

The Evolution of Electricity Markets and the Challenge for Nuclear Power

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Liberalized electricity markets in the United States have evolved over the past two decades to feature three distinct market products, each of which represents a different kind of service offered to the Regional Transmission Organizations (RTOs) that run the power grid and oversee electricity markets serving approximately 70% of all U.S. electricity demand. *Spot markets for electric energy* have historically made up the vast majority of power-plant revenues and are the primary means by which RTOs match supply and demand on a day-to-day and hour-to-hour basis. *Capacity markets*, while not used in every RTO, have become a common way of providing financial incentives for sufficient bulk generation capacity. *Ancillary services markets* provide RTOs with backup or adjustment power in case of contingencies on the grid, or to allow the grid to adapt to fluctuating wind and solar power.

The transition in many parts of the U.S. towards lower-carbon power generation would appear at first to advantage nuclear power technologies, as nuclear generation has no associated air emissions and has among the lowest life-cycle air emissions of any available technology for producing electricity. The reality has been very different, because electric power generation technology shifts in the U.S. have been driven not by a unified policy goal but by a combination of new low-cost natural gas supplies; subsidies and incentives for specific technologies (such as wind, solar and energy storage); and electricity market structures that have been particularly accommodating to natural gas and renewables. There have been three important impacts on the market environment for nuclear in particular.

First, existing nuclear power plants are suffering from intense competition that has driven down spot market prices for electricity, eroding operational margins for existing plants. As shown in Figure 1 below for the PJM electricity market, the share of power plant revenues in the spot electricity markets has declined substantially over the past several years. Some RTOs are reporting an increasing frequency of *negative* spot market prices, which can reflect the subsidies given to specific renewable generation technologies.

Second, new nuclear builds are suffering from a market structure that rewards plants with quick build times and low capital costs, even if their operational costs may be highly variable (depending on fuel prices, availability of wind and sun, and so forth). While Figure 1 suggests that capacity market prices are increasing as spot electricity markets decline, those increases have generally not been sufficiently large to cover capital costs for new nuclear power plants, and in some cases have not covered the going-forward costs of existing plants. Capacity markets are designed to ensure sufficient generation capacity exists to meet future electricity demand, but these markets do not generally provide for long-term revenues to ensure that capital costs are paid off. Wide regional differences also exist in the frequency of long-term contracting between utilities and power generation firms. Substantial improvements in energy efficiency have also impacted capacity prices, as electricity demand growth has been sluggish in many regions of the U.S.

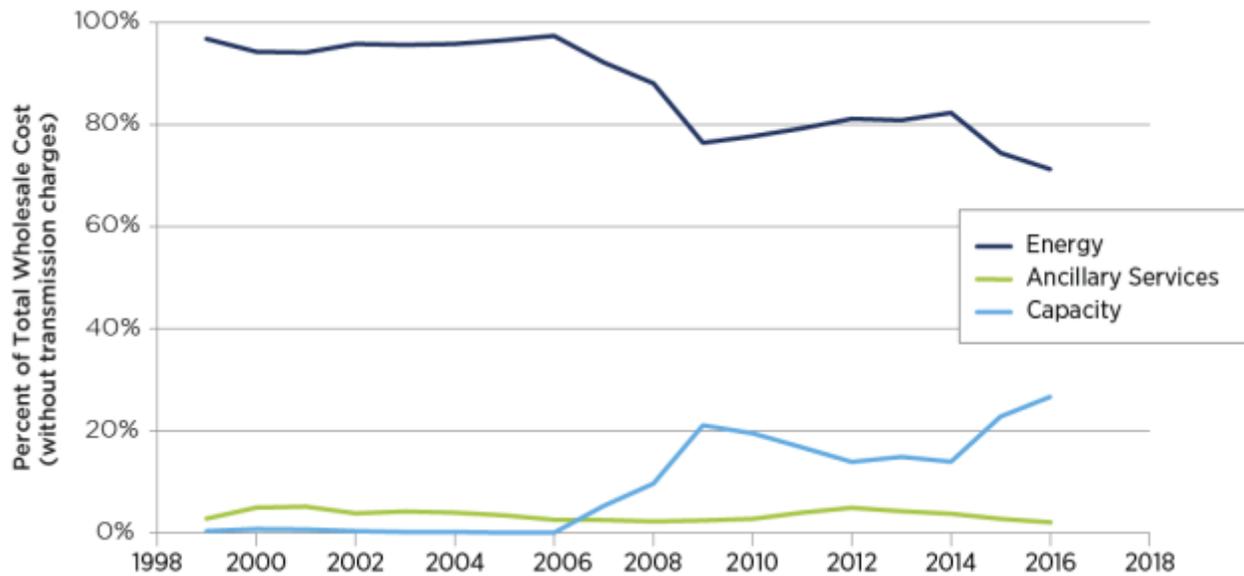


Figure 1: Share of total wholesale power costs in the PJM electricity market. Source: [PJM](#)

Third, existing electricity markets have had a very difficult time placing an explicit economic value on either diversity in the technology mix or the operational attributes that specific technologies provide, such as base-load power versus load-following ability. Nuclear power in the U.S. has historically operated in a market space that emphasizes spot energy and capacity market revenues – exactly the two markets that have been under the greatest competitive pressures. Regions of the U.S. that have seen rapid growth in wind and solar generation are starting to adjust their market structures to emphasize the need for flexibility, not just megawatts of generation capacity.

These market shifts leave nuclear power in the United States at a critical juncture. Some nuclear power plant operators have sought relief in the form of state subsidies, but these are costly and distort markets further. Electricity market reform of some kind is likely needed that recognizes the changing technology landscape for power generation and explicitly values the different services that are needed to keep power grids operating reliably. The nuclear power business, however, will need to shift as well, away from a model focused so much on megawatt quantity and levelized cost, and towards a model that can anticipate and provide the most-valued services demanded by grid operators.