THE EVOLUTION OF THE U.S.A. OPEN ACCESS TRANSMISSION REGIME

by
George Gross
University of Illinois at Urbana-Champaign
Urbana, IL 61801, USA
gross@uiuc.edu

ABSTRACT

The electric utility industry, the last major regulated monopoly to undergo restructuring, is in the midst of its most turbulent period since Edison started the Pearl Street Station in 1882. A number of driving forces including the environment, technology advances, legislative/regulatory initiatives and market pressures are bringing major changes to the industry. There are major developments underway to bring about full competition in many of the electricity sectors. From the very beginning it was realized that the role of transmission in the development of competitive markets in wholesale electric power was of critical importance. In this paper we focus on the ramifications of the implementation of open access in the US. We discuss the various developments on both the legislative and regulatory fronts and assess the impacts of the evolving market. The objective of the paper is to develop a clear understanding of the roles, challenges and opportunities of transmission open access in the development of competitive electricity markets.

The paper reviews the transformation of the vertically integrated utility structure into the unbundled services organization that is currently underway. The breakup of the generation monopoly of electric utilities and the impacts of market forces and FERC initiatives are examined. We describe the initial stages of the breakup of the old vertically integrated structure as it is being replaced by various implementations in the restructuring of the electricity industry. We review the key legislative and regulatory developments in the US leading up to the FERC Orders No. 888 and 889 as well as the major thrusts of these Orders. The nature, growing pains and challenges of open access transmission and the accompanying unbundling impacts are explored. We examine the concept of the Independent System Operator and of the push toward the regionalization of the transmission system currently underway.

1. INTRODUCTION

The electric utility industry, the last major regulated monopoly to undergo restructuring, is in the midst of its most turbulent period since Edison started the Pearl Street Station in New York. A number of driving forces including the environment, technology advances, legislative/regulatory initiatives and market pressures are bringing major changes to the industry. There are major developments underway to bring about full competition in many of the electricity sectors. From the very beginning it was realized that the role of transmission in the development of competitive markets in wholesale electric power was of critical importance. In this paper we focus on the ramifications of the implementation of open access in the US. We discuss the various developments on both the legislative and regulatory fronts and assess the impacts of the evolving market. The objective of the paper is to develop a clear understanding of the roles, challenges and opportunities of transmission open access in the development of competitive electricity markets.

To understand the role of transmission it may be helpful to briefly review how the industry evolved into its current form. In the vertically integrated utility (VIU) structure, the entire system – generation, transmission, and distribution – was constructed and operated to supply the utility's loads. The transmission system was built and operated very much in a supportive role to ensure that the generation outputs could be delivered to the load centers. The primary purpose of the utility was to supply the utility's *native load customers*. Under the industry organization in place, all the facilities and the loads served are owned/controlled by the utility. All the utility's services were bundled and all the costing was performed on a bundled basis.

The basic design was for the entire system to meet the utility's own customers' needs: transmission loading and voltage were specified in such a way as to supply all the customers under peak demand conditions and generation capacity installed was sized for the same purpose. Transmission systems consequently developed primarily to meet the demands of the native load customers by connecting remote generating resources to load centers and later by interconnecting utilities for reliability and constructing ties to support inter-utility transactions. Moreover, all support activities or services such as voltage regulation, frequency control, var support, generation and var reserves were all bundled into this single design for that very purpose.

The transmission network was designed and planned to meet the needs of the utility's customers and its use for third party purposes was of secondary importance. In general, the use of the transmission system by others was relatively limited in the past. Transmission owning entities did supply limited amounts of transmission services to other entities but these services were *non-comparable* as will be discussed later in the paper. The native load customers had priority and the transmission service purchaser had tight limits on amounts of service provided and the conditions under which service was provided. In many cases, the transmission provider would undertake bundled deals to provide generation, operations support and planning together with transmission. A typical example of services was the bundled package deals under which transmission, full/partial requirements services and control area services were provided. In certain cases, a limited amount of transmission only services was provided to embedded (captive) transmission dependent utilities and embedded nonutility generation. The principal vehicles used were interconnection contracts, integration agreements and power pooling arrangements. These instruments described all terms, rates and conditions for providing and receiving the transmission services. Typical service provisions include: the amount, path(s), and point(s) of receipt/point(s) of delivery; the duration/term; the firmness/interruptibility; the curtailability; the flexibility; obligations for capacity increase; ancillary service obligations; and pricing.

As the structure of the industry changed, there were major pressures on transmission owning utilities to open up their systems for use by third parties. The push for the implementation of competitive markets in electricity requires first the establishment of well functioning competition in the wholesale sector. All players – buyers, sellers, brokers and marketers – require non-discriminatory transmission services to get products to markets or to acquire products competitively from the supplier of choice. Each transmission customer needs to have service *comparable* to that available to native loads of the transmission service provider. Transmission service is the most critical element in making competitive electricity markets work. Unfortunately, there is no clear definition of what constitutes transmission services. In conceptual terms, transmission services constitute the means for one or more generators to get the output to one or more loads. We may view transmission service to comprise the collection of resources, facilities and processes that are required to enable the "movement" of electricity from one location to another and the set of activities that uses the transmission system and economically impacts the provider and the user. A more ambitious definition is the following. Transmission services are the services provided by harnessing and coordinating the various equipment/facilities/generating resources directly connected to the transmission network and possibly some of the distribution network (wires), as well as using the complex data gathering, communications and control equipment and processes which are part of the energy management system.

In the competitive wholesale electricity markets, unbundled transmission service is taking on a common carrier role. The existence of smoothly running electricity markets requires nondiscriminatory transmission services for all players. The implementation of open access in the US to accomplish this goal is the scope of the work reported in this paper. The ramifications of open access in breaking up the well-entrenched VIU structure and the attendant unbundling of electricity services are discussed in detail. The paper outlines the challenges and opportunities associated with the separation of services and costs in the new regime. The changing nature of electricity to a structure with customer choice, vertical unbundling and horizontal consolidation, increasing volume in inter-regional energy transfers, a growing proliferation in the number of transactions, "instantaneous" changing of suppliers and buyers, independent grid operators without generation resources and decentralized decision-making has major repercussions in the organization and operation of transmission. Management of transmission resources has become very challenging requiring the coordination of disparately owned entities, the allocation of costs among the many transactions and the specification of the *rules of the road* for an effective and efficient system. The accommodation of market forces with the physics/engineering of power systems makes the task even more complex. At the same time, maintenance of system security/reliability remains as important under the new structure as it was in the old one.

This paper consists of six additional sections. Section 2 provides a brief review of the initial stages of the breakup of the old vertically integrated regime as it is being replaced by various implementations in the restructuring of the electricity industry. We discuss the key legislative and regulatory developments in the US leading up to the FERC Orders No. 888 and 889 in Section 3. The major thrusts of these Orders are outlined in Section 4. The nature, growing pains and challenges of open access transmission and the accompanying unbundling impacts are discussed in Sections 5, 6 and 7. We describe the concept of the Independent System Operator in Section 8 and conclude the paper with a discussion of the push toward the regionalization of the transmission system in Section 9.

