Appendix A6:
A Systems View of the Modern Grid

ENABLES MARKETS

Conducted by the National Energy Technology Laboratory
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EXECUTIVE SUMMARY

The systems view of the modern grid features seven principal characteristics, one of which is the characteristic of fully enabling markets for electrical power. (See Figure 1.)

Figure 1: The Modern Grid Systems View provides an "ecosystem" perspective that considers all aspects and all stakeholders.

Correctly designed and operated markets efficiently reveal cost-benefit tradeoffs to consumers by creating an opportunity for competing services to bid. In general, the fully functioning modern grid will account for all of the fundamental dynamics of the value/cost relationship. Some of the independent grid variables that must be explicitly managed are energy, capacity, location, time, form (e.g., high voltage vs. low voltage; AC vs. DC), rate of change of capacity (e.g., ramp rates), resiliency (e.g., ability to accommodate perturbations), and energy quality/value (similar to return on investment). Markets can play a major role in the management of these variables.

The challenge for the modern grid is to allow, as much as possible, regulators, owners and operators, and consumers to modify the rules of business to suit operating and market conditions. Markets can enable efficient operation under both low stress and high stress conditions. Markets can enable automatic reconfiguration of facilities and equipment as needed to operate reliably and efficiently. Figure 2 shows the differing time frames for market operations and the supporting infrastructure required for those operations.

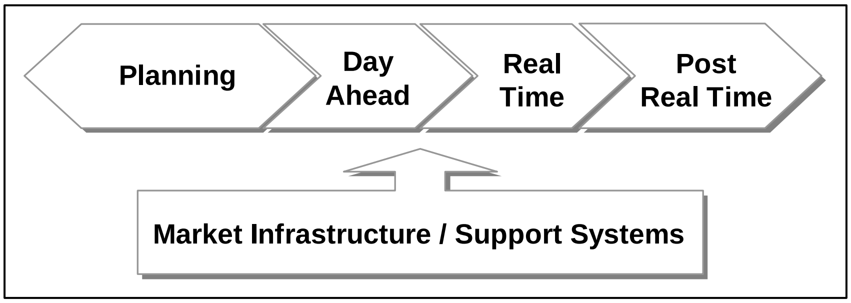


Figure 2: Time frames for market operations and their supporting infrastructure define the concept of enabling markets.

"... better and cheaper technologies will be invented once retail energy is subject to free entry and exit. No one knows what combination of technology, cost and consumer preferences will be selected. And that is why the process must be exposed to the trial-and-error experiment called free entry, exit and pricing. As in other industries, investors will risk their own capital – not your tax dollars or a charge on your utility bill – for investments that fail. Also, as in other industries with dynamically changing product demand, competition will force prices to be slashed off-peak, and increased on-peak to better utilize capacity." (Vernon Smith – 2002 Nobel laureate in economics, *Wall Street Journal*, 2003)

- **Planning**—This part of the market provides the long-term and intermediate-term regional infrastructure (generation, transmission and demand) planning activities that forecast load and congestion, develop capacity and adequacy, and schedule outages.
- **Day ahead**—This part of the market provides the short-term planned capacity requirements, MW injections, MW withdrawals, financial transmission rights (FTR) and ancillary services.
- **Real time**—This part of the market provides the real-time generation dispatch, management of injections and withdrawals, congestion management, ancillary services, and real time reliability management.
- **Post-real time**—This part of the market provides the settlement of the energy dispatch and financial transactions, as well as analysis and auditing of the Day Ahead and Real Time market operations.

Market infrastructure and support systems are critical factors in the success of enabling electricity markets in the modern grid. Advanced components and widespread communication in the modern grid will support market operations in every time frame above and provide full visibility of data to the market participants.

This document covers:

- The current and future states of electrical markets.
- The requirements for moving to a modern grid that enable these markets.
- The barriers to be overcome.
- The benefits of fully enabled markets.
- Recommendations to move forward.

Although it can be read on its own, this paper supports and supplements "A Systems View of the Modern Grid," an overview prepared by the Modern Grid Initiative (MGI) team.

CURRENT AND FUTURE STATES

Before we detail the requirements to realize the modern grid's "enable markets" characteristic, we need to understand the difference between the current state of electrical markets and their potential future state.

