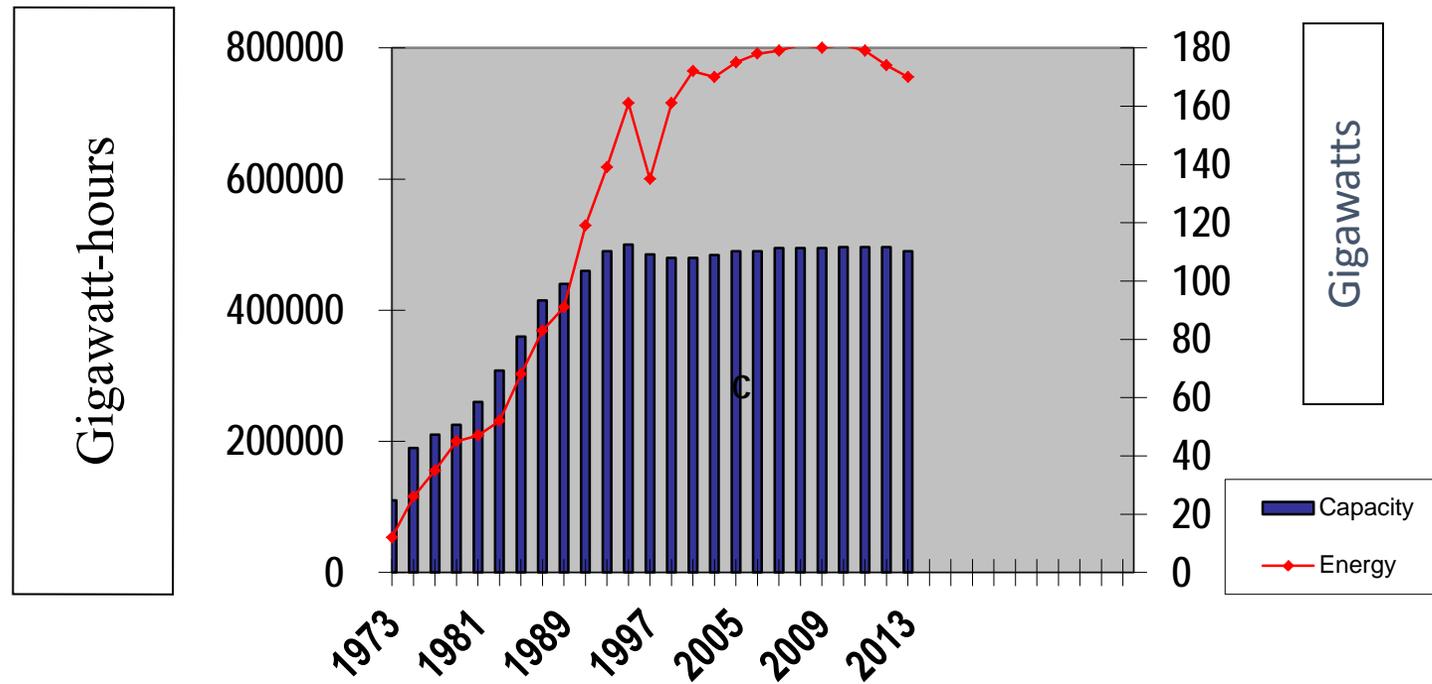
New Reactors and Competitive Markets

- In 1978 the U.S. Congress passed a law requiring utilities to buy power from anyone who could supply it more cheaply than the utilities could generate it. After predicting disaster and filing law suits, utilities eventually complied;
- The resulting independent power industry provided far more generation and innovation than had the utilities, and at lower prices. This had two consequences:
 - Improved utility operations
 - Electric restructuring and market development in about half of the U.S.