2. THE BEGINNING OF THE BREAKUP OF THE VERTICALLY INTEGRATED UTILITY (VIU) STRUCTURE

In pre-restructuring times, electric utilities were *natural monopolies* governed by a *regulatory compact*. The traditional structure of the electricity industry was that of strong vertically integrated utilities (VIU's) with the generation, transmission/distribution and the customer service seamlessly fused together. The notion of a regulated public utility was introduced in the 1930's with the intent that *regulation* would act as a proxy for competition. Utilities typically received franchise/service territories with protected captive markets. In exchange for a monopoly franchise in the service territory, a utility accepted an *obligation to serve* all existing and future customers on a non-discriminatory basis at *tariff rates*. The rates of the regulated monopoly were set by the regulatory agencies. Rates were cost based, i.e., cost of service regulation, and resulted in making utilities *cost-plus* businesses.

This traditional structure of the electric utility industry resulted in a number of distinct characteristics. Due to the cost-plus nature of the business, there was low emphasis on cost control, heavy staffing and low tolerance of risk and uncertainty. The regulatory compact encouraged capital investment, which was recovered with the allowed rate of return through the rates collected. Typically, utilities constructed many facilities which lead to the labeling of utilities as being *gold plated*. The fact that the utility was the only source of electricity resulted in a very limited menu of service offerings; moreover, utility employee mentality was one driven by a *culture of entitlement* – the utility employee knew best what the customer *needed* and *could get*.

The 1950's and 1960's constituted the golden era for electric utilities. This was a period of high electricity demand with a relatively stable growth in the demand. The advances in technology were exploited and resulted in large economies of scale. Such economies combined with the moderate construction costs and the low interest rates lead to major boom in the construction of new facilities. There was considerable expansion of the utility systems during that period. The overall effect was a steady decline in electricity rates.

The 1970's, however, brought about a decade with many changes, which inalterably changed the face of the industry. The OPEC oil embargo in 1973 put an end to declining electricity prices and predictable growth in demand. As a result, the conservation ethic was adopted and demand-side management was born. The decade was characterized by double digit inflation and interest rates. The high cost of borrowed funds impacted particularly heavily on the well being of the industry. Rampant escalation of costs and regulatory delays pushed capacity costs from $150 to $5,000 per kW. An important development was that the increasingly prominent role of the environmental activist movement as a major stakeholder in the affairs of utilities. These developments resulted in huge pressures on utilities in all directions. The result was a series of massive cancellations of capacity additions and major ratepayer resistance to the escalation of electricity rates. Prudence reviews of utility projects resulted in huge disallowances which negatively impacted on utility shareholders. Ratepayers balked at the spiraling costs of new plant. Regulators' reluctance to raise electricity rates put utilities under tremendous financial stresses. Under these circumstances the *regulatory compact* began to unravel and a new era for the utilities was beginning.

The Public Utility Regulatory Policies Act (PURPA) enacted in 1978 put an end to the electricity generation monopoly that the utilities enjoyed up to that time. PURPA introduced new electricity generating entities known as qualifying facilities (QF's) that had to meet specific criteria. The Act mandated each investor owned utility to purchase power from a QF located in its service territory at *avoided cost*, i.e., the cost that the utility would have incurred with all but the QF. The implementation of PURPA was left to the individual states and resulted in widely varying definitions of avoided cost. The once fledgling private power enterprises constitute today a multi-billion dollar industry and play a critically important role in the electricity business.

PURPA unleashed competition through the introduction of QF's. In fact, the QF's and other nonutility generating projects such as those of independent power producers or IPP's became the dominant source of supply of new capacity in electricity. Figure 1 shows the increasing importance of the nonutility ownership of new generation over the years 1985 – 1995.

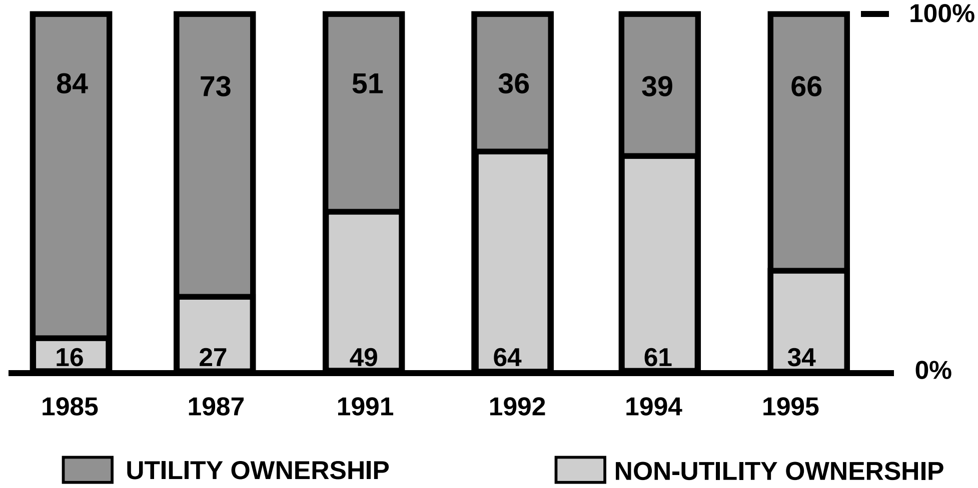


Figure 1. The ownership of new generating capacity additions

3. MAJOR LEGISLATIVE AND REGULATORY DEVELOPMENTS

The advent of new generating entities such as IPP's and QF's put new pressures on the utilities. These new players were particularly interested in tapping into the higher – priced electricity markets if they could find a way to *transport* their outputs from their generation sites to other regions. For example, the wide range of prices for residential electricity in the various parts of the USA for the year 1995 is shown in Figure 2.

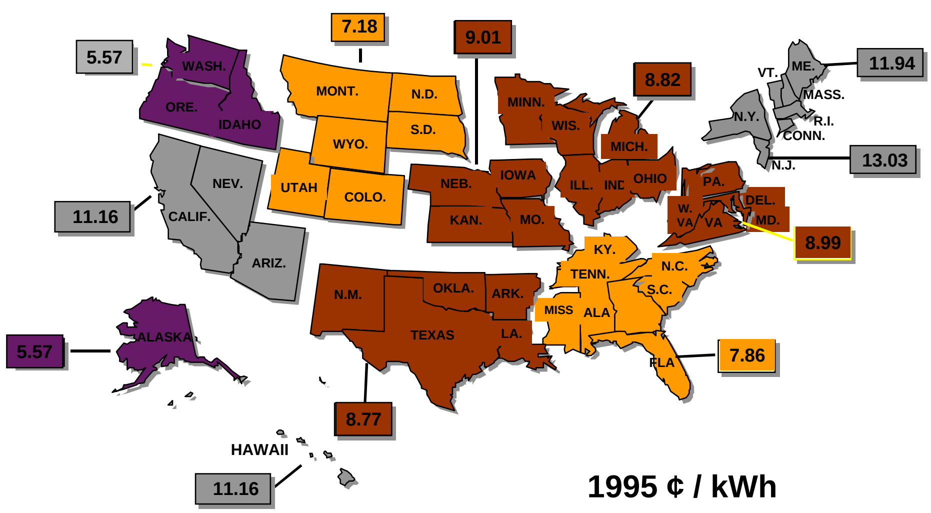


Figure 2. Average residential electricity costs in 1995

The structure of the VIU despite the advent of new players did not change, as seen in Figure 3. The nonutility generators were dependent on the transmission owning utilities for access and service. The ability of these entities to obtain transmission services from the transmission owning entities was, however, virtually nonexistent. There were several major developments on the legislative and regulatory fronts aimed at addressing the issue of opening up the transmission system to provide nondiscriminatory transmission services to these and other interested entities.

