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# **SUMMIT REPORT:**

## Demand Pull of Distributed Energy Resources (DER) Based on Real and New Valuation of Electricity

Executive Summit  
Washington, DC  
May 30, 2001

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Communications and Control Program  
Office of Energy Efficiency and Renewable Energy  
Office of Power Technologies  
Office of Distributed Energy Resources

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U.S. Department of Energy

**SUMMIT REPORT:**

Demand Pull of Distributed Energy Resources (DER)  
Based on Real and New Valuation of Electricity

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## 1.0 Introduction

This report resulted from a one-day Executive Summit sponsored by the U.S. Department of Energy (DOE) Communications and Control Program (C&C) on May 30, 2001, in Washington, D.C. The C&C is being established within the DOE Office of Energy Efficiency and Renewable Energy (EERE) Office of Power Technologies (OPT) Office of Distributed Energy Resources (DER). As a new Program, the C&C sets out to establish an industry/government partnership to jointly pursue research, development, demonstration, and deployment of emerging technologies to address needs and opportunities relating to communications and control of integrated DER systems. Through these enabling communication and control technologies, various DER hardware and software components can be aggregated into an integrated operation with scalability to meet individual user, facility, and utility requirements. Further, the enhanced information flow and system control capabilities will allow practice of demand-side management. When this demand management is combined with an increased supply from aggregated capacities of DER systems, true values and benefits of DER can be fully realized to meet the nation's power generation, transmission, and distribution challenges.

This Executive Summit is the first step in the C&C's strategic planning process. This Summit aimed at identifying values and benefits of DER through better understanding of valuation of electricity, ideas for revising electricity pricing to reflect its valuation in today's environment, and information requirements for and barriers to implementing new pricing structures. For example, power quality and reliability have an increased value in the new economy. The integration of DER into on-site energy generation will ensure that custom quality and reliability requirements are met. Additional benefits of DER include immediate relief in transmission congestion problems causing the blocking of electricity flow to where it is needed as well as relief in transmission upgrade costs. Through these discussions on valuation and associated information requirements and barriers, the role of DER and its contribution to the power infrastructure can be better defined. The Summit findings will therefore be used to guide an ensuing Technology Workshop to further identify technology development pathways and execution strategies to fulfill the capabilities required for realizing DER values, meeting information requirements, and overcoming the barriers identified in the Summit.

Thus, the C&C's strategic planning process that began with this Executive Summit will, through the follow-on Technology Workshop, lead to establishment of the industry/government partnership to implement technology development pathways and strategies. The industry/government partnership, established under the auspices of the C&C, will aim to provide enabling communications and control platforms to transform traditional electricity generation, transmission, and distribution into electronically controlled, smart electricity networks. The new capabilities developed under the C&C support will be available to customers, utilities, third-party providers, and regulators so that (1) DER values and benefits can be realized and quantified for incorporation into the existing marketplace, (2) state and federal regulators can make appropriate changes in market rules to allow customer choice in generation alternatives, and (3) demand-side management of energy use can be widely adopted. The desired outcomes will be simultaneous mass production of DER systems and maximization of end-user values.

It is important to note that valuation of electricity is subject to varying opinions of stakeholder groups, some of whom were represented at the Summit; not surprisingly, not all participants have agreed on the findings of this Summit Report. One such varying opinion is on the

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internalization of externalities (particularly, the environmental factors related to power generation) into electricity evaluation. This Summit Report reflects only the majority opinions of those who participated, as listed in Appendix A.

## **2.0 Background and Perspectives**

DER could contribute significantly to the nation's power infrastructure by introducing new and more competitive value opportunities. These value opportunities are real in that they affect the cost of goods and services (productivity, yield, general and administration) and quality of life (cost of living, environment, employment); however, they do not appear in the current electricity tariff metric.

To achieve the potential of and develop a viable market for DER, technology advancement must continually evolve, not only in regard to the technology used to generate and deliver electricity, but also in the way that electricity is valued for its contribution to the work that it does. This new valuation is prompted by the current transition from the economic age of "mass production" to the "information age." The basic underlying element of the information age is the ability to gather, correlate, and act on large amounts of information with a high degree of resolution. This change has created a fundamental shift in value from point-of-production to point-of-consumption. A principal tool of this change is "mass customization," which is the ability to use information to customize an offering by combining the economies of scale of mass production with end-user customized energy values, or the "locational values," based on what end users want and need.