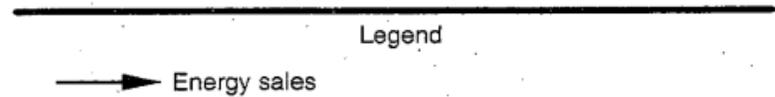
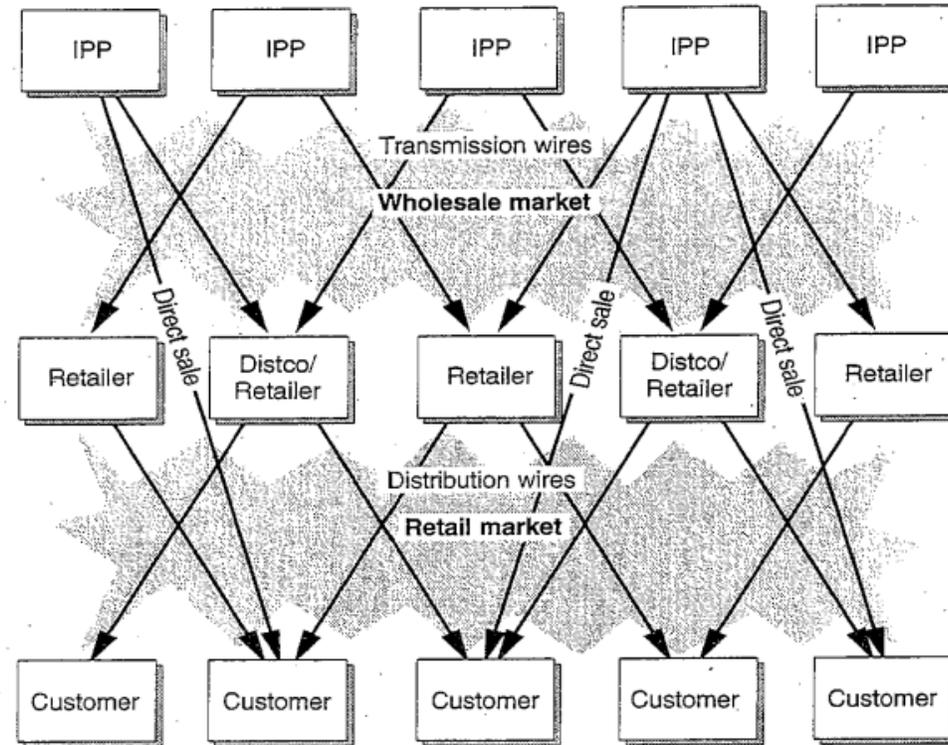
Competitive Wholesale Electricity Market Structure



U.S. Nuclear Output and Nuclear Capacity, 1973-2012: Productivity Improvement in the Face of Competition



Full Retail Competition and Divestiture



No new reactors in states with restructuring activity

- The reason is clear: Restructuring shifts the risk of poor economic performance to investors, who refuse to bear it.
 - Instead, nuclear power must seek long term contracts (which shift the risk back onto the buyers, whether customers or governments)
 - And/or loan guarantees which shift risk on to taxpayers
 - Special “stranded cost” charges that require customers to pay all above-market costs of existing reactors;
 - Relief from obligation to abide by results of open power procurement auctions or least-cost power supply plans.

Power Market Lessons of the 1970s, Which the Nuclear Industry Now Struggles to Reverse