A very important piece of legislation, the National Energy Policy Act (EPAct), was enacted in 1992. This Act addresses all the major elements of national energy supply and use and was the most important energy legislation enacted since the creation of federal regulation for electricity in 1935. Among its many provisions are the establishment of new federal policies governing the generation and sale of electric power in the wholesale market place. EPAct established a new class of independent generators known as exempt wholesale generators or EWG's. Such entities are exempt of the Public Utilities Holding Company Act (PUHCA), which was revised with this new Act. The provisions for reforming the 1935 Federal Power Act and the powers of the Federal Energy Regulatory Commission (FERC) to be able to mandate wheeling by transmission owning utilities are the key legislative developments for open access transmission.

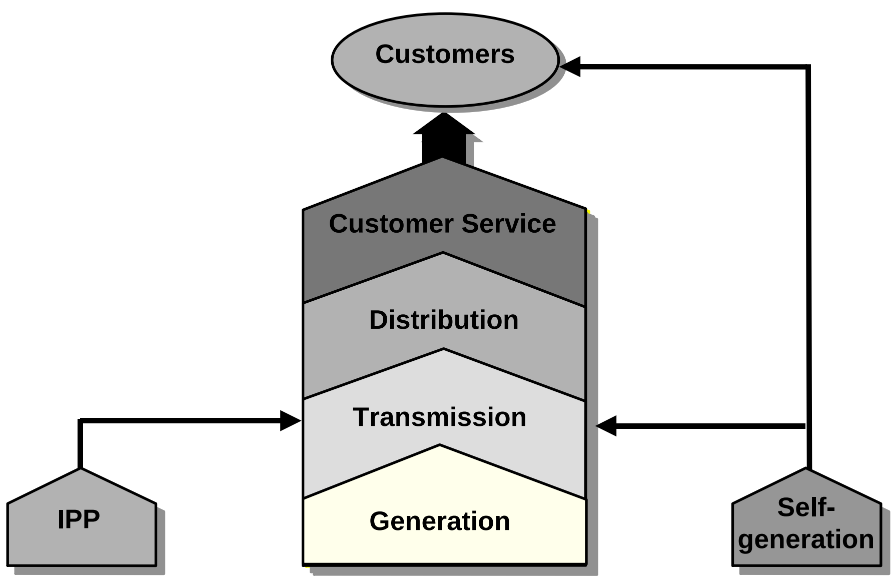


Figure 3. The structure of the VIU industry: all the generating entities depend on the transmission of transmission owning entities

EPAct transmission requirements allow any electric utility, federal power marketing agency or person generating electric energy for sale at wholesale to request transmission service from a transmission owning utility (TOU). A TOU must respond to a good faith request for transmission service within 60 days; if such request is not met, the eligible party may apply to FERC for a transmission order. FERC may issue a transmission order if it is in the *public interest*. FERC has the authority to order a utility to expand its transmission facilities if constraints exist to provide requested transmission service. EPAct requires FERC to give consideration that its order would not unnecessarily impair the continued reliability of the transmission owner's system.

The passage of EPAct marks the end of a highly regulated and structured period for utilities. The various electricity provisions push aggressively wholesale competition and served as the prime mover for the new regulatory initiatives of FERC. By broadening the powers of FERC to mandate wheeling by transmission owning entities, EPACT made possible the start of the transmission open access regime in North America. FERC seized on its newly enlarged authority and issued a series of decisions which laid out the regulatory framework for the operation of the open access transmission system. Within the US regulatory framework, the FERC has undisputed authority over all matters of interstate electricity commerce. In particular, FERC has exclusive jurisdiction over all electricity sales for resale and over transmission rates, terms and conditions. Using this authority, FERC undertook a series of highly important rule makings that brought about fundamental changes in the electricity business. In essence, prior to EPAct, transmission owning entities had very limited obligations to provide transmission service under the Federal Power Act (FPA) of 1935. The exceptions typically arose in the application of Federal anti-trust acts, from some acute political pressure in the 1960's, the 1970 Amendments of the Atomic Energy Act and the very specific and limited authority granted in PURPA. There was wide recognition of the critical need for open access for establishing well functioning competitive electricity markets but prior to 1992 FERC only addressed the issue on a case-by-case basis.

The cornerstone of all FERC initiatives is the policy of comparability, which became the FERC *golden rule* for transmission service . Comparability requires a transmission owning utility to offer access to third parties "on the same or comparable basis, and under the same or comparable terms and conditions, as the transmission provider's uses of its system." A transmission owner must "charge itself on the same or comparable basis that it charges others for the same service." Comparability aims to eliminate any competitive advantage that a utility may have because it owns transmission.

On March 29, 1995 FERC released an ambitious Notice of Proposed Rulemaking (NOPR) entitled

> *"Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities and Recovery of Stranded Costs by Public Utilities and Transmitting Utilities"*

The NOPR was the most fundamental reexamination of wholesale electric power regulation and operations since the introduction of federal regulation of electricity. The basic premises for the rulemaking were the persistence of wide spread discrimination arising out of the continuing market power in transmission. The FPA requires FERC to remedy undue discrimination and FERC believed that the new rule was needed to order utilities to file open access comparable transmission tariffs. Following nearly a year of hearings, technical conferences and comments on April 24, 1996, FERC released two major Orders defining the regulatory structure for the establishment of universal open access in North America:

Order No. 888 – Open Access Transmission and Stranded Cost Recovery

Order No. 889 – Open Access Same-Time Information System (OASIS)

The Orders constitute a *generic* remedy for the undue discrimination in the industry's past practices in providing transmission services. They serve to aggressively promote robust competition in wholesale markets, remedy undue discrimination in transmission and establish standards for recovering stranded costs.

4. FERC ORDERS NO. 888 AND 889

The Orders laid out a broad range of requirements that the transmission owning utilities must meet. The major thrusts of the requirements imposed on transmission owners in the two FERC Orders are:

- provision of non-discriminatory open access through tariffs of general applicability
- functional unbundling of transmission and generation services
- unbundling of *ancillary services* from transmission services
- establishment by each transmission provider of an electronic bulletin board known as OASIS (Open Access Same Time Information System)
- compliance by all jurisdictional utilities with the *Standards of Conduct*
- specification of the basic service requirements of transmission providers

In addition, the Order No. 888 laid out the standards and procedures to be followed for the recovery of stranded costs resulting from increased competition under the new FERC rules. In an attempt to make the reach of FERC's sphere of influence as wide as possible, Order No. 888 included provisions for reciprocity to transmission service providers by all non-FERC-jurisdictional entities.