CURRENT STATE

The majority of the nation's electrical power system operates in accordance with rate structures established by state utility regulators. Rates are based on expenses plus a reasonable return on investment. Some expenses are passed directly to the consumer. Examples include fuel cost adjustments and power line losses.

Retail markets operate in several regions of the nation, governed by state requirements. Retail markets typically separate production costs, i.e. the cost of generating electricity, and transportation costs, i.e. transmission plus distribution expenses. This transportation expense is sometimes referred to as the wires cost.

However, the consumer is served by the same electrical infrastructure (wires) used before the retail choice was enacted, so the cost structure of the wires is the same and is billed as a fixed price-per-unit of energy. There are no savings to the consumer from retail choice as far as the wires cost is concerned.

In retail markets, the consumer may choose from a list of producers of electricity. But the production of the energy is also billed as a fixed price-per-unit of energy. Since the competing producers of electricity operate within the same wholesale competitive market, their price variations are minor or the market would not choose them to produce electricity in the wholesale market in the first place.

Wholesale markets select producers of electricity on an economic merit order, so the least expensive units are selected before more costly units. A constant fixed wires charge plus a production charge which only varies slightly has resulted in a small change in the total consumer energy bill.

The resulting minimal cost savings to consumers is the reason for low participation rates in the retail choice programs. There are only two rate options in the Time-of-Day (TOD) program, on-peak rates and off-peak rates. Hours of use for on-peak and off-peak time periods are recorded with electric meters, and a consumer bill is normally produced monthly. The ratio of peak to off-peak rates ranges only from about two to three. There is a much higher degree of variability in the wholesale market hourly prices where a daily high to low hourly price ratio of ten to one is a common occurrence.

There is a win-win scenario where the consumer takes a more active role, joins with other consumers into a large coalition representing a large load, service or generation supply and sells those products in the marketplace at a fair price. The power of the consumer has reduced prices in other markets and if organized, can do the same for electricity. The operators of the market also win in that they get a product that was previously not available to reduce the cost of delivered energy or increase reliability at a minimum cost.

Even though retail choice and wholesale markets have been around for decades, they have not become the normal way we conduct energy business. The Federal Energy Regulatory Commission (FERC) State of the Markets Report, a staff report by the Office of Market Oversight and Investigation published in January of 2004 states that operating or forming markets serve 70% of the U.S. population. While that may be true, participation in many of those markets is low. The graph and table below show greater detail. (See Figure 3 and Table 1.)

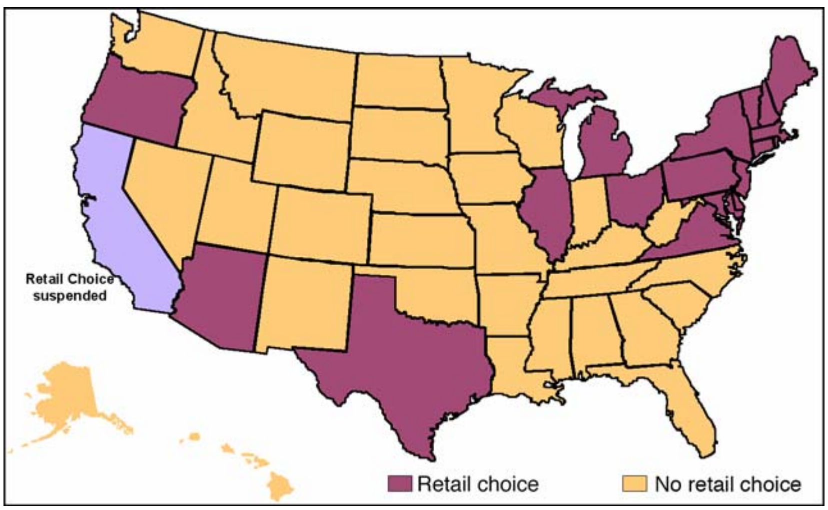


Figure 3: States Participating in Retail Choice, Status of State Electric Industry Restructuring Activity. (DOE EIA 2003)

