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Overview:

Building the Sustainable Electricity Grid & A New Utility Incentive Framework

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I. Sustainability: A 21st Century Imperative

A. Sustainable Development Definition

Sustainable development has been defined most broadly as " Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Committee on Environment and Development, 1987). Energy use and it's economic, ecological, and social consequences are crucial issues for sustainable development.

B. Sustainability Imperative

The unsustainable consequences of current energy use include the gathering threat of global climate catastrophe, resource wars for fossil fuels, enormous trade deficits, massive pollution, resource depletion, ecological damage and habitat destruction. The electricity sector is a significant, but certainly not the only, contributor to these problems. We cannot continue indefinitely upon the current unsustainable path. In the 21st century, economic growth must mean ecological improvement, not ecological destruction. Prosperity and ecological sustainability are not only possible, but also essential for the survival our dynamic market system.

C. Market Rules for Sustainability

In a market economy, the market rules and regulations must send proper economic and ecological signals to all market participants in order to properly value and reward sustainable conduct. Our hearts tell us what we should do. Market prices tell us what we will do. Sustainability as a practical goal cannot be separated from sending proper price signals.

As the amount and rate of pollution, depletion, and ecological damage increase, the rate of profit must decrease. Conversely, as the amount and rate of pollution, depletion, and ecological damage decrease, the rate of profit must increase. This is the essential characteristic of sustainable markets and sustainable market rules.

This inverse relationship between profit and pollution is the basis for monitizing the triple bottom line of sustainability - the economic, the ecological, and the social. Production and consumption must be based on market rules and timely price signals that make the unsustainable cost more, and the sustainable cost less, in order to send proper incentives for market behavior, including savings, investment, production and consumption.

These sustainability incentives must impact entire supply chains, as well as product and process life cycles. We cannot view sustainable conduct as meeting a single metric - for example, carbon use - or a single goal - for example, preventing global climate change. Reducing carbon is a necessary, but not sufficient step in meeting the challenge of building a sustainable and prosperous future, of moving from an unsustainable industrial present to a durable and prosperous ecological future.

A prosperous, sustainable and democratic market system is dependent upon the ability of all market participants to do both good and well.

II. Basic Principles of Sustainable Electricity Network

The 21st century sustainable, smart utility grid will be a network where each user, both as generator and consumer, indeed each device connected to the network, will respond in real time to signals on system prices and state, and will react in an appropriate fashion. The challenges in building this network are not merely technical issues of electrical and mechanical engineering, but must encompass appropriate market rules, regulation, proper utility incentives, and financial engineering. The principles guiding development of the network include:

A. Rates and Market Rules Send Proper Economic and Ecological Signals

Building a sustainable and smart utility grid system requires that all participants who generate, transmit, and use energy at any point in the network, can respond in a timely fashion to accurate, real-time price signals that reflect the true costs of a system operation - economical, ecological, and social.

1. Market Prices Are Fully Loaded

Network market prices should be a combination of marginal price fluctuations and long term costs and consequences of system investment and operation. To the extent possible, the market price viewed by all participants should be structured to encompass all costs associated with operation. Thus, for example, the decision made by a user to consume more or less power or to self-generate, should be made on the basis of a price signal that includes fully loaded costs for generation in all aspects: distribution, forward capacity, ancillary services, carbon emissions, and credits for renewable energy generation and capacity.

2. Market Prices Are Non-discriminatory for All Participants

All participants in the network, large and small, should be exposed to real time costs of system operation. The social need for cost averaging and rate relief for customer classes should be accomplished in ways that do not remove effective price signals, although they may mitigate their effects.

3. All Smart Grid Network Participants Must Be Capable of Receiving Real Time Signals on Market Prices and System State

Decisions made on the basis of real time information on price and system state will facilitate user decisions, and work in a self-regulating fashion to help balance the system. Thus, as price and load increase, consumers respond by either reducing usage or increasing self-generation, thereby decreasing system load and price.

Current technology allows for five-minute price signals to users. Ultimately, signals can be in the range of two seconds or less. This level of performance provides a system-wide response capability that is similar to today's Automatic Generation Control (AGC).

B. The Smart Grid Must Be Based on Open Source / Open Access Protocols

As an understanding evolves of the needs of a smart grid, we must begin to establish open access and open source protocols. Regulators and utilities should be cautious about adopting proprietary standards that could preclude future innovative in control, communication and metering technologies.

