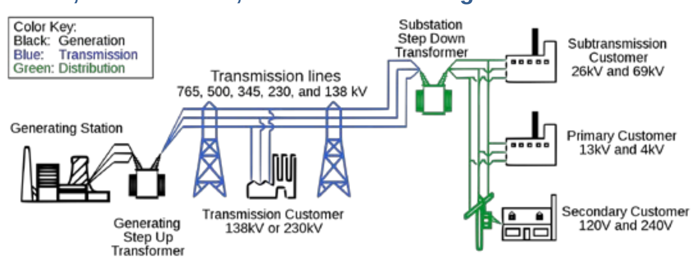
Power Markets

History of Power Markets

The U.S. power markets are extremely complex, not only in their technical dimensions but in their business structures. Markets operate with both public and private ownership, in both regulated and deregulated environments,[1] and under both federal and state regulatory control. In addition, electricity markets create contracts with a flow of obligations for power delivery that do not match the flow of electrons. The result is a physical infrastructure with varying contractual structures, and complex, occasionally-conflicting incentives.

In an industry that was served by highly-regulated, regional or local monopoly utilities, the electric grid started simply as a delivery device for electric service, owned and operated by vertically-integrated utilities. These utilities managed and invested in their own local generation, transmission, and distribution infrastructure, with the changing needs of their service area and with the blessing of state regulators. Eventually utilities began connecting their local transmission grids to neighboring systems, primarily to improve reliability, but also to reduce redundant generation. While state regulators oversaw the retail rate setting and utility investment decisions, the federal government, through the Federal Energy Regulatory Commission (FERC), regulated transactions across state lines—namely, wholesale power purchases and transmission investments. Typically, a retail electricity rate is composed of three charges: generation, transmission, and distribution.[2] The supply charge accounts for the largest percent of the total rate while the transmission charge accounts for the smallest percent (e.g., a Duquesne Light residential consumer in 2012 paid 7.86 cents/kWh for supply, 1.46 cents/kWh for transmission, and 4.85 cents/kWh for distribution).[3]

Exhibit 1 Generation, transmission, and distribution regulation and ownership



	Generation	Transmission	Distribution
Regulator	▸ State Public Utility Commissions (PUC)	▸ FERC ▸ State PUCs ▸ North American Electric Reliability Corporation (NERC) (sets reliability standards)	▸ State PUCs
Owner	▸ Investor-owned utilities ▸ Publicly-owned utility ▸ Independent power producers ▸ Federal power marketing authorities	▸ Investor-owned utilities ▸ Publicly-owned utility ▸ Federal power marketing authorities ▸ Independent transmission companies	▸ Investor-owned utilities ▸ Publicly-owned utility ▸ Federal power marketing authorities

Source: U.S.-Canada Power System Outage Task Force [4]

[1] Many of the technical terms used in this primer are defined in a companion *Glossary for Power Market Primers.*

[2] United States Government Accountability Office. (2008). *Electricity Restructuring: FERC Could Take Additional Steps to Analyze Regional Transmission Organizations' Benefits and Performance.* Retrieved on September 16, 2011, from http://www.gao.gov/products/GAO-08-987

[3] Duquesne Light Company. (2012). *Electricity bill – rate: RS – Residential Service*. Retrieved on June 14, 2012, from a customer bill.

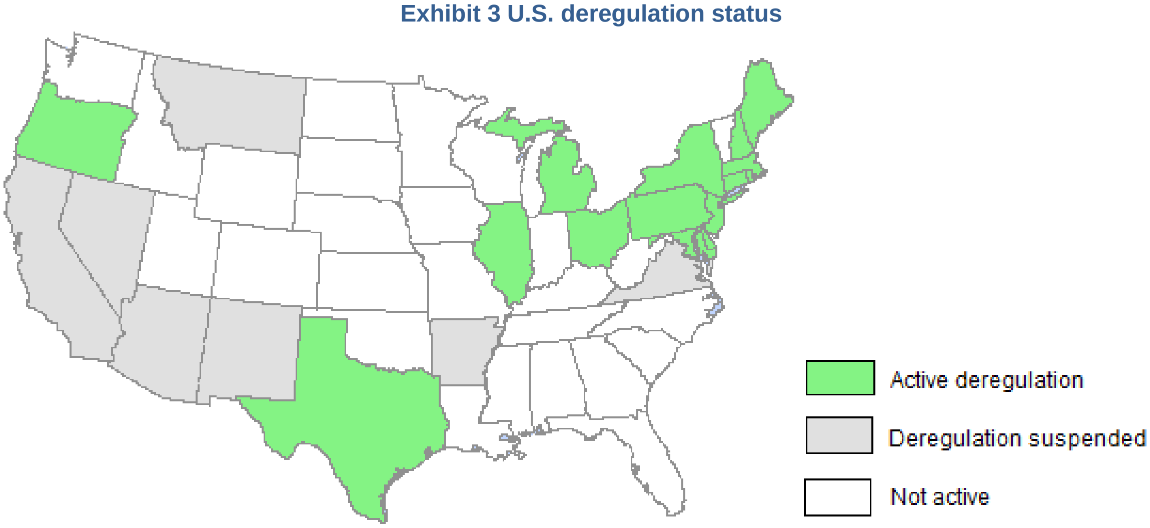
[4] U.S. – Canada Power System Outage Task Force. (2004). *Final Report on the August 14, 2003, Blackout in the United States and Canada: Causes and Recommendations*, p. 5. Retrieved on September 16, 2011, from http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/BlackoutFinal-Web.pdf