State	Penetration	State	Penetration
Arizona	Not Reported	**New Hampshire**	Not Reported
California	16%	**New Jersey**	2%
Connecticut	Not Reported	**New York**	21%
Delaware	Not Reported	**Ohio**	18%
DC	13%	**Oregon**	11%
Illinois	12%	**Pennsylvania**	4%
Maine	32%	**Rhode Island**	Not Reported
Maryland	4%	**Texas**	Not Reported
Massachusetts	25%	**Virginia**	Not Reported
Michigan	11%		

Table 1: For those states that have tried retail choice, consumer participation is low. ("Status of State Electric Industry Restructuring Activity", DOE EIA, Feb 2003; "Status of Electric Competition in Michigan", Michigan Public Service Commission, January 2005)

Wholesale market operations are also operating in several regions of the nation, governed by the FERC in coordination with state utility regulators. The process has four steps:

1. Generators initiate offers to sell their energy to the market and load-serving entities submit bids to purchase it.
2. When a balance is reached between sellers and purchasers, then all loads are served and the market is declared to be 'cleared.'
3. Market participants are advised of the 'cleared' results to include injection MW, withdrawal MW, hours and prices for each hour thereby initiating their market responsibilities.
4. Settlements occur based upon the bids, offers and actual injections and withdrawals of energy per hour.

States participating in wholesale markets are shown in Figure 4.

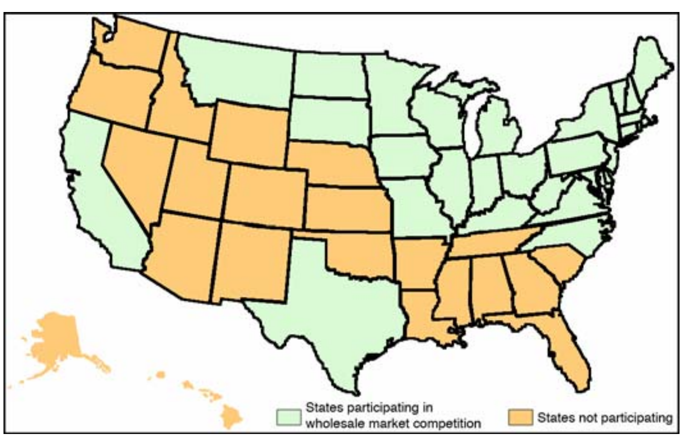


Figure 4: States participating in wholesale market competition. (DOE EIA 2005)

In the United States, the extent of the electricity market today can be described as follows:

- The majority of wholesale transactions are bilateral and long term
- A small portion of the country is using real-time wholesale energy markets
- A smaller portion of the country is using day-ahead wholesale energy markets
- A small portion of the country is using wholesale ancillary services markets
- A portion of the country is using zonal pricing models in wholesale markets
- A small portion of the country is using nodal (locational) pricing models in wholesale markets
- Retail choice (retail electricity markets) represents less than 5% of the electric load in the nation

The DOE National Transmission Grid Study, published in May 2002, states that the benefits of the existing wholesale electricity markets in the United States are $13 billion annually. A study of the Eastern Interconnect 1999–2003, which was released in 2005, determined that consumers realized $15.1 billion in value from wholesale electric competition.

Yet another study, conducted by the Fraser Institute in late 2004, determined that the United States could have dropped electricity prices 7%–9% between 1997 and 2002, following the completion of industry restructuring and the offering of a wholesale market to all consumers. This corresponds to an annual national benefit of $10–$13 billion, based on $0.04/kwh and an average of 3,600 billion kwh consumed annually.

FUTURE STATE

In the future, the scheduling and use of electricity will be fully commoditized by creating open-access markets across the country based on wholesale and retail models. These economically constrained market operations will drive reliability in the grid and open utilities and consumers to new service models that better fit the needs of all grid participants. Electricity markets in the future will integrate many diverse technologies and control functions to include the following:

- Suppliers in the various markets will be seamlessly integrated across all generating unit sizes (from 10kw to 1,300MW)
- The vast majority of all types of consumers (industrial, commercial, and residential) will participate in the market seamlessly through various forms of decision-assistant software
- All loads will have some measure of intelligent control, enabling new demand-response (DR) markets

Regional differences in the transmission level of the electricity network affect the enabling of markets. In the Northeast, load is concentrated, so the network is compact. In the Northeast, it may take only 100 miles of transmission line to "touch" one million consumers. In the West, except for major metropolitan areas, load is spread over an expansive geography, so the network must travel long distances between major loads with few lines supporting it. Varied circumstances create varied reliability and economic limitations. In the West, it may take over 1000 miles of transmission line to "touch" one million customers.