Today electricity is priced, marketed, and managed as a mass-produced commodity using methodology optimized for "mass production." The metrics of the price of electricity are made up of some two-dozen cost components as expressed in the tariff rate. These components represent the common or mass production values. Consumers are then grouped into broad categories with general similarities such as residential, commercial, or industrial. Customers then take service within these broad tariffs without regard to individual burdens or values. Under the concept of mass customization, the electricity end user's total cost of energy in his final finished goods or services should be assessed by a combination of the common values and the custom or locational values. If concepts enabled by the information age, such as real-time pricing, activity-based accounting, and mass customization, are to be realized in electricity consumption, there will then have to be information flow from the demand side to the supply side.

This information system from the demand side (user) will grow from today's simple electric meter to an interactive communication and control system that will manage energy's common and locational values to achieve the most competitive delivery. Further, the enhanced information system will allow demand-side management to incorporate market prices for electricity as one of the bases for managing electricity consumption. This transformation will provide customers with real choice in procuring energy supply and managing energy use, based on individual needs for power quality and reliability while balancing individual valuations of economic, environmental, and ecologic effects.

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### 3.0 Summit Objective

The objective of this Executive Summit was to discuss a new set of valuation metrics for electricity that are based on how customers value power quality with respect to the effects on costs of products/services as well as on quality, rather than the traditional, mass-production-based tariff structure. Concepts for this valuation were identified and then voted on by the attendees based on their relative contribution to the new cost/value structure for electricity. For each concept, a discussion of information needs and flow occurred. With the definition of these information requirements, this Summit will serve to guide an ensuing Technology Workshop that will involve a broad spectrum of energy communities representing technology manufacturers and suppliers, trade associations, utilities, government agencies, national laboratories, and energy users. The Workshop will define technology needs for measuring and quantifying valuation metrics and associated information requirements identified in this Summit. In addition, performance targets of communication and control technologies for integrated DER systems and success measures will also be defined in the Workshop.

Thus, this Summit leads off a new partnership to provide technology solutions to address the nation's power infrastructure. The Summit Report findings will help guide the DOE Communications and Control Program in developing its strategic areas to attain the DER vision goals:

- The *near-term* goals for 2005 are to:
  - Develop "next generation" distributed energy technologies, and
  - Address the institutional and regulatory barriers that interfere with siting, permitting, and interconnecting distributed energy resources coming on-line prior to 2005.
- The *mid-term* goal for 2010 is to supply 20% electricity capacity additions in the United States with a suite of distributed energy technologies that are cost-competitive and have low emissions and high efficiency and reliability.
- The *long-term* goal for 2020 is to make the nation's energy generation and delivery system the cleanest and most efficient, reliable, and affordable in the world by maximizing the use of cost-efficient distributed energy resources.

### 4.0 Summit

This Executive Summit was attended by 10 invitees who, as a group, provided authoritative and balanced perspectives on valuation metrics of importance to energy users. Additionally, two DOE managers and three support staff members participated. The participants' contact information is provided in Appendix A; the Summit agenda is provided in Appendix B.

Summit discussions are presented below in order of roundtable discussions on the four major questions posed to each attendee.

#### 4.1 Valuation of Electricity

This brainstorming session introduced each participant's views on the value of electric service in today's information-based economy, how that value relates to electricity production and delivery

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costs, and how it is reflected in electricity rates and pricing for users. Each participant was asked to define electricity's value in terms of its contribution to the cost of goods/services or quality of life.

With respect to the current valuation system, participants expressed the following viewpoints:

- Values (such as ecology, constraint, quality, etc.) are not reflected in electricity rates, which are a compilation of costs in production, transmission, and generation.
- Suppliers do what regulators want, not what customers need. More demand-side information is needed.
- The value of electricity is not fully appreciated until it is unavailable. Costs of electricity interruption differ among users.
- People don't know or don't care to know the cost of electricity in the work environment.