Exhibit 2 Power market regulators

FERC	▸ Federal Energy Regulatory Commission (FERC) – an independent commission with regulatory power over issues of interstate commerce of electricity, natural gas, and oil pipelines ▸ Monitors and investigates energy markets, establishes transmission tariffs, and maintains the authority to impose civil penalties on energy organizations or individuals who violate FERC rules
NERC	▸ North American Electric Reliability Corporation (NERC) – a non-profit organization formed in 1968 to ensure adequate power supply for electric utility systems in North America ▸ NERC is designated by FERC as an electric reliability organization ▸ NERC primarily works with industry to develop standards for power system operation monitoring and enforcing compliance with those standards, and assessing resource adequacy[5]
State PUC/PSC	▸ Public Utility Commissions (PUC)/Public Service Commissions (PSC) – state-by-state regulatory bodies with responsibility for overseeing utility activity within the state ▸ Primary activities include reviewing proposed utility investments and establishing allowable rates for utilities to charge ratepayers

In the early 1990s, the federal government, along with several states, began to take a series of steps aimed at restructuring the electricity industry, particularly targeted at increasing competition in wholesale power markets. In order to facilitate competition, FERC issued a variety of orders, starting in April 1996 with Order 888[6], which required that transmission owners under FERC jurisdiction (mainly large investor-owned utilities) allow other entities to access the transmission owners' transmission lines at the same prices and with the same terms and conditions that they applied to themselves. Deregulation of power markets has been implemented in several states, while other states have suspended deregulation due to a variety of factors.

Exhibit 3 U.S. deregulation status



Map created by NETL. Source: ABB Velocity Suite[7]

[5] More details about NERC can be found in *North American Electric Reliability Corporation* primer.

[6] Federal Energy Regulatory Commission. (1996). *Order No. 888: Promoting Wholesale Competition Through Open Access Non-discriminatory Transmission Services by Public Utilities and Recovery of Stranded Costs by Public Utilities and Transmitting Utilities*. Retrieved on September 16, 2011, from http://www.ferc.gov/legal/maj-ord-reg/land-docs/order888.asp

[7] ABB Velocity Suite. (2012). *Intelligent Map - US Electric Deregulation*. Retrieved on June 14, 2012, from https://velocitysuite.globalenergy.com/Citrix/MetaFrame/auth/login.aspx

Regulated Markets

Typically in both regulated and deregulated markets the retail rate of electricity is viewed in three components—generation, transmission, and distribution. In regulated states all these rates continue to be monitored and controlled by state PUCs/PSCs. Utilities are allowed to recover the costs of service along with an approved return on investment, which is typically presented as a percentage of the value of assets in a utility's "rate base." The components of a utility's rate base are dominated by the annual cost of property, plant, and equipment, but can also include other expenses at the discretion of each individual state's PUC/PSC. A utility's largest operating expense—fuel—is typically treated as a pass-through to consumers without an additional return on investment to the utility. PUCs/PSCs are tasked with ensuring the utilities operating in their state are able to provide reliable energy services to the state's population at the lowest possible cost. However, the state PUCs/PSCs must also allow utilities to follow legislative requirements, such as meeting Renewable Portfolio Standards, which could cause a utility to procure power at a cost higher than the lowest technically possible cost (i.e., by using different energy sources).

Deregulated Markets

In deregulated states, distribution rates are still regulated by state PUCs/PSCs, and transmission rates are regulated by FERC, but generation rates and ancillary services markets are determined by competitive markets. The wholesale markets continue to be monitored by FERC to ensure that they are competitive markets. Deregulated states typically have markets for wholesale power, ancillary services, and capacity services. In addition, Regional Transmission Organizations (RTO) or Independent System Operators (ISO), which maintain grid operations, typically facilitate other markets or provide other services such as transmission congestion hedging, integration studies, and functioning as a contract clearinghouse.

Wholesale power markets consist of transactions of large amounts of power from a generator to a supplier, such as a load serving entity (LSE). The LSE is typically a business, such as a generator, broker, marketer, aggregator or utility that sells electricity to consumers using the transmission or distribution facilities of an electric company, and pays a tariff to the distribution company. Wholesale market prices are set on a local ("node") basis to account for the physical restrictions of transmission capacity and generation asset access. Wholesale markets are typically managed on a day-ahead, hour-ahead, and spot basis such that generators can plan their operations and consumers can count on adequate supply. Additionally, generators, LSEs, or large retail users can enter into bilateral contracts —buying/selling power between two parties—without going through the wholesale market; however, the grid operator (typically an RTO/ISO) must be aware of the contract in order to maintain reliability and order generators dispatch.