This would suggest that the cost of physically enabling a wholesale market in the West might be ten times that in the Northeast. However, if underground is required, the cost of transmission construction in the Northeast is significantly more costly per mile. While challenges differ in the West and Northeast, it is equally true for both regions that curbing peak loads and making loads more predictable are common elements of wholesale markets, and all regions will improve in grid reliability through advanced control and protection.

The competitive wholesale market has steadily made more services available to participants, including bilateral transactions, scheduling, day-ahead markets, and reserve sharing.

If present trends hold, generation resources of the future will be dispersed throughout the load areas mostly to minimize fuel transportation costs and they will be much smaller in electrical size. This change in generator size-mix over time requires new thought on how to control this vastly distributed resource as well as the impacts in the marketplace. Studies show that the nation can expect to add an additional 120,000 distributed generating units under 50MW over the next 20 years.

The future will reveal the need for new market elements. The experiences of the various Regional Transmission Organizations (RTO) and Independent System Operators (ISO) show that participants in the market are active in requesting new services and market forums:

- Expansion of the ancillary services market offerings.
- Introduction of renewables, carbon trading, and other specialty markets.
- Inclusion of DER market operations and other consumer-rich markets at the wholesale and retail market levels.

REQUIREMENTS

Having examined the current state of electrical markets and their desired future state, what requirements must the modern grid meet to fully enable markets?

The basic requirements of electricity markets are the existence of an adequate physical and informational infrastructure, sound market rules, vigilant oversight, and fair and equitable access.

- **Adequate infrastructure**—Markets can affect load and load can affect network reliability, therefore proper enabling of electricity markets supports a more reliable grid. A properly enabled marketplace assumes that the information and control architecture is adequate to provide needed information to appropriate decision makers.
- **Sound market rules**—Markets are based on proven first principles of physics and economics.
- **Vigilant oversight**—In each phase of the electricity market there is independent monitoring and review of operations and participants to assure fairness in the market and reliability of the grid.
- **Fair and equitable access**—The foundation of the market is the idea that "it is the same electricity market for all who qualify." Those who "qualify" have learned how to function in the market both financially and operationally.

DESIGN CONCEPT

To establish new markets and market services requires the development of new tariffs, systems, information flows in real-time and training for market participants. Therefore, new markets and services must roll out in logical pieces. For example, a market may open with a real time market only and as the market gains experience, later it will open a day-ahead market. An ancillary services market would follow the real time and day-ahead markets. These have been the actions at both the Midwest Independent System Operator (MISO) RTO and PJM RTO.

The seamless architecture of the modern grid can and must extend the electricity market into the electric distribution level. The distribution consumer may participate in demand response (DR) or distributed energy resource (DER) programs which when aggregated, become a market commodity in the wholesale market. While nearly all the distribution systems are operated as state-chartered monopolies, this is the area where the greatest variability in customer needs resides.

In order to apply DR and DER as market commodities, the modern grid needs to expand current electricity market thinking to include

designing for open-access market participation. This expansion of market thinking may take place in the wholesale market, the retail market, a new intermediate market, or some combination of these markets.

"Increased use of information technologies, computers, and consumer electronics has lowered the tolerance for outages, fluctuations in voltages and frequency levels, and other power quality disturbances. In addition, rising interest in distributed generation and electric storage devices is adding new requirements for interconnection and safe operation of electric distribution systems." ("Grid 2030" A National Vision for Electricity's Second 100 Years, Department of Energy, Office of Electric Transmission and Distribution, July 2003.)

Today, FERC regulates interstate wholesale markets and state and local agencies regulate retail markets. For the modern grid to provide seamlessly integrated markets, it must include interstate wholesale markets, regionally based retail markets, and a new intermediate market that joins them at the distribution level.

Summarized, the design concept must include:

- Fully effective wholesale markets
- Selective expansion into retail markets
- New, presently unidentified markets that may not fit the traditional wholesale/retail model

Design Features and Functions

The design of the modern grid must be consistent enough to enable the electricity market to operate coast-to-coast and deliver economic benefits. In addition, the modern grid requires more sophisticated models to analyze options, refine market performance and design new markets. The basic design can be described in the context of the market's time horizons and infrastructure shown previously in Figure 2.