Eligibility for open access service was for all entities engaged in wholesale purchases or sales of energy. The Orders specifically exclude transmission and sales directly to retail customers and sham wholesale transactions. However, unbundled retail access under voluntary and/or state-imposed programs is permitted.

The requirements in these Orders resulted in fundamental changes in the functioning and the operations of electric utilities. All new open access transmission tariffs had to incorporate the comparability requirement. The filing of non-discriminatory open access tariffs was completed by the jurisdictional utilities in 1996 and various levels of progress on meeting the scope of all other requirements are visible throughout the nation. We next examine the nature, scope and impacts of these requirements.

The functional unbundling serves as the basis for the implementation of non-discriminatory open access transmission by requiring the transmitting utility to

- separate pricing of wholesale generation, transmission, and ancillary services,

- take transmission and ancillary services for all its future wholesale transactions under the same terms, conditions and rates as offered to its competitors, and
- provide access to all transmission customers to the information on the same OASIS, at the same time and in the same manner.

These unbundling requirements are far reaching and are leading to the breakup of the VIU structure. The FERC stopped short of requiring the corporate unbundling of transmission facilities. However, the functional unbundling requirements raise serious questions whether transmission ownership will continue to provide the strategic value it has in the past.

The OASIS is the primary tool for the implementation of functional unbundling. In order for all transmission customers to have access to the same information as the transmission provider *at the same time* and in the same manner, the information must be disseminated electronically using real-time information networks and industry-wide communications protocols. The *equal information availability* nature of OASIS is illustrated in Figure 4. The OASIS must display information on transmission services available, tariffs, schedules and *available transfer capability* estimates.

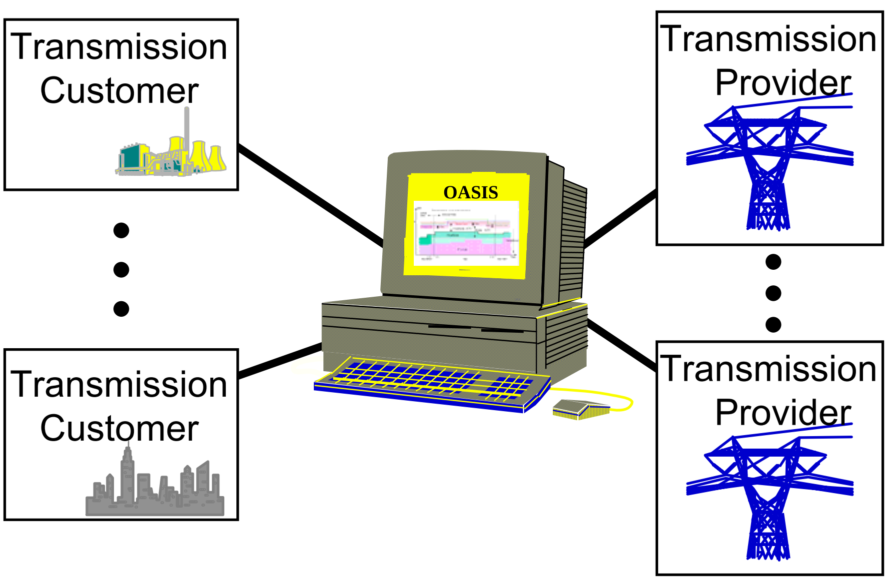


Figure 4. The OASIS is the key to equal information availability

The set up of OASIS is accompanied by the establishment of *Standards of Conduct* which create a clear separation between the merchant and transmission functions. All transmission owning utilities must erect this so-called “Chinese” wall in order to prevent preferential access to transmission prices and availability. Compliance with the *Standards of Conduct* requires the merchant function to conduct itself as any other transmission customer and to obtain information from OASIS, the transmission provider or public domain. In particular, the Standards prohibit the utility employees in the merchant function to undertake transmission system operations and reliability functions and to obtain access to system control facilities and any information that differs from that provided to all other transmission customers.

The basic service requirement provisions obligate transmission entities to offer transmission and ancillary services which they are reasonably capable of providing. There are two classes of basic transmission services that a provider must offer – network integration transmission service (NITS) and point(s)-to-point(s) transmission service – applicable to both wholesale and retail transactions. There are six mandated ancillary services which must be offered unbundled from basic transmission service. The comparability requirement refers to *comparability* of service rather than *equality* of service. Pricing in the Orders is to be on an unbundled basis but is not specified; recovery of opportunity costs and system expansion costs are allowed . The transmission owner retains the obligation to construct new facilities.

The reciprocity requirements signal FERC's intention to make its rules applicable, in effect, continent wide by requiring compliance by not only jurisdictional entities but also by nonjurisdictional utilities. The latter include Federal power marketing agencies (PMA's), co-ops, public power entities, Canadian and Mexican utilities that are seeking service under the new tariffs. They must, in turn, provide comparable service to the transmission provider from which they request service. Provisions for nonjurisdictional utilities to request a waiver or seek a FERC safe harbor order regarding the comparability of their tariffs are also given and can be used under certain conditions.

These two important FERC Orders signal FERC's intention to move away from the patchwork case-by-case transmission rulings of the past to *universal* open access. They aim to aggressively promote the development of a competitive wholesale electricity market by mandating open, non-discriminatory transmission access. The Orders provide the generic definition of a utility's comparable transmission service obligations under the Federal Power Act. The stranded cost provisions address transition costs associated with industry restructuring. The effective implementation of OASIS has the potential to bring about standardization throughout the industry.

5. OPEN ACCESS TRANSMISSION SERVICES

FERC Orders 888 and 889 together with other associated decisions serve to make transmission a *common carrier* service. Figure 5 depicts the use of the transmission system in such a mode. A key impact of the *common carrier* transmission network is the utilization of the transmission grid in very different ways than those for which it was planned. This is due to a large part to the proliferation in the number of transactions and the increasing number of new players who are transmission customers. A second and equally important development is the breaking up of the VIU structure into various separate components. Developments on both the regulatory front and in the evolving markets are resulting in the unbundling of services with energy completely separated from transmission, basic transmission service provision to all eligible entities engaged in wholesale markets and all ancillary services being provided as separate services.