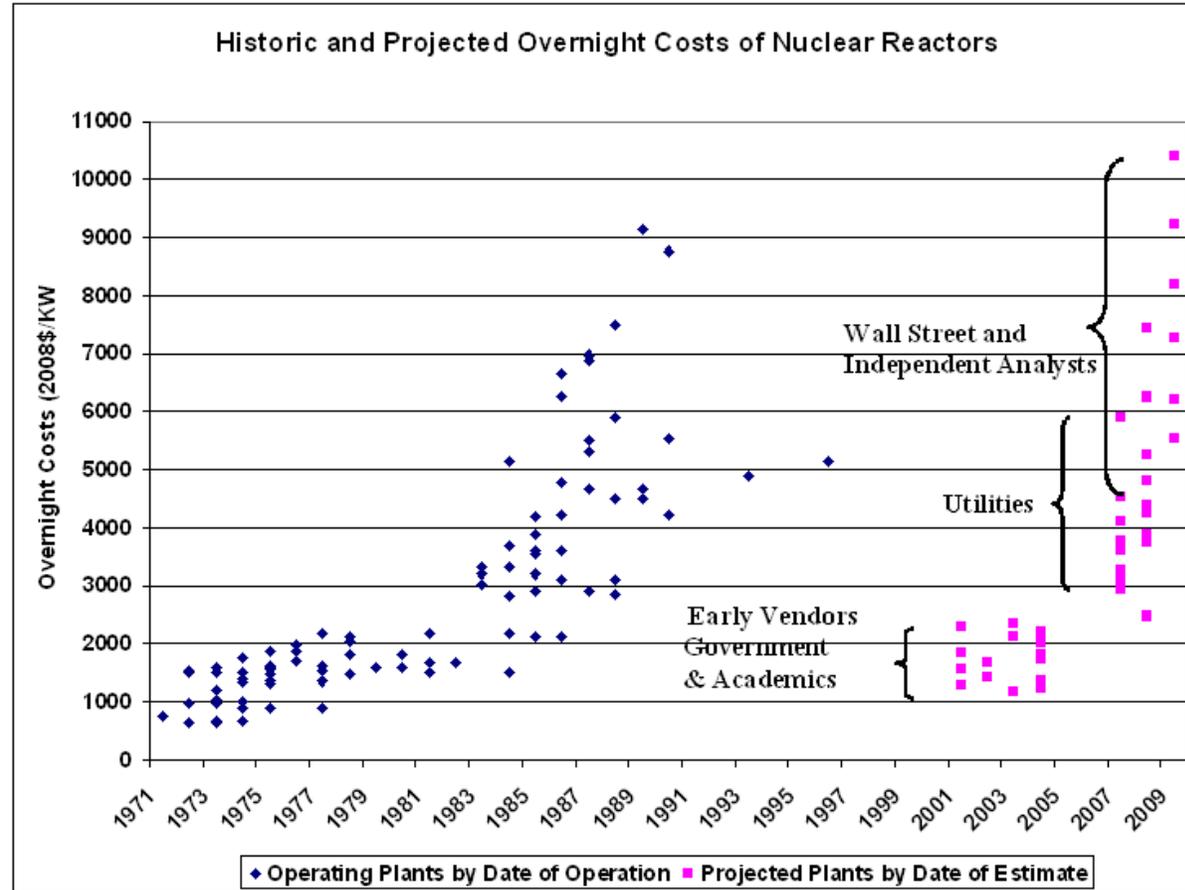
Who bears risks of runaway costs and/or canceled plants?

1970s	1980s and 1990s	Today (for new units)
customers	Investors	taxpayers and customers

Lessons from Electric Restructuring

- Incumbent utilities will resist fervently, alleging unreliability and higher cost, neither of which are true
- Incumbent utilities will also demand to have their “sunk costs” paid off by customers as a condition of allowing more competition;
- These payoffs may make political sense, but only if they provide an assured road to competition
- Assurances of future competition should be based on structural reforms, not merely on effective policing by the state.

The Strange Story of the Nuclear Renaissance



Energy Policy Act of 2005

- Loan guarantees (\$4 billion) available to all carbon free technologies
- Production tax credit (1.8¢/kWh for first 6 GW)
- Other forms of political and economic support.