With respect to new and real valuation systems to reflect the impact of electricity on the cost of goods/services and quality of life, the following opinions emerged:

- The real cost of energy should more accurately reflect its effect on the environment.
- Options should be established for value-based pricing, market-based systems, demand pricing, and real-time pricing for all customers, not just large industrial users. The effect of such price elasticity has been proven effective in other deregulated industries, such as the popularity of Saturday-night stay fares by the airlines. Additionally, time-of-use pricing has been used extensively in industrial sectors, and a recent trial use by residential customers in San Diego has resulted in a 15-20% reduction in electricity use.
- Marginal cost of power interruption to individual users must be established to guide initial market penetration by DER. For example, power interruption and power quality more acutely affect production costs at semiconductor manufacturing facilities and electric-arc-furnace operations at steel plants.
- Hedging contracts should be established to include DER and other alternative energy suppliers. The same market rules must apply to all suppliers, including common valuation metrics.

## 4.2 Ideas for Revising Electricity Pricing

Following discussions about real and new valuation of electricity, this session dealt with specific ideas participants have to effect it. Participants were asked to respond to the question: What are your specific ideas for revising the way electricity is priced to better reflect its value to users, the costs of electricity production and delivery, and the future of retail energy services markets? After all ideas were collected on index cards, they were discussed and grouped into categories. (Similar ideas were combined or presented in sub-bullets.) Each participant was then given three votes on those ideas viewed as most important. These ideas are presented below by defined categories, with the number of vote(s) received for each idea listed in parentheses:

- Real-Time Pricing
  - Have retail price track wholesale power price. (5 votes)
  - I want real-time pricing in my home using an Internet-based meter, which also provides me with email and 2 free wireless sensors. (4 votes)

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- Provide a mechanism for auctions for customers to submit blind bids for units of electricity. (3 votes)
  - True spot market for unscheduled electricity. (2 votes)
    - o Auction inadvertent interchange (i.e., unscheduled flow from one utility to another).
  - View price variability as way to control biggest machine.
    - o Use real-time pricing by providing for the dispatch of better control equipment and communication systems for metering.
  - Locational Values
    - Deregulate transmission rates. Let them be disciplined by entry of distributed generators. Currently, the rates do not capture DER's value in constraint relief. (5 votes)
    - The distributor should only be required to produce the most cost-effective power quality. The customer should upgrade to the desired level using DER or using energy services companies (ESCOs). (3 votes)
    - Pay locational marginal price (LMP) for distributed generation (DG) and demand-side management (DSM); also meet scalability needs. (1 vote)
    - The value of power quality, reliability, etc. to users must be determined.
    - Users buy what electricity does for them, not electrons or kWh. Information flow is required to segment the market by user valuation. Costs of production and delivery are not visible to users even if they are germane.
  - Pricing of Ancillary Services
    - VARS priced in wholesale/retail markets. (4 votes)
      - o Assess the effects of reactive power in pricing.
    - 13 ancillary services sold at load. (2 votes)
  - Pricing Demand-Side Resources
    - Have Integrated Resource Planning (IRP) reflect avoided costs from distributed resources. (3 votes)
    - Market mechanism for trading demand savings. (2 votes)
    - Offer wholesale prices to DG and DSM. (1 vote)
  - Pricing Environmental Costs
    - Include environmental costs in energy price. (5 votes)
      - o Develop a pricing system that passes on significant environmental costs to the end user. Currently, no one pays for the effluent from a coal plant.
      - o Electricity needs to be priced in relation to its true costs (externalized waste/environmental impact). Need incentive system to reward efficiency gains by users.
    - Recognize that the internalization of externalities cannot be done through regulation.
    - Green power needs to be federally supported for further efficiency improvements to become economically competitive for utilities to invest in new environmentally friendly technologies to produce/supply energy.

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- Market Rules and Participation
    - All end users should have option of leaving the system, choosing among suppliers; contract for quality/load/price. (2 votes)
    - The future of retail energy services is huge. Electric meter “utilities” disappear and energy services include commodity. (2 votes)
    - Encourage bi-lateral contracts with price transparency established through real-time electric markets that involve both the supply and demand sides. (2 votes)
    - Develop market rules by scale factor. (1 vote)
    - Condition de-regulation on mitigation of market power. (1 vote)
    - View tariffs as hedges/futures. (1 vote)
    - Establish a “pro forma” distribution tariff for DG and DSM. (1 vote)
    - Develop system of accountability (supply, demand, manufacturing).
    - Ensure multiple buyers and sellers for both the electric commodity and a rebundled product.