Planning

- **Power systems coordination and planning**—Long-term development of strategies that improve overall reliability of the grid and accommodation of future loads
- **Load forecasting**—Long- and intermediate-term forecasting of future loads and load profiles across the grid in sufficient detail for power systems coordination and planning
- **Facility and operational data**—Developing the necessary data integration and acquiring the necessary grid facilities information (attributes and behaviors) to support accurate modeling of the grid for planning and operational purposes
- **Long-start resource commitment**—Planning that incorporates the long start-up sequence for large, central generation plants into the market operations and reliability coordination of the grid
- **Congestion management**—Factoring congested transmission pathways into the planning for current operations, new grid assets, and upgrades
- **Reliability planning and coordination**—Establishing operating strategies that implement the performance and planning goals of the grid
- **Generation and transmission outage coordination**—Determination of outage impacts and scheduling for the purpose of minimizing challenges to reliability and fair market operations

- **Financial transmission rights** (FTR)—Running the advanced (forward contracts) allocation of FTRs to asset holders and establishing the simultaneous feasibility requirements of the upcoming auction of rights in the market

Day-Ahead

- **Generation supply offers**—The introduction of offers by generators to supply the grid with a specified amount (and profile) of MW for a specified period of time at a specified start time, based on an estimated price at a specific grid node
- **Demand bids**—The submission of bids to take power from the grid and serve loads of a specified amount (and profile) of MW for a specified period of time at a specified start time, based on an estimated price at a specific grid node
- **Physical bilateral transactions**—A specific agreement between one seller of generation and one buyer of power for serving a load of a specific amount of MW for a specified period of time at a specified start time for a specified price
- **Financial transactions (bilateral, FTRs, virtuals)**—A financial hedging function where one party takes control of a specified amount of transmission capacity at a specified grid node for a price; as the transmission service is used by the party or other parties, the difference between the agreed price and the eventual real-time market price is settled
- **Ancillary services offers and bids**—The introduction of offers and submission of bids for spinning reserve requirements, volt/VAR support needs, demand response needs, renewable energy credits, etc.
- **Market results (clear day ahead)**—The process by which the electricity market settles the financial commitments made and accepted during the day-ahead market period
- **Re-offer period**—A short period at the end of the clearing of the day-ahead market where unfulfilled non–real-time offers and bids can be reintroduced to the electricity market

Real-Time

- **Supply offer instructions**—The continuous process of sending generating unit production targets to market participants to balance supply and demand at least cost while recognizing current operating conditions.
- **Security Constrained Economic Dispatch (SCED)**—An algorithm-based continuous process to simultaneously balance injections and withdrawals at least cost, manage congestion, and produce ex-ante LMP to establish resource baselines
- **Physical bilateral transactions**—The process of executing previously planned bilateral agreements
- **Prices**—The continuous process of determining and publishing real-time pricing every 5-minute interval at every commercial node in the electricity grid

- **Re-dispatch**—The process of dispatching previously uncommitted (but available) generation to fulfill an emerging demand in real-time at previously set prices or market prices
- **Emergency ancillary services**—The process of dispatching available reserves to manage congestion or fulfill a demand (load) that another supply (generator) has failed to serve

Post-Real Time

- **Metering/Meter Data Management Agent (MDMA)**—The system where real-time metering data is submitted on behalf of each market participant to the grid operator through a real-time portal
- **Settlement calculations**—The performance of a series of computations on received metering data (real-time metered MW, cleared day-ahead MW, and real-time prices) at different post-market day intervals (operating day, 7 days, 14 days, etc.) to reconcile supply, demand, and associated pricing in the Day-Ahead, Real-Time, and FTR markets
- **Accounting and billing**—The transference of market settlements into individual market participant accounts and creating the appropriate payments and invoices for receivables
- **Settlement disputes**—The correction of differences and disagreements in the market results before payments and invoices are made
- **Market auditing**—The on-going, independent review of market operations and settlements to assure market fairness and openness

All present day markets ensure that the uplift cost for these services is kept at an acceptable level.