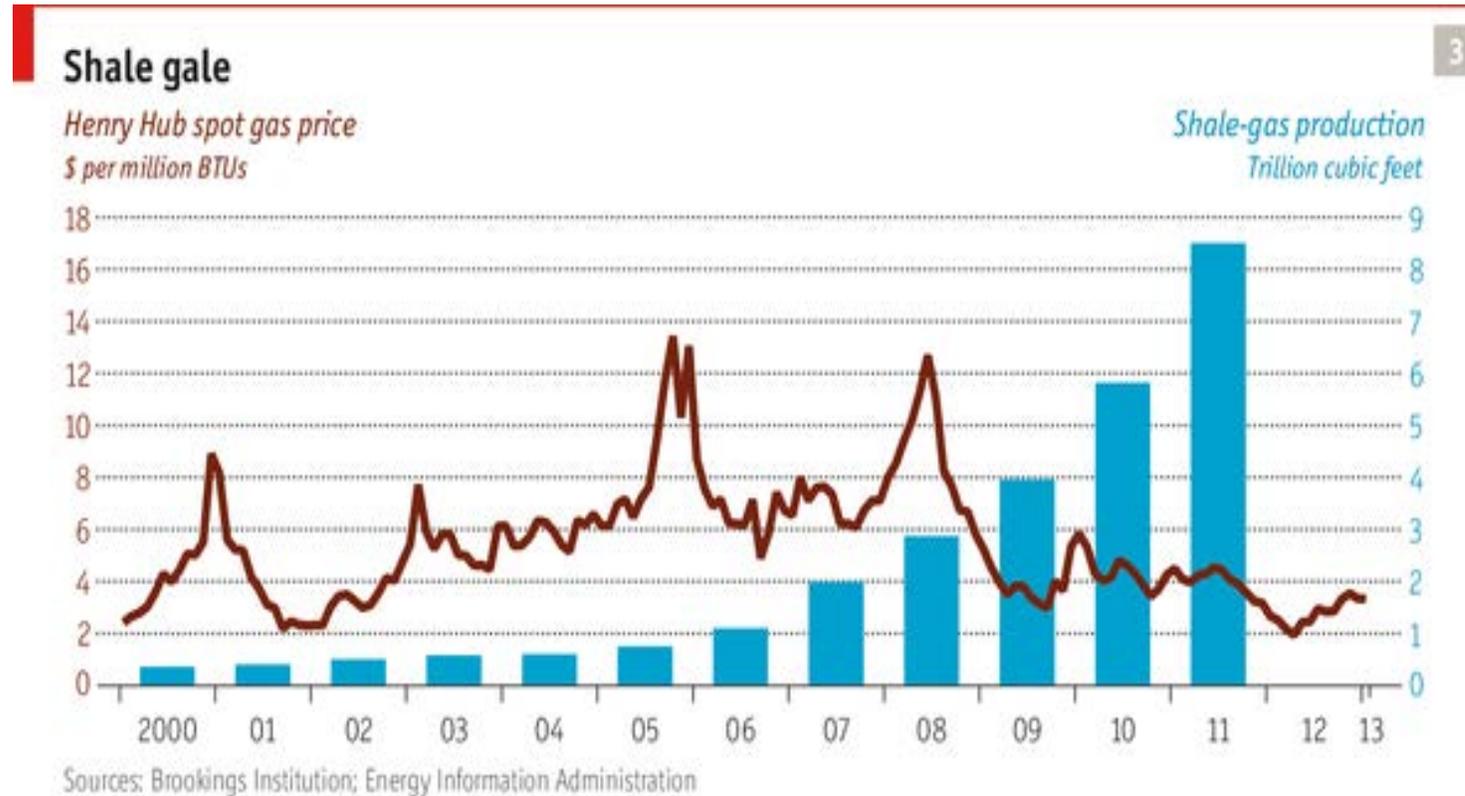
More Efforts to Negate the Market Verdict Against Nuclear

- 2006 – Several Southeastern states pass “early cost recovery” laws.
- Once utility commission certifies a need, then cost recovery begins, with no refunds and minimal reviews of prudence or need for the power.
- 2008 presidential campaign – Obama supportive, McCain promised 50 new reactors by 2030, later doubled to 100.