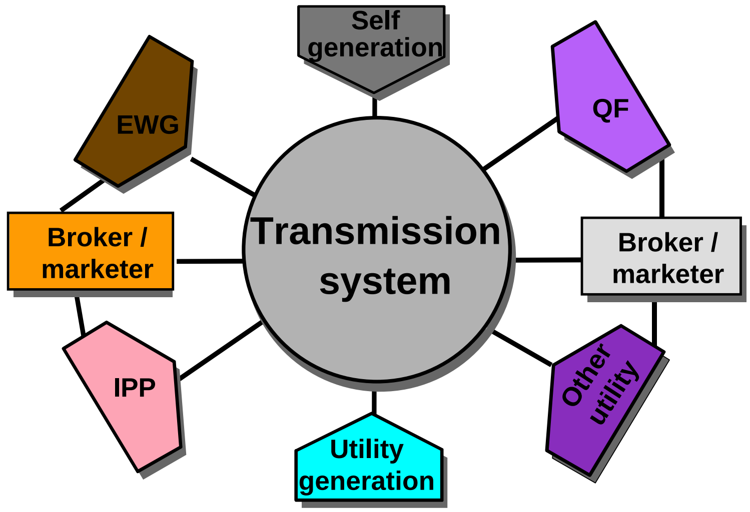


Figure 5. The use of the transmission system in the *common carrier* mode

Under the FERC *pro forma* tariffs for standardized transmission services filed by each jurisdictional transmission owning utility, the offer of all transmission and ancillary services which it is reasonably capable of providing is included. The required services under the *pro forma* tariffs are

- point-to-point service: receipt and delivery of capacity and energy at designated buses
- network integration service: integration, dispatch and regulation of existing and planned resources to serve loads in a manner comparable to that with which the transmitting entity serves its native load
- unbundled ancillary services

Point-to-point transmission service specifies a single injection node, called a point of receipt (PoR), and a single withdrawal node, called a point of delivery (PoD). Such service may be used between one or more user-designated point pairs of receipt and delivery. The minimum term of the service is 1 hour with no limit for the maximum term. The transmission user receives transmission priority equivalent to that of network integration service. The transmission customer has flexibility to switch points of receipt/delivery if alternative paths become available and is not responsible for congestion management costs. The charges are based on the higher of either the sum of reservations at the PoD's or the sum of reservations at the PoR's.

The network integration transmission service involves multiple injection nodes and multiple withdrawal nodes. Conceptually, we may view network service as a collection of point-to-point services. Such a service is designed for embedded, transmission-dependent utilities with dispersed generating resources. The transmission customer designates its network loads and resources. The user agrees to least-cost redispatch of its resources by the transmission service provider to accommodate new network and firm transmission customers and to handle transmission congestion in real-time. Charges for the user include a pro rata share of congestion costs and a pro rata load-ratio share of transmission system costs. The user receives credit for its network transmission facilities and is compensated at cost for redispatch. The transmission provider plans for network loads. For such service, the transmission service customer must provide sufficient information for transmission provider to adequately analyze service requirements. A key issue is the ability of the transmission service provider to have all the flexibility inherent in such service.

Both types of service use (see Figure 6) the entire network and open access may involve both types of service simultaneously on a transmission provider's network. However, the service based on the type of customer – point-to-point or network integration service – is inherently non-comparable since different bases are used for reservation, for curtailment priorities and for payments. This also allows the possibility for gaming by transmission customers. Moreover, points-to-points service makes little sense in a network.

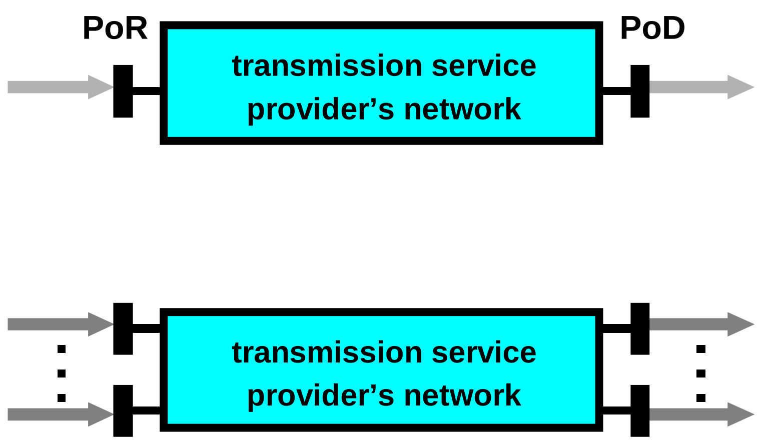


Figure 6.Two types of services

In an attempt to remove the ambiguity of the language that has been adopted in the industry to describe transmission service, FERC introduced some new terminology to replace the current terms. There are two important terms: *recallability* and *curtailability*. *Recallability* is the right of a transmission provider to interrupt all or part of a transmission service for *any* reason, including economic, that is consistent with FERC policy and the provisions of the transmission provider's tariffs and contracts. *Curtailability* is the right of a transmission provider to interrupt all or part of a transmission service due to constraints that reduce the capability of the transmission network to provide the transmission service. Transmission service can be curtailed only in cases where system reliability is threatened, e.g., outages of facilities/equipment along the transmission path and unscheduled flows, or emergency conditions exist.

These definitions give rise to two categories of transmission services. *Recallable transmission service* is a service which a transmission provider has the right to interrupt or curtail, for any reason, including economic, that is consistent with FERC policy and the provisions of the transmission provider's tariffs and contracts. This, in essence, corresponds to "non-firm" service. *Non-recallable transmission service* is a service which cannot be recalled by the transmission provider and is subject to curtailment by the transmission provider for specified conditions. This corresponds to "firm" service. These definitions are designed to replace the previous terms such as as-available, economy, interruptible, firm and non-firm but, in practice, that has not become the case. Both point-to-point and network integration transmission services can be either recallable or nonrecallable.

We next consider the transmission network under the open access regime. It is clear that transmission systems are being used in a manner and asked to do tasks not contemplated when they were planned and designed. The increasing number of users of the system, the greater volume and variety of transactions involving transmission, the increasingly greater volatility in generation patterns and the growing tendency to reserve firm transmission service result in more frequently encountered grid constraints. Other open access impacts on the network include heavier line loading, increased loop flows and wider variability of transmission pricing as a result of the increased use of constrained interfaces. In turn, these impacts bring on the need for more detailed transmission planning studies arising from constrained interfaces.

It is important to note that the technical considerations under open access are still the same as in the VIU environment. The physical characteristics of the electric transmission system – the lines, transformers and substations – remain unchanged under open access. Transmission lines and transformers must be protected against high currents that would cause damage; this need becomes particularly critical during system disturbances. The system must be protected against violations of its physical, operational and technical/engineering limits. Under open access, the system security monitoring, analysis and control function remains unchanged but may be placed in hands different than those in the VIU structure. In terms of system security requirements, there are significant implications of contingency definition and selection, the setting of limits and relays for operations and in the implementation of system control. The protection of the system from overstress due to the proliferation of transactions, the large number of players and the new *rules of the road*, remains a basic requirement for reliable electricity.

6. UNBUNDLED ANCILLARY SERVICES

Ancillary services are system support services that are essential for physical delivery of energy from a source point to a load point. Such services are fundamental and indispensable system services required for the provision of transmission service and in their absence instantaneous system collapse would result. The FERC list of ancillary services specified in Order No. 888 consists of:

- scheduling, system control and dispatch
- reactive power and voltage control from *generating sources*
- regulation and frequency response
- energy imbalance
- spinning reserves
- supplemental reserves

These services are provided mostly by generation sources. The six mandated ancillary services must be offered under *the pro forma* tariff and cannot be bundled with basic transmission service. A transmission customer may decline offer of the transmission provider's mandated services only if it can demonstrate existence of an alternative supplier, including itself. Table 1 indicates the services a transmission provider must offer to each customer and the unbundled services that a customer must take. Pricing allows for *package deals* in addition to rates for services purchased separately and transmission. The scheduling, system control and dispatch service encompass the activities required to maintain a generation/demand balance, including the implementation of interchange transactions, and to ensure operational security. These services must be provided to all customers by the transmission provider but may be modified due to system reliability/security considerations. These services must be purchased by all customers from the transmission provider. It is important to note that in a competitive environment scheduling and dispatch respond directly to *price* signals.