Market Infrastructure and Support Systems

Market infrastructure and support systems for the modern grid must be complete, robust, and of high quality. The following functions and processes are required for a market infrastructure.

- **Systems functions**—Tagging and scheduling, Organization for the Advancement of Structured Information Standards (OASIS), day-ahead/real-time market systems, power system simulation of the network and the real-time market, accounting system, configuration control, reserve sharing applications, settlements application, algorithms for clearing market prices, etc.
- **Business processes**—Structure methods for converting tariffs to market processes, consensus market rules, continuity plans, published grid operator and control area functions, emergency operations and processes to engage, etc.
- **Market participant readiness functions**—Open participant portal, market participant training and certification, client relationship management, credit management system, etc.
- **Independent market monitor (IMM) functions**—IMM interface/ connectivity, real-time market data access, etc.

- **FTR functions**—FTR applications to include an allocation system, auction system and simultaneous feasibility test
- **LMP and state estimation (SE) functions**—Fundamental nodal model of the grid, high-speed network model, real-time telemetry, state estimator applications, reliability assessment and commitment (RAC) application, commercial node application, energy node application, LMP model, adequate resolution and precision in each system, etc.
- **Contingency functions and processes**—Back-up market and control operations systems and facilities, a process to accommodate RAC failure, systems for LMP/settlement with SE failure, unit dispatch system with SE failure, congestion relief process/system with SE Failure, Net Scheduled Interchange system with SE failure, etc.
- **Control area functions and processes**—Operator routine and emergency operations training, market participant interface (message and response) via communication and telemetry, systems for network visibility, etc.
- **Joint operating agreement functions and processes**—Seams agreements, data communication with the rest of the nation's regional markets, handling of marginal losses and congestion across seams, etc.

OTHER REQUIREMENTS

Common Information Model

The Common Information Model (CIM) architecture is a critical element for standardizing data shared by the various elements of a modern grid.

> **"…the CIM facilitates the integration of Energy Management System (EMS) applications developed independently by different vendors, between entire EMS systems developed independently, or between an EMS system and other systems concerned with different aspects of power system operations, such as generation or distribution management." (IEC 61970-301)**

CIM is a necessary foundational element of successful market development because the real-time information important to proper operation comes from hundreds of sources and dozens of entities (transmission owners, generators, market participants, etc.). For example, at MISO, state estimation, location marginal pricing, and network topology depend on commonly used information across more than 30 EMS/SCADA and GIS systems at utilities.

Communications

For electricity markets to function properly, near real-time information communication must flow seamlessly between market systems and monitoring and control systems throughout the region. This will require a much dispersed, highly reliable, multi-variant communications infrastructure.

Policy and Regulation

In a June 2005 testimony to the House Government Reform Subcommittee on Energy and Resources, FERC Chairman Pat Wood made three important points about enabling markets in a modern grid:

1. "The industry and its regulators (state and federal) must find ways to accelerate investment in transmission, if customers are to receive the many benefits achievable with competitive wholesale markets . . ."
2. "...Most traditional, vertically integrated utilities with retail service obligations must go before their state commissions to seek retail rate recovery for any investment they make in new transmission. This can involve opening up all of their costs as well as their entire rate structure for reevaluation, a step few utilities desire . . . "
3. ". . . Finally, development of a robust inter-utility transmission grid may come into conflict with an individual utility's fiduciary responsibility to its shareholders if such a grid will allow competing generators to more economically serve the transmission-owning utility's wholesale customers."

Codes and Standards

Voluntary standards must be adopted by federal and state authorities as new law regulates performance of the grid and markets. For example, the Organization for the Advancement of Structured Information Standards (OASIS) has developed standards for business transactions, legal, education and biometric uses. There are many new standards in development including tax, voting and medical. A trusted professional organization such as OASIS must emerge to manage the data protocols of all the energy-related transactions of the new energy market.

Quality

Like the real-time operating systems that manage the modern grid, market infrastructure support systems must utilize ISO-certified or Capability Maturity Model Integration (CMMI)-based software solutions as standards to improve the openness, scalability, and maintainability of electricity markets.

User Interface

Traditionally, the electric grid has been managed by a select few individuals, with little interface between systems and consumers. Energy management systems use interfaces based on the specialized knowledge of grid operators.