C. The Distribution Utility Has a Key Role in Maintaining and Developing the Smart Grid

The 21st century distribution utility has a vital role in the development, operation and maintenance of the smart electric grid. It must reconfigure its network, as needed, to handle power flows in both directions, and it must develop a two-way communication and control system for the optimal operation of the smart grid.

D. Distribution Utilities Must Receive Proper Economic Rewards and Incentives

The current system, wherein distribution utility revenue and profit is dependent upon through-put of central generation or purchased power, is incompatible with building a sustainable smart grid and must be changed. The current system has perverse economic incentives. It penalizes utilities for distributed generation and anything else that reduces demand for power, such as energy efficiency. Unless a new and logical sustainable revenue model is adopted, sustainability will remain marginal. Utilities should be rewarded, not penalized, for assisting and encouraging development of all aspects of the sustainable grid in a non-discriminatory fashion. A specific new revenue model is outlined below.

E. The Smart Grid Will Support Sustainable Development

The smart grid will help to develop other methods of sustainability by assigning proper value to renewable and energy conserving physical ventures. In addition, it will facilitate new financial arrangements, such as hedge contracts or pre-buys that help both customers and developers.

III. Utility Incentives for Sustainable Smart Network Development and Operation

The existing incentive structure for utilities dates back to a time when social goals were met by increased extraction and conversion of mineral and energy resources. Mining and oil production were subsidized, investments in the electrical generation and centralization were fostered. Increased centralization and elimination of smaller generators provided efficiency improvements and cost reduction for everyone. The new plants were larger, cheaper and more efficient. Everyone benefited from the elimination of most distributed generation. These economies of scale and efficiency persisted into the 1950's and 1960"s, when steam cycle efficiency peaked, practical size limits were reached, and natural monopoly characteristics began disappearing as interconnections between systems increased. The cost of fuel and power plants began to increase and become a significant economic cost. Emission control has become important for health, environment and climate impacts. Availability of fuel has become a security issue.

While these changes were occurring, the essential incentive structure remained the same; utilities were rewarded primarily for making investments.

An effective revenue model for a sustainable, smart electric network system for distribution utilities should:

Remove Disincentives for More Efficient Operation and Optimized Use of Distributed Generation, Heat Pumps, District Heating, Co-generation, Leading to Maximum System Efficiency and Economic and Ecologically Sound Operation

A new model will need to continue providing the distribution utility a reasonable opportunity for investment recovery and a rate of return. Additional performance incentives for achieving better load factors and other cost reducing changes will be needed. Volume changes should be a pass-through.

Customer charges should cover interconnection cost. Variable real time kWh charges, reflecting local distribution congestion, should cover the remaining costs.

We present what we believe is a fair, useful, and durable model for distribution utility revenue that will support and properly encourage the development, growth and maintenance of a sustainable, smart utility grid system. The changes proposed to the existing system, while very important, are not that great.

Some of the detailed characteristics of our proposed system are as follows:

Cost of service study
A cost of service study is performed, as it is today, to include new changes to the distribution network that would optimize two-way power flow.

Estimation of volume
Utility would estimate the projected monthly power flows for the coming year to establish a baseline price per kWh. This would be the total cost of the system minus customer charges, divided by the projected kWh.

Price adjustment for feeder loading
The utility would assess load factor and growth on each major feeder and develop a real-time price adjustment that would raise the baseline distribution price during heavily loaded times and reduce the price during periods of low load. These adjustments would be added to ISO prices at that feeder. The real-time price adjustment based on actual loading replaces the conventional distribution demand charge and standby charges.

Reconciliation of actual performance with projections

Periodically, perhaps monthly or quarterly, actual sales and revenue would be compared with projected values. The baseline price per kWh would be adjusted up or down to maintain revenue. Major changes in cost of service would require a new cost of service study.

Interconnection costs would be recovered in a customer charge
Cost of equipment and services that can only be used by one customer such as metering secondary wiring communication equipment and transformer would be paid for in a customer charge. The customer charge might be fixed by customer class or take the form of a demand charge.

Performance incentives
Utility would receive management fees or a higher rate of return for better utilization of its investment, better planning to adjust for new variables and other behaviors that reduce cost and improve performance.