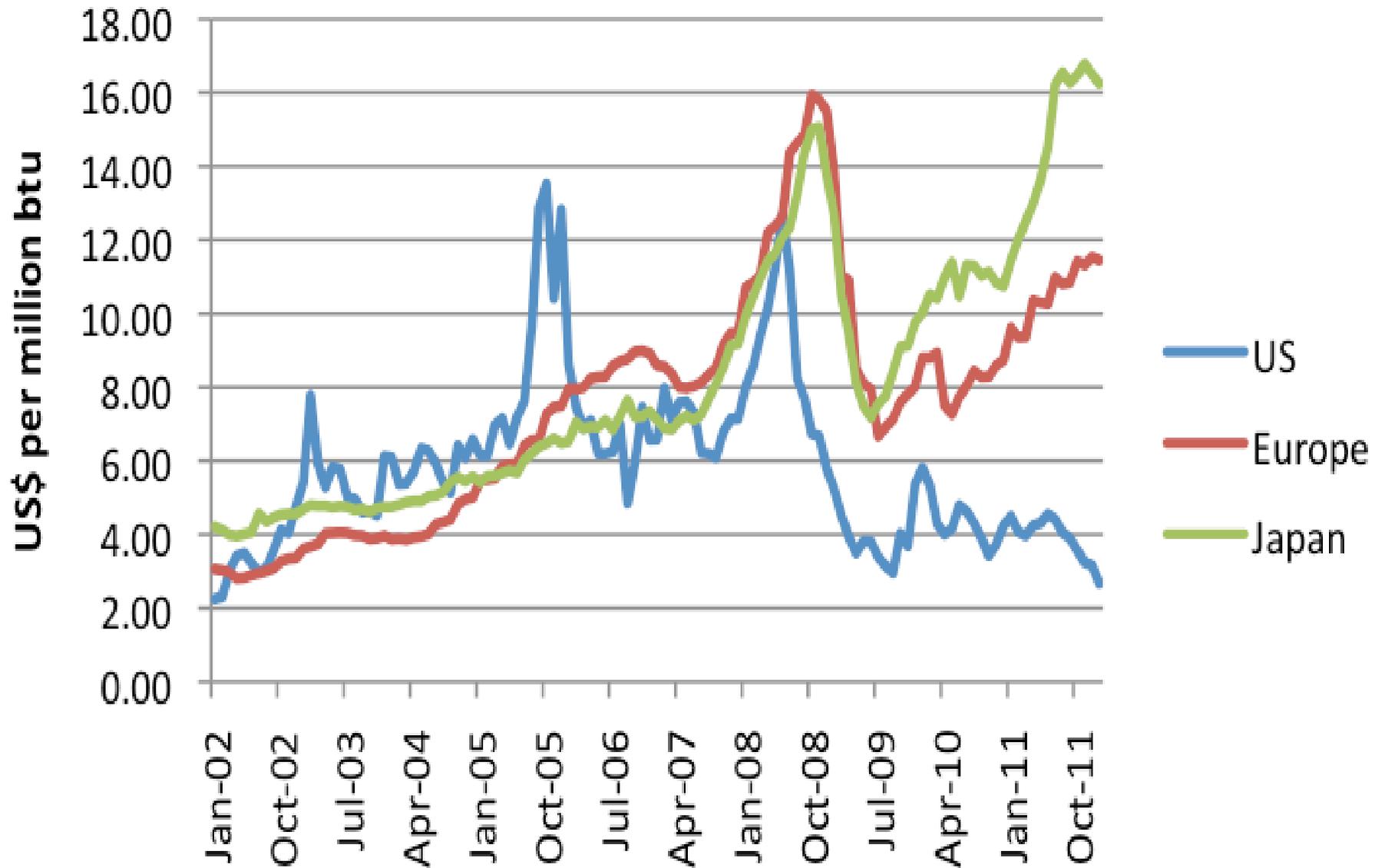
Nuclear Renaissance Autopsy

- By the end of 2008, applications for 29 new reactors were on file at the U.S. NRC, with four more expected in 2009.
- But only two more arrived.
- Only four of the 31 renaissance reactors are being built.
- For the first time in 15 years, operating reactors closed in 2013.