With the introduction of electricity markets, new users will bring a wide variety of needs, skills, and levels of knowledge. The user interface will require an easier, more socialized interface to accommodate this constituency.

This trend will gradually expand as the electricity marketplace is demystified and user interfaces become easy to use in an open-access environment. In time, accessing the modern grid electricity market will be as easy as logging on to eBay or Amazon.com.

BARRIERS

Meeting some of the basic requirements of enabling markets in the modern grid means overcoming some significant barriers.

Parochial regulations, limited skills of market participants, complex information infrastructure, and burdensome capital investments comprise some of the more common barriers.

- **Regulations** – Both federal and state regulations are required to support full scale integrated markets to fulfill the needs of all consumers. The regulators of low energy cost states are naturally reluctant to have their low cost energy sent out of state to the detriment of their consumers. The regulators of high energy cost states feel pressure from their base constituency to block market entry and keep out low cost energy providers. This preserves the profits of the high cost resident energy providers, who are also high tax payers and influential in the political process through lobbying efforts. In the change to fully enabled markets, there will be winners and losers.
- **Market Participant Skills** – An educated consumer is required to effectively operate in a market. All market participants should try through legal means to make as much money in a market as possible. That is true of all markets and should be expected in a new energy market. The best way to maximize profit is to understand the detailed mechanisms of the market tariffs and billing procedures. This is no small effort and every mistake will likely cost the market participant money.
- **Information Infrastructure** – A vast amount of data is required to operate and run a market. In the startup of the Midwest Independent System Operator Market, over one hundred thousand telemetry data points of system components were required to assure accurate pricing and operating signals. The collection and transmission of this data requires an extensive communications network. If multiple control areas are involved in making up a market, then common information protocols, security provisions and timing add to the complexity.
- **Capital Investment** – It takes a large capital investment to set up, operate and monitor a market. The market participants are the only source of funds. Generators must be convinced that they will be able to sell at higher prices and load serving entities representing the consumers must be convinced that they will be able to purchase power at cheaper prices. It takes a great deal of optimism to open a market with such risks.

BENEFITS

As barriers are overcome, the infrastructure to enable markets will gradually be implemented and important benefits will accelerate the evolution of the modern grid.

As consumers respond to market data about increases in price, demand will be mitigated. Plus, consumers become more engaged in determining alternate lower cost solutions, which spurs new technology and process development. As consumers suffer interruptions, the load profile and generation profile shift as alternate load management and distributed generation schemes become more prevalent in the industrial, commercial, and residential sectors. These drivers and changes result in fewer and briefer interruptions.

From a marketplace looking for alternate lower costs solutions, the modern grid will be able to offer a wide array of load-management strategies. Distributed generation, energy storage, demand-response strategies and new ways to effectively manage voltage will emerge to cope with a more volatile operating environment. In addition, such marketplaces spawn new ways to improve performance. The addition of a residential fleet of distributed energy resources (DER) would also provide service for the self-healing feature of the modern grid.

Fully enabled electricity markets will also drive smarter decisions about where to locate grid resources. Examples include the locational marginal price (LMP) as an added input to independent power producer (IPP) generation siting in Wisconsin, and added input to siting distributed generation in Connecticut. From a systems view of the modern grid, it is important for generation siting to have all the related information available to make the best decisions possible.

The modern grid's fully enabled market would open the electricity infrastructure to all consumers, not just transmission owners (TO) and independent power producers (IPP). Extending electricity market participation to a wider stakeholder group (e.g., distribution companies, distributed generation owners, and consumers) can greatly increase the performance and reliability benefits of a market, whether wholesale or retail. For example, the open access of the cable television industry has greatly expanded services, now providing telephone and internet along with programming selections. The open access to the electricity market will likely result in a similar expansion of commerce.

RECOMMENDATIONS

Four broad actions taken in parallel would ensure that the modern grid's design and implementation would support fully enabling markets for electrical power.