> ***Ancillary services***
>
> - **Frequency regulation support:** Generators that provide a short-term response capability (or demand response) used to balance short-term deviations between system load and generation
> - **Operating reserve:** Generators and demand resources that are used to balance shorter-term deviations between system load and generation, correct-load forecasting errors, handle forced outages, and recover from a contingency
> - **Reactive power**: Used to compensate for voltage drops, typically provided closer to the load than real power needs

Reliability is ensured by the market (and facilitated by grid operators) via forward capacity markets and services markets. Forward capacity markets provide payment to generators for having generating capacity available in sufficient quantity to provide a reserve margin above the anticipated demand for a certain period. Forward capacity markets are typically for medium to long term, with generators providing capacity availability for three months to a year, up to three years in advance. Ancillary services markets are run on a shorter timeframe, with generators bidding capacity to provide availability for regulation support, operating reserve, or reactive power in order to maintain the minute-to-minute reliability of the grid.

Another key feature of deregulation is the ability for retail consumers to choose their supplier of electric services. Through FERC Order 888, transmission lines are required to be offered to the market at established tariffs; similarly, deregulation typically provides for distribution lines to be available to the market at established tariffs. Each of these elements is key to retail competition in that they allow third parties (i.e., parties other than the direct owner of the transmission or distribution line) to access the lines and provide electric service to consumers. Retail choice in an electric provider means that a consumer can sign a contract with a qualified third party electric service provider who could, in turn, contract with a generator (on a bilateral basis), self-generate, or purchase power in the wholesale market, and pay the necessary tariffs to the transmission and distribution owner. Third party electric service providers make money when they are able to sign contracts with retail consumers at higher prices per kWh than they must pay for transmission, distribution, and wholesale power, and often engage in energy trading or hedging activities.

While the markets have devised methods for writing contracts between generators, LSEs, and transmission owners, these contracts do not necessarily reflect the physical flow of electrons on the grid. Electrons flow along paths of least resistance, not as written in a contract. Contracts will, in part, reflect this reality, as RTOs/ISOs will account for the maximum transmission line capacity when administering contracts and will disallow contracts that exceed the physical limitations of the grid. However, other contracts—such as retail purchases of “green” power—are allowed despite the physical reality that once electrons enter the grid it is impossible to determine which electrons are delivered to a load. Contracts may be written as shown in Exhibit 4 depending on a variety of economic factors, including the marginal cost of production for each generator, the marginal price at each node, costs of congestion, and expected line losses. However, depending on the resistive properties of each node (including the distance from each generator to each node), the actual power flow may be different from the contract power flow.

Exhibit 4 Simplified contract flow

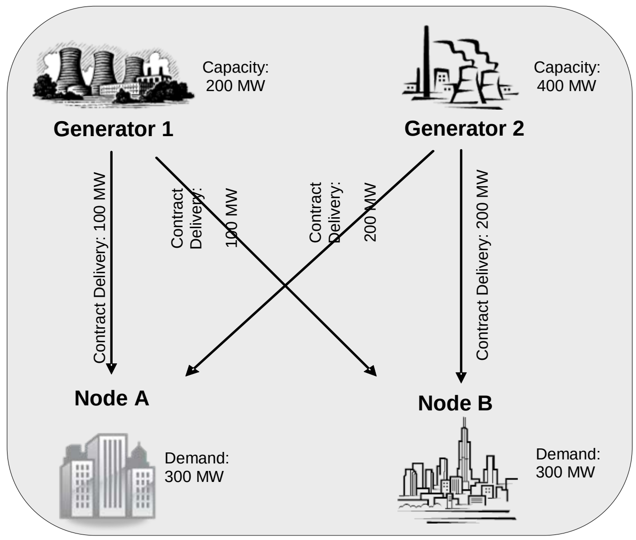


Image created by NETL.

RTOs and ISOs have the responsibility for maintaining the physical flow of power, but this is done on a day-to-day (and hour-to-hour) basis by providing dispatch signals to generators in the region. The RTO then administers the market by settling contracts between buyers and sellers of power based on the forward contracts that were previously executed or by the spot prices that existed when the RTO sent the dispatch signal. In the simplistic example above, the RTO would settle payments from the load center based on the contract flow, not on the expected physical flow.

Although the physical power flows and contractual agreements do not match, FERC and other market players have decided that this inconsistency is acceptable, and thus there are no adverse impacts on generators or LSEs for the mismatch. FERC recognized this difference in Order 888, which determined that contract flow was acceptable predominantly because going to a power flow-based contracting system would be too disruptive to the industry and thus would slow the move to more competitive wholesale power markets and hinder open access to transmission.

More details about different markets can be found in the primers *Energy Market*, *Ancillary Services* and *Capacity Market*. More details about different ISO/RTO can be found in the ISO/RTO primers *California Independent System Operator*, *ERCOT Independent System Operator*, *MISO Regional Transmission Organization*, *ISO New England Regional Transmission Organization*, *New York ISO Regional Transmission Organization*, *PJM Regional Transmission Organization* and *Southwest Power Pool, Inc*.