The reactive power and voltage control service is a rather complex phenomenon.

The maintenance of an acceptable voltage profile is a key requirement for system integrity; this, in turn, sets up the need for reactive power injections at various buses of the system. This need for reactive power support is a *system requirement* and its provision is an intrinsic part of transmission service. Reactive power requirements may vary with time, location and control response in addition to the magnitude and nature of transactions in place. Moreover, transmission users connecting to the network may "consume" reactive power in addition to real power and this sets up a need for reactive power due to the nature of the load and is a local var support requirement. Also, reactive reserves are required for maintaining voltages at appropriate levels during contingencies.

Table 1. Ancillary service obligations on transmission providers and customers

Service	Must	
	Offer	Take
Scheduling, control, & dispatch	Ć	Ć
Reactive & voltage support	Ć	Ć
Regulation & frequency response	Ć	
Energy imbalance	Ć	
Spinning reserves	Ć	
Supplemental reserves	Ć	

The provision of reactive power from generation sources for the support of transmission operations including the ability to continually adjust transmission system voltages in response to system changes must be sold as an unbundled service. The reactive power and voltage control service must be provided to all customers by the transmission provider and must be purchased by all customers from the provider. Supply of reactive power can come from generation sources or from reactive power devices. The FERC definition of this service is limited to the supply from generation sources only. Since reactive power cannot be transmitted efficiently over distances, any "market" for reactive power must be local. However, in reality there is very limited supply since production of reactive power by itself is unattractive to generators and the establishment of competitive markets in vars is questionable. Reactive supply from capacitor banks may be bundled with basic transmission service.

The regulation and frequency response service is essentially automatic generation control (AGC) and involves tracking the load on practically a second-by-second basis to ensure synchronous frequency is maintained and all wholesale interchange contracts are kept at specified values. This service may be provided by the *control area* transmission provider or by a third party. There is the possibility of acquiring this service on a competitive basis but competitive provision of this service may require more extensive metering and communications.

Energy balance is essentially a requirement for conformance with operational guidelines: in the implementation of contracts, the actual quantities may differ from the specified amounts resulting in *inadvertent interchange*. The energy balance service provides for correction for any hourly mismatch between the transmission customer's energy supply and the demand served. Typically, inadvertent energy is characterized by an admissible bandwidth and an allowed maximum amount in a specific period. A repayment/penalty scheme needs to be implemented to correct for such unbalanced situations. Under competitive conditions, repayment of inadvertent energy may be implemented using market mechanisms.

Generation reserves serve the role of insurance for unexpected generation outages and sudden unexpected increases in demand. The spinning and supplemental reserve services may be provided by on-line generation sources loaded at less than their maximum outputs or by generating sources that can be made operational within a short period. The effectiveness of these services requires a spread over a number of units to provide adequate geographic coverage and appropriate response time. These services may be acquired competitively.

The regulation and frequency response, energy imbalance, spinning reserves and supplemental reserves services must be provided by the transmission provider to all customers in its control area and may be purchased by customer from control area transmission provider or third party or self-provided. While the provision of these services on a competitive basis is feasible and markets for these services could develop, there are several issues that need to be addressed in cases of services being self-provided or purchased from a third party. Key are those related to the monitoring the quality and "quantity" of service provided. The energy imbalance is the easiest to monitor and reserves are not too difficult to monitor. But, load following is difficult to monitor. Careful thought needs to be given to the consequences of failing to provide the service(s).

The rationale for unbundling ancillary services stems from the functional unbundling that became reality with FERC Order No. 888. The establishment of independent grids lead to the need for the acquisition of ancillary services and the advent of competitive marketplaces makes possible the provision of such services. The various generation companies desire to participate in these markets as potential sources of income and profits. Most importantly, the establishment of competitive markets can enable innovation through mechanisms such as unbundling and rebundling of services. The establishment of such markets allows provides a wide range of choices for a unit or plant to sell its services. This is shown graphically in Figure 7.

Unbundling of services brings about new measurement and metering needs.

A primary requirement for the institution of an unbundled service is its quantification to be able to buy/sell such a service. Each service introduces its own specific needs in measurement: nature, level of detail, frequency and accuracy. Specialized communications may be required to transmit measurement data to interested parties. A logical conclusion is that metering may be offered as an unbundled service.

There are numerous challenges and opportunities associated with metering in an unbundled environment. The area of effective data management presents many challenges in collection, storage, extraction, compression, utilization and dissemination of the massive volumes of data that will be monitored/metered for various purposes. Dedicated new schemes to deal with *data overwhelm* and for data visualization will be needed. A key issue is the ownership of the metering data. This arises because of unbundling and the multiple users of the data will be different entities than the entity providing measurement and other data services.

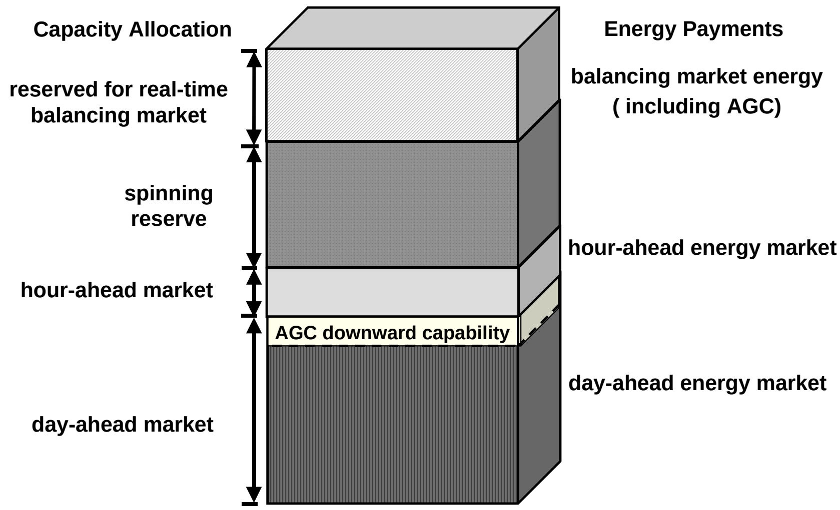


Figure 7. A unit or plant must decide the allocation of its capacity/energy for the sale in different markets.

Similar to metering, settlement and billing become an unbundled service. This service has data collection requirements for all services sold and bought. Settlement and billing entail the production of periodic bills for all providers and consumers of services. Examples of measured data include the MWh injected by each generator, the MWh withdrawn by each load, the Mvarh of reactive energy support by each generator, all other ancillary service measurements in terms of both capacity and energy, the transmission network usage and contract information and the transmission congestion information.