#### 4.3 Price and Other Information Requirements

After generating ideas for revising the way electricity is priced to better reflect its real and new valuation as perceived by energy users, ideas with four and five votes were singled out for further discussion. (Those ideas with three votes or less were not discussed because of time constraints.) It is worth emphasizing that the voting results reflect only the opinions of those present at the Summit and are used only to facilitate more focused discussions among the Summit attendees. These results should not be viewed as the representative “ranking” by the electricity stakeholder community.

Discussions on these top vote-getters centered on the following question: What specific price and other information will be needed by users, DER equipment makers/operators, and energy services providers to implement better pricing in future retail energy services markets? The identified information requirements are summarized in Table 1 on the following page. In the Table, pieces of information required by more than one entity are italicized.



Table 1. Price and Other Information Needed by Users, DER Equipment Makers/Operators, and Energy Services Providers to Implement Better Pricing in Future Retail Energy Services Markets

<b>Pricing Ideas (top vote getters)</b>	<b>Energy Users</b>	<b>DER Equipment Makers/Operators</b>	<b>Energy Services Providers (including utilities)</b>
<p><b>Have retail price track wholesale power price</b></p> <p><b>"I want real-time prices in my home...."</b></p> <p><b>Market rules and participation*</b></p>	<p>Schedule of prices, equipment costs, benefits</p> <p>Schedule of prices for operating specific appliances/equipment</p> <p>Energy usage of equipment-time profiles; schedule of use</p> <p>Power factor of equipment</p> <p>Time-of-use metering</p> <p>Real-time (15-minute interval)</p> <p><i>Spot prices</i></p>	<p><i>Aggregator needs to know load factor</i></p> <p><i>Availability of DG systems</i></p> <p><i>Generation of DG systems</i></p> <p><i>Spot prices</i></p>	<p>Priority of power uses in buildings and manufacturing</p> <p><i>Aggregator needs to know load factor</i></p> <p><i>Availability of DG systems</i></p> <p><i>Generation of DG systems</i></p> <p><i>Spot prices</i></p>
<p><b>Normalize energy and environmental prices</b></p> <p>o <b>Measure emissions from point of use</b></p>	<p><i>Costs of environmental consequences of electricity generation, transmission, and distribution</i></p> <p><i>Emissions rates for generators and system alternatives (externalized, hidden costs)</i></p> <p><i>Schedule of green prices</i></p> <p>Use MVP (measurement verification program) to quantify emissions reduction</p> <p>Thermal efficiency at point of use</p>	<p><i>Costs of environmental consequences of electricity generation, transmission, and distribution</i></p> <p><i>Emissions rates for generators and system alternatives (externalized, hidden costs)</i></p> <p><i>Schedule of green prices</i></p>	<p><i>Costs of environmental consequences of electricity generation, transmission, and distribution</i></p> <p><i>Emissions rates for generators and system alternatives (externalized, hidden costs)</i></p> <p><i>Schedule of green prices</i></p> <p>Baseline environmental emission level and Correlate emission rate with power generation</p> <p>Environmental pricing</p>
<p><b>Price VARS and other Ancillary Services (A/S) in wholesale &amp; retail markets**</b></p>	<p>Price of A/S and what quantities of various A/S the customer has to sell, i.e., revenue stream</p>	<p>Location of loads on systems that use A/S and which customers pay and how much</p> <p>Amount of A/S produced by DER devices and VAR vs. KW tradeoffs</p> <p>Bidding rules for supplying A/S into spot market</p> <p>A/S could be priced as a schedule</p> <p><i>Marketing strategies and communications channels from energy services providers to operators to users</i></p> <p><i>Portfolio of techs and their costs for providing A/S in relation to savings</i></p> <p><i>Aggregation of small customers to sell A/S; market mostly in large users</i></p>	<p>Where A/S are needed on location-specific basis</p> <p>Voltage levels; A/S outputs at generation</p> <p><i>Marketing strategies and communications channels from energy services providers to operators to users</i></p> <p><i>Portfolio of techs and their costs for providing A/S in relation to savings</i></p> <p><i>Aggregation of small customers to sell A/S; market mostly in large users</i></p>
<p><b>Deregulate transmission rates</b></p>	<p>Transmission costs; and potential cost avoidance and revenue from DER</p> <p>Need better understanding of OASIS, terms, and value of access</p> <p><i>Access to OASIS info base</i></p>	<p><i>Geographically disaggregated transmission prices</i></p> <p>Relative costs and benefits, today and future, of transmission and alternatives</p> <p><i>Access to OASIS info base</i></p>	<p><i>Geographically disaggregated transmission costs</i></p> <p>Load forecasts and line loading, and availability</p> <p>Effects of DG on transmission loading and parallel paths</p> <p><i>Access to OASIS info base</i></p>