Gas Volatility v. New Nuclear Power at 12 Cents/kWh



Natural Gas Prices in US, Europe, Japan

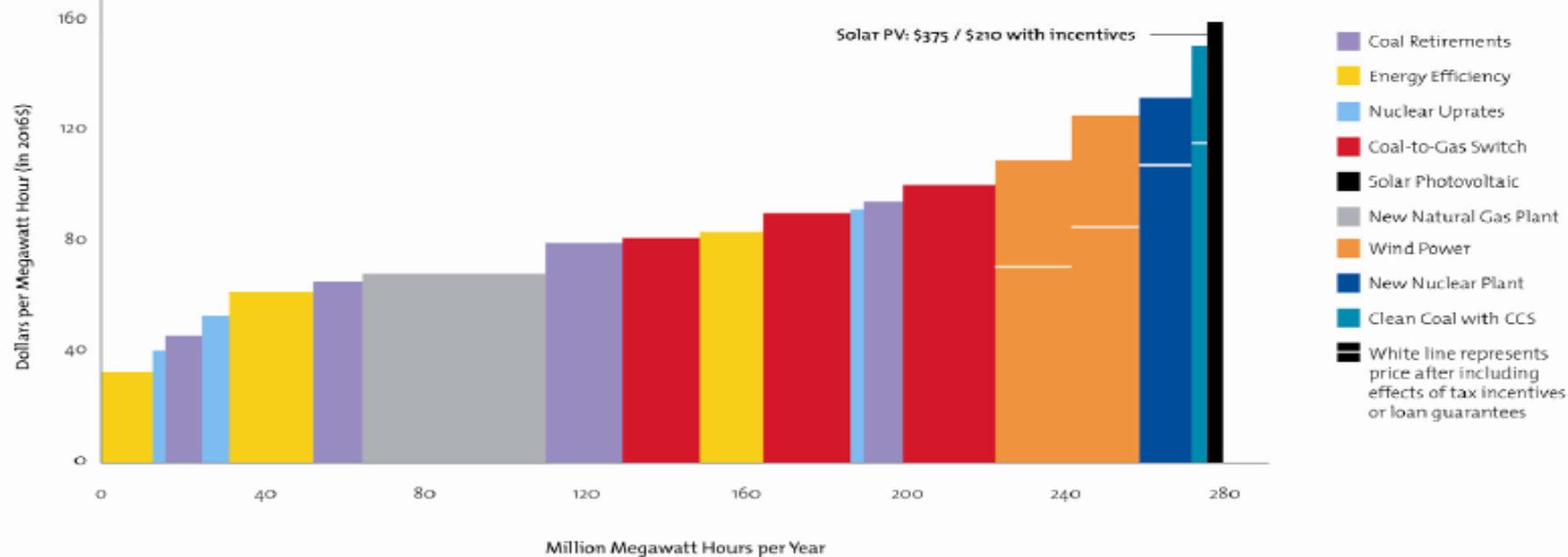


Low Carbon Alternatives as Seen By the Largest U.S. Owner of Nuclear Plants

There are Cheap Ways and Costly Ways to Clean the Generation Fleet

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Levelized Cost of Clean Energy Options in PJM



Note: Adjusts for the market value of the generation's reliability and production profile.

Technology cost assumptions (in 2016 \$/kW):
Combined-cycle gas turbine: \$1,300 - \$1,700
Wind: \$2,000 - \$2,500
Nuclear: \$5,000 - \$6,000
Clean coal with CCS: \$5,500 - \$6,500
Solar photovoltaic: \$3,000-\$4,000

Autopsy Notes: Causes of Demise

- Too much economic risk for power markets or private investors, shown by a cascade of events, any one of them arguably fatal:
 - Nuclear construction cost estimates up by 2-300%
 - Demand down due to recession and low cost energy efficiency;
 - Natural gas prices below MIT 2003 low end estimates;
 - No carbon pricing;
 - Discrediting of federal subsidies especially among pro-nuclear Republicans
 - Fukushima

The British Restructuring Experience

- An inefficient nuclear program including reprocessing from government to private ownership in 1989;
- Introduction also of customer choice;
- British surprise that investors would not buy the nuclear plants;
- In order to override the verdict of the British electricity market, the government is now making an astonishing commitment to have France and China build two reactors at a price guaranteed for 35 years (and adjusted for inflation) at about twice the level of the current British power market.

A Nuclear Support Policy That Might Have Made Sense

- What we really need is what we have always needed – market-harmonized ways to a nuclear policy that serves wise public policy, not the other way around.
- Such a policy might have included support for a few reactors balanced by a sensible carbon policy. Nuclear proponents might have bought it expecting success, opponents expecting failure.
 - Building new reactors “On time and on budget” won’t help if “on budget” means “twice the market price of electricity”.

Last Lesson

- It is possible to explain the downfall of the nuclear renaissance in the U.S. and Europe without mentioning safety, waste or proliferation.
- But of course no other energy source has these issues associated with it, and they are components of the exposure to economic risk that makes new reactors almost impossible to undertake through private capital markets.