The FERC list of ancillary services is by no means exhaustive. For example, NERC has developed a set of so-called interconnected operations services, which includes the six FERC services. The NERC list consists of the following services:

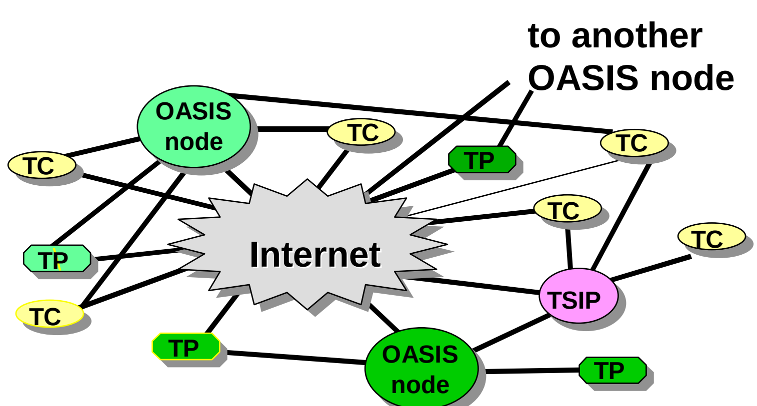
- regulation
- load following
- energy imbalance
- operating reserve – spinning
- operating reserve – supplemental
- backup supply
- system control
- dynamic scheduling
- reactive power / voltage control from generation sources
- real power transmission losses
- network stability services from generation sources
- system black-start capability

While more comprehensive, this list does not include all the possible unbundled services. A lesson from restructuring in other industries is that far more customer segments emerged than anyone ever imagined or believed possible and it is unlikely that electricity will be different.

7. OASIS

OASIS is the principal source of information on the availability of transmission system information. FERC's clear intent for transmission providers to make available commercially *useable and useful* information is, however, far from reality. The OASIS is operational since January 3, 1997. It is a network comprised of 23 nodes operated by 175 transmission providers. It is one of the first large-scale Internet *business to business* applications. Communication standards for transmission service customers and providers are found in the document *OASIS Standards and Communications Protocols* (S&CP), which FERC accepted for filing. S&CP contains definitions for query/response templates. Figure 8 shows a schematic of the OASIS network.

In Order No. 889, FERC specified the information requirements for OASIS. The OASIS needs to provide: transmission system information, such as the available transfer capability (ATC) data, the total transfer capability (TTC) and the assumptions for each constrained path; posting of transmission and ancillary service information including the complete tariff, any service discounts, ancillary services and reassignable services; the processing of transmission service requests including the scheduling of services, service interruptions and curtailments, date and time stamp for all information and an audit log for discretionary action; as well as, general information such as *Standards of Conduct* violations, historical and study information, announcements/want ads and any value-added services.



- **Operational since January 3, 1997**
- **Network comprised of 23 nodes operated by 175 transmission providers**
- **One of the first large-scale Internet applications for *business to business***

Figure 8. The OASIS network

By far the most important figure of merit to be disseminated on the OASIS is the ATC. This is the measure of the ability of interconnected electric systems to reliably move or transfer power from one area to another over all transmission lines or paths between those areas under specified conditions. ATC is defined for a given sending area (source) and a given receiving area (sink); it is time specific and is dependent on the parameters and state of the system. ATC is the key data in *transportation availability* information. ATC information needs to meet the basic requirement of providing dependable information upon which commercial transactions are planned and sound business decisions are reached. Each OASIS must be in compliance with FERC requirements to post continuous ATC information for the next hour and month and for the following 12 months.

Numerous complications arise in transfer capability evaluation. Every change in the system or in transactions changes ATC. In addition, the dependence among flows on the lines of the transmission network, the lack of coordination among transmission customers of system use and the nonlinearity of the network constraints as a function of flows are major contributing factors to making the evaluation of ATC and TTC very challenging. Considerable work needs to be done in several aspects of transfer capability evaluation including framework and definition, analysis and computation, implementation and commercial applicability.

To date, OASIS has been a failure: it is too cumbersome and too prone to transmission owner biases and gaming. The information is not sufficiently reliable. ATC information needs to become sufficiently dependable and timely to allow competitive markets to work efficiently and effectively. In addition, ATC practices must adapt to market needs by encouraging competitive markets.

8. THE INDEPENDENT GRID OPERATOR (IGO) CONCEPT

The unbundling brought about by the FERC actions serves to spur competition, results in the entry of many new market players and changes the industry's structure. Most prominent among these new players are the power marketers and brokers whose advent has established the MWh as a commodity not different than any other (e.g., hog bellies, aluminum, coffee, etc.) that are widely traded today. Today, utilities, financial services, marketers, brokers, generating entities and speculators are buying, selling and swapping power/energy on a scale unimaginable a few years ago. In fact, electricity is by far the largest of all commodities. The proliferation in financial and physical flow transactions is changing the face and organizational structure of the industry at a rapid pace. A major development is the establishment of an independent system operator (ISO) in various regions of the nation. The motivation for the ISO concept stems from the FERC policies that make it clear to transmission utilities that the "transmission and…" business would be difficult, problematic and possibly of limited strategic value. In light of the increasing volumes of transactions in each region, the need to solve transmission problems on a regional basis became critically important. Transmission owning entities realized that independent decision making on transmission service and pricing issues necessitates the removal of control of the transmission system from the owners who also control other sectors of the electricity business. In addition, the facilitation of the commercial market by an independent entity can remove impediments to grid access and can provide transmission service.

In Order 888 FERC set out eleven principles with which a properly constituted ISO must comply. The basic requirement is compliance with FERC's nondiscriminatory transmission tariff requirement. The following are the eleven ISO principles:

- fair and nondiscriminatory governance
- absence of ISO financial interest in its or its employees' performance in any power market
- single, non-pancaked, unbundled grid-wide tariff
- primary responsibility for ensuring the operational reliability of grid in full compliance with NERC/Regional Reliability Council standards/guidelines
- control over transmission system operations within the ISO's region
- ability to identify and manage effectively actions to relieve transmission constraints
- incentives for efficient management and administration and for acquisition of ancillary services competitively
- pricing should promote efficient use of, and investment in generation and transmission and efficient consumption; responsibility for identifying operational problems and appropriate system expansion strategies
- provide transmission system information on an OASIS
- coordinate with neighboring control areas
- establish, implement and use a voluntary alternative dispute resolution process

The establishment and operation of an ISO, essentially a regulated monopoly, is under FERC jurisdiction, except in Texas, where it is under state regulation. The approval of all existing ISO's met FERC's eleven principles to a greater or lesser extent. There are six FERC ISO's in the US: California, ERCOT, New England, New York, Midwest and PJM. There are also several ISO's under development. There is a major push toward regionalization and the creation of regional transmission organizations or RTO's.

The advent of the new players was accompanied by the establishment of various market mechanisms for the trading of electricity. In addition to the conventional physical-flow-based transactions, a large amount of financial transactions have been taking place. The market mechanisms have introduced new structures such as the power exchange (PX) in California. In other venues such as PJM, the market mechanism has been integrated as part of the new ISO. The issues associated with the various paradigms for restructuring are very complex and are beyond the scope of this paper.

In the restructuring, the role of NERC, the industry self-regulating organization for ensuring reliability is also undergoing major transformation. NERC has played an active part in facilitating the markets to evolve through its involvement in the development of OASIS, the evaluation of ATC and the establishment of new security coordinators for the security monitoring. There are many activities underway to replace the voluntary NERC organization by the mandatory NAERO structure, which would have FERC as a regulatory backstop.