\* "Market rules and participation" is the heading for a category in the previous session. Many ideas were grouped under this heading; as an aggregate, this area reflects great importance. Thus, participants included it in this session's discussions.

\*\* Besides the entities identified, wire companies need to know A/S as well, because they affect the capacity of transmission line.

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#### 4.4 Barriers to Realizing New Valuation System for Electricity

The Summit concluded with a session focusing on the barriers and pitfalls (e.g., technical, institutional, social, financial) that participants think are likely to interfere with the realization of the new pricing structures and information flows in future retail energy services markets. All barriers identified by participants were collected on index cards. They were discussed and grouped into the following categories.

- Financial
  - Allocation of liability, such as safety considerations for contractors and standardized listing in building codes related to DER.
  - Liquidated damages, i.e., cash payments for non-delivery of electricity.
- Pricing and Information
  - Energy priced on flow rather than capacity.
  - Absence of quality information at all levels (energy, economics, market economy, utilities).
  - Lack of timely information about pricing, especially on A/S, (in real time or at 15-min intervals) and ability of individuals/companies to do something about it.
  - Pollution measured at point of production because of available information flow, not at point of consumption that measures its true impact.
  - Need "roadmap" to get from today to new pricing structure.
- Government and Regulations
  - Market power.
  - After California, many states are going to be reluctant to change structures, but technology is not a problem. Education is key.
  - Division between wholesale (Federal Energy Regulatory Commission or FERC) and retail (state regulation).
  - Politics/electioneering.
  - Financial incentives to conserve do not include environmental concerns.
  - Government and regulations.
- Technical
  - The lack of a common protocol (software) that allows and facilitates communication (data transfer) seamlessly between devices.
  - Large bandwidth required for communicating with meters to meet information resolution and latency (i.e., the degree of accuracy and data collection frequency).
  - Lack of substation automation. Substation automation is critical to optimized DER return, which allows export of excess electricity to the grid. Only 4% of 1.2 million substations are automated. The low percentage is attributed to lack of standards for automation hardware and software. GE, Siemens, and ABB were mentioned as the big-3 major equipment providers, each with its own proprietary system.
  - Measuring and quantifying benefits in efficiency improvements, emission reductions, and other valuation metrics.
    - Availability of environmentally friendly DG capacity to establish a viable alternative to central plants monopoly. (A key factor is cost competitive.)
  - Load management system, self operated or signal triggered by distribution companies.

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- Mindsets (Social)
    - Acceptance of new technology at utilities—education is needed.
    - Mindset of consumers: must serve their demand at “fair” uniform price.
    - Mindset of distributors: all demand must serve at flat price.
    - Utilities have been reducing O&M to make bottom line look better. They want a simple, fixed, traditional infrastructure. They will fight this sort of “sea change.”

## 5.0 Summary

This Summit helped define valuation of electricity, based on the user’s perspectives of electricity’s contribution to the cost of goods/services and to quality of life. These perspectives on electricity value, as conveyed in this report, are not reflected in the tariff-rate structures currently used by utilities. For DER to be developed into a competitive marketplace, one must consider all factors valued by the user, such as power quality, reliability, and environmental impact, in addition to the costs associated with electricity generation, transmission, and distribution.