1. Modify existing and create new polices and regulations that remove the economic and political barriers to integrated markets. It will take a systems view and, most likely, federal directives to align policies toward integrated markets that benefit all consumers. There are complex issues to be undertaken and, as in any political process, no one wants to end up with a disadvantage.
2. Provide widespread market education to all stakeholders in the modern grid, especially distribution level consumers. Thousands of consumers may join a demand response group that may sell its DR product in the real time market. Knowing the potential gain and potential liability of such a venture is a must for an informed consumer.
3. Standardize the communication of market information throughout the design of the modern grid with equipment, software processes and protocols. A broker of market information is to the advantage of all market participants, like the reporting of stock values. Any consumer should have access through non-proprietary equipment.
4. Incentivize capital investment. Regulators wish to have access to competitive markets to lower prices, yet are reluctant to authorize investments that spread benefits outside their regulatory jurisdiction. Options for resolution include cost sharing, benefit sharing or some combination of the two.

SUMMARY

"Enables Markets' is the name we give to one of the seven principal characteristics featured in the systems view of the modern grid. It is an important characteristic because well-designed and operated markets efficiently reveal cost-benefit tradeoffs by creating opportunities for competing services to bid.

Such a market for the modern grid would be attained by a market infrastructure that supports the four time frames of market operations:

1. **Planning** – For intermediate and long-term regional operations.
2. **Day ahead** – For short-term capacity requirements.
3. **Real time** – For managing generation dispatch, congestion relief and reliability.
4. **Post-real time** – For settlement of transactions, analysis and auditing.

Attaining fully enabled market infrastructure for the modern grid requires action in four broad areas:

1. **Regulations** – Both federal and state regulation must be overhauled to remove parochial barriers to a seamless integration of electrical markets.
2. **Market education** – To maximize their profits, all market participants must gain a detailed understanding of the operations and economics of electrical power services.
3. **Information infrastructure** – The collection and distribution of the vast amount of market data requires an extensive network and common information protocols.
4. **Capital investment** – Market participants must be reasonably certain their investment will be profitable, given the large commitment needed to set up, operate, and monitor the market.

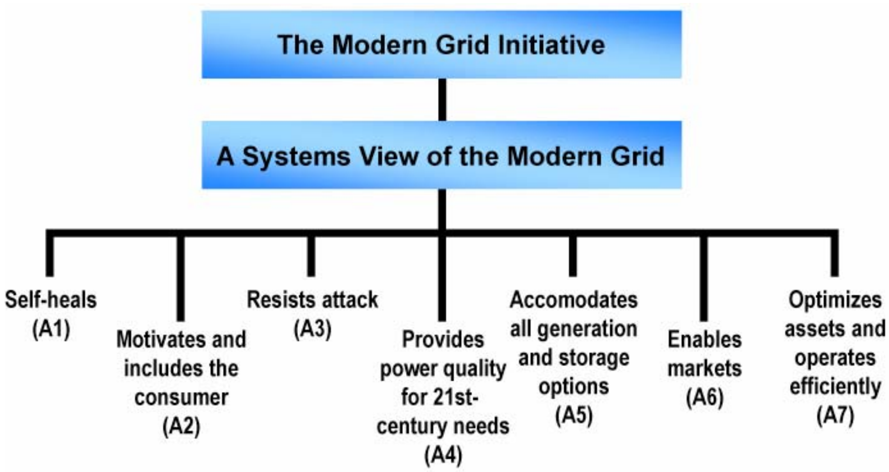
Even partial successes in these four broad areas would provide substantial benefits.

- As consumers respond to market data about increases in price, demand will be mitigated and consumers will seek alternate lower cost solutions in new technologies and products.
- Consumer demand for solutions will stimulate a market for distributed generation, energy storage, and other distributed energy resources that, in turn, improve the reliability of the modern grid.
- Fully enabled markets will provide data for smarter decisions about where to locate grid resources.

- Access by all consumers, wholesale and retail, to the electrical market will expand commerce for future services and products that support their needs for lower cost energy.

For more information

This document is part of a collection of documents prepared by The Modern Grid Initiative team. For a high-level overview of the modern grid, see "A Systems View of the Modern Grid." For additional background on the motivating factors for the modern grid, see "The Modern Grid Initiative." MGI has also prepared seven papers that support and supplement these overviews by detailing more specifics on each of the principal characteristics of the modern grid. This paper describes the sixth principal characteristic: "Enables markets."



Documents are available for free download from the Modern Grid Web site.

The Modern Grid Initiative

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