In an unbundling structure different visions of the ISO concept (Figure 9) are evident in the implementation in place or planned. The key dimensions along which they differ are:

- geographic extent
- level of authority vested in the organization and responsibilities
- amount and nature of information available to the organization
- level of centralization/decentralization in the control authority

There is considerable controversy among various industry participants and FERC has given notice of its proposal to extend the ISO concept into a regional transmission organization (RTO).

An RTO would be a central authority covering a larger geographic territory with responsibilities encompassing both operations and planning. For the purposes of this paper, we adopt the notion of a *generic* independent grid operator (IGO) so as to remove any of the "baggage" associated with the ISO/RTO issue. The principal role for the IGO is to facilitate markets, i.e., to attempt to enable the undertaking of as many transactions as possible by the various market players.

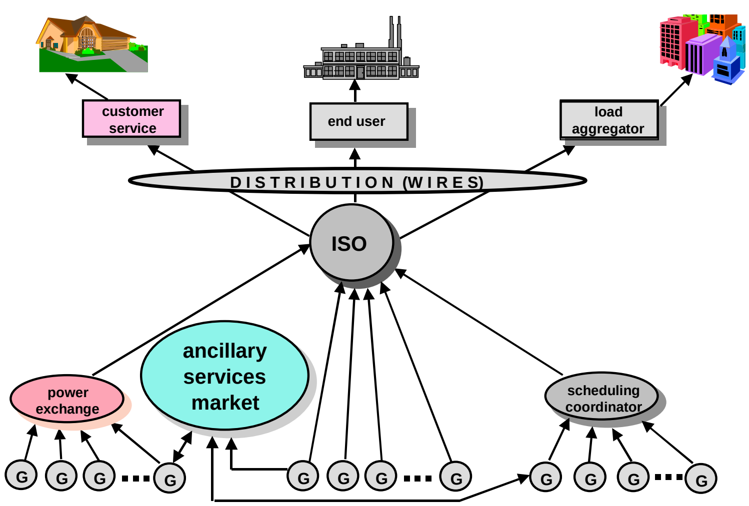


Figure 9: The unbundled structure

This role is discharged under the constraint of maintaining the reliability and security of the interconnected system. The IGO has the obligation to provide transmission service to all customers to have reliable supply so as "to keep the lights on". The IGO has the responsibility to acquire all necessary services such as ancillary services to fulfill this obligation. We assume that the IGO is independent of all entities under its control and that it has no ownership/financial interests in any of these entities.

9. THE PUSH TOWARD GRID REGIONALIZATION

There are major issues in open access that have frustrated the attainment of universal nondiscriminatory transmission service for all eligible players. The functional unbundling adopted by FERC has not resulted in the desired separation of transmission and merchant functions. Transmission providers employ subtle means to frustrate competition such as the posting of useless or incorrect OASIS information, discriminatory allocation of transmission capacity through prejudicial treatment of affiliates and *native load* and the arguable deployment of *Standards of Conduct* violations. In addition, many transmission customers have witnessed that congestion management has been used in a discriminatory fashion and to frustrate the market.

There is little doubt that residual discriminatory practices continue to exist. Transmission-owning utilities have poor incentives to provide equal service to their competitors since transmission market power allows them to make more sales at higher prices and also deter entry by other market participants. Clearly, functional unbundling did not change these incentives; it only reduced their ability to act on such incentives. Moreover, pancaked rates result in smaller markets and less competition. The tremendous growth in transactions has made the loop flow problem more pronounced.

Planning and construction of transmission facilities have not kept up with the increasing volume of bulk power trading. There is a major lack of coordination between transmission planning and the addition of new generation resources since often generation is being added, but not always at the most appropriate location from the transmission point of view. Finally, there are far too many entities with unclear lines of authority and communications: more than 100 grid owners, over 140 control areas, 10 reliability councils and 23 security coordinators.

Some of the same factors also play a major role in erecting barriers to forming other ISO's. Some perceive continuing strategic value of transmission to transmission owners. Some transmission owning utilities are concerned about the loss of primacy over the transmission service and the accompanying loss of competitive advantages in electricity markets. Many entities fear with great trepidation the loss of autonomy over the operation of the transmission system. In addition, reaching consensus on sharing of transmission revenues among transmission owners is a major challenge. Finally, the lack of participation by publicly-owned transmission facilities is a further barrier.

The clear conclusion is that transmission service is at the heart of problems of competitive markets. The lack of timely availability of system and operations information is a major issue. Economic inefficiencies resulting from congestion management and pancaked transmission rates are key contributors. The lack of coordinated planning and expansion of transmission facilities results in many cases from the residual discriminatory practices, exercise of market power in transmission and/or discrimination in the allocation of ATC. Such problems fuel the push toward regionalization.

Among the major drivers of regionalization is the desire for the resolution of lingering discrimination in transmission access arising from the insufficient separation between transmission service and merchant functions, the market power in generation due to transmission management and the experiences with OASIS that are frustrating rather than encouraging competition. There are also pressures to take advantage of the potential benefits of regionalization through the establishment of broader markets and the ability of addressing problems most appropriately solved at a regional level such as congestion, loop flow issues and planning. There is a growing realization that the problems plaguing the new environment need to be solved on a regional basis.

RTO is a generic term for a new i*ndependent* transmission management structure that will control transmission operations and planning uniformly in large regions of the US. A possible definition of an RTO is an independent entity with responsibility for the reliable operation, maintenance, and expansion of a geographically widespread grid. The scope of RTO activities include the implementation of appropriate mechanisms for transmission pricing and congestion management that lead to the efficient and nondiscriminatory use of the system by informed market participants.

The functions of an RTO may include the following:

- creation of market mechanisms to manage transmission congestion
- administration of the tariff and use of a transmission pricing system that will promote efficient use and expansion of transmission and generation facilities
- planning and coordination of necessary transmission additions and upgrades
- acting as a supplier of last resort for all ancillary services
- operation of a single OASIS site for all transmission facilities under control with responsibility for TTC and ATC evaluation
- monitoring of markets to identify design flaws and market power situations

For an RTO to be able to discharge such responsibilities it is important for it to have independence from market participants, appropriate authority/control to maintain reliability and to operate all transmission facilities and an adequate scope for effective regional coverage.

The creation of RTO’s should bring about major benefits. Elimination of rate pancaking encourages competition by increasing the geographic scope of the markets. Regionally based solutions can alleviate loop flows, implement more effective congestion relief measures and encourage additional transmission construction. In effect, an RTO becomes a one-stop shopping for transmission services. Such benefits will lead to the removal of barriers to entry of new players.

The issue of RTO formation is one of great current interest in the US. All electricity business players will be impacted by the new developments in this area.

10. CONCLUDING REMARKS

This paper has presented a broad overview of the changes and their impacts of the implementation of open access in the US. The rapid pace at which changes are hitting the industry is not likely to slow down. There are many problems that need to be solved along the way to constructing well functioning and smoothly running electricity markets. The paper outlined some of the most challenging areas that need attention as well as the great opportunities afforded by the implementation of the new open access regime. New developments will be reported in future papers.