Various ideas were introduced in the Summit for revising current metrics in electricity pricing to better reflect its valuation. Real-time pricing, locational values as inherent in DER, inclusion of environmental costs and ancillary services, and new market rules involving both demand and supply sides are the main areas identified for incorporation into electricity price structures. The information required for implementing those ideas considered most important was identified with respect to the data/information needs for decision making by energy users, DER equipment makers/operators, and energy services providers including utilities. Lack of bi-directional information flow in real time (i.e., at 15-minute intervals) between the generation and consumption sides was cited repeatedly during this Summit as a major impediment to implementing many facets of new pricing structures, such as schedules of prices, time-of-use metering, measurements at point of use, contracts and market rates setting, etc. This, in turn, limits many remedy options for resolving the problems of brownouts and blackouts. Additionally, the concept of mass customization that combines individual customers’ needs in power quantity/quality with mass production requires an amount of information flow currently not available from the consumption side. This lack of information flow also hinders our ability to incorporate risk identification and assessment into energy management. Consequently, the inability to conduct risk management results in insurance companies not offering coverage for power outages, purportedly a loss of \$250 billion per year in business that insurance companies covet.

Barriers to effecting new pricing ideals and to gathering information required were identified in financial, institutional, social, and technical areas. Regarding social barriers or mindsets, information dissemination and education cut across as the central theme. The mindset of the current user, “people don’t know and don’t care to know,” is rooted in the practice of no real user choice. This lack of user choice and the mindset can be changed with information flow (e.g., cost-based signal, time-of-use metering) to allow the user to make sound financial decisions. Regarding technical barriers, standards for communication and automation systems, broadband communications, load-management systems, and cost-competitive DER systems were identified, among others, as needing further development, along with the need for correlating emission rates with power generation. With respect to building DER into a

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competitive marketplace, participants advocate the approach of building constituencies, i.e., coalitions with utilities, energy services providers, and others for expanding DER use and to publishing success stories such as the Salt River project and those occurring in the cities of Palo Alto and San Diego.

This Summit served its purpose by identifying key areas of importance in electricity valuation, ideas for restructuring electricity pricing, and information/data requirements for and barriers to effecting the changes. DER and communications and control for DER have key roles in the new market force for efficient, reliable, and environmentally responsible energy resources. The Summit provided the top-level framework for further defining technology strategies and pathways to fill in gaps in information/data needs and to overcome technical barriers. Ideas and needs identified in this Summit will be used as points of discussion in the ensuing Technology Workshop.

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**Executive Summit on Distributed Energy Resources (DER)**

*Session: Demand Pull of DER Based on Real and New Valuation of Electricity*

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**Agenda, May 30, 2001**

- 8:00-8:30 a.m. Registration and Coffee
- 8:30-8:45 a.m. Introduction and Welcome  
Eric Lightner, Communications and Control Program, DOE Office of Distributed Energy Resources
- 8:45-9:00 a.m. DOE's Distributed Energy Resource Program  
Patricia Hoffman, Office of Distributed Energy Resources, DOE Office of Energy Efficiency and Renewable Energy
- 9:00-9:15 a.m. Meeting Objectives and Process  
Richard Scheer, Meeting Facilitator, Energetics, Inc.
- 9:15-10:15 a.m. Roundtable Discussion on Valuation of Electricity  
Define electricity's value in terms of its contribution to the cost of goods/services or the quality of life. Identify what the electricity value should be measured against or the metrics, as compared to those governing current tariff determinations.
- 10:15-10:30 a.m. Break
- 10:30 a.m.-12:00 p.m. Roundtable Discussion on Market Rate Determining Factors  
Define regional and national market structures and associated key elements for determining or reinventing rate structures.
- 12:00-1:00 p.m. Lunch
- 1:00-2:15 p.m. Roundtable Discussion on Prioritization of Metrics  
Prioritize those metrics and market rate elements identified, based on their relative values as perceived by electricity users.
- 2:15-2:30 p.m. Break
- 2:30-3:50 p.m. Roundtable Discussion on Methods for Metrics  
Identify methods for quantifying each metric identified as important.  
Identify information flow and resolution required for "new" market structures.
- 3:50-4:00 p.m. Summary of Meeting Action Items and Next Steps  
Richard Scheer, Meeting Facilitator, Energetics, Inc.
- 4:00 p.m. Adjourn