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Building A 21st Century Electric Utility System:
Smart Metering, Net Metering, Interconnection, Efficiency:

Comments for the Energy Policy Advisory Board

Roy Morrison and Pentti Aalto

Overview

We have the opportunity to build a 21st century electric utility system based on developing smart networks that can dramatically improve system utilization, efficiency, and control.

The smart network will perform better economically and ecologically. It will benefit all users from residential to industrial. It will make the entire system more reliable and reduce its ecological footprint. It will be a network that maximizes communication, control and interconnection based on relevant and secure open source/open access protocols. It will be capable of sending real time price signals based on the system state that include values for all aspects of generation and distribution using market prices and dynamic regulatory pricing structures. It will develop means to appropriately reward and incentivize users from all customer classes, generators of all sizes, control and efficiency providers, transmission and distribution utilities. All of us will benefit from the operation of this smart network.

These aims and goals of the smart network provide a basic framework for users, generators, policy makers, utilities, and regulators to shape the institutions and polices that will build the smart 21st century network.

There are a variety of issues raised under the Energy Policy Act of 2005 (EPAct) Sections 1251, 1252 and 1254 being considered currently under NHPUC investigation DE 06-061) that provide an essential opportunity for further development of the smart network.

Within the context of building the smart network, the following points are most relevant in regard to current issues being discussed:

1. Financial Incentives

Relevant to questions of net metering, smart metering, interconnection, and fuel mix is the question of developing proper financial incentives and rewards for all parties from smallest users, to generators of all sizes to distribution utilities.

If distribution utilities, for example, are not properly incentivized and rewarded for efficient operation of the smart network they will logically resist its development.

A key element for the expeditious development and optimal use of smart metering, distributed generation, and net metering is regulatory structure, for example, an increase in utility rate of return, to accompany the more efficient and rational utilization of an integrated system using real time price information and control of load and distributed generation.

The distribution utility should not be put in the situation where it is penalized for a decline of purchased power due to distributed generation and improved efficiency. Distribution utilities should be rewarded, not punished for their pursuit of building the smart network.

The use of real time price signals should not be limited to energy prices but can evolve to include overtime a fully loaded price that includes information based on the system state that includes market prices for energy, capacity, ancillary services, and a dynamically regulated price for distribution services. The smart network will be capable of sending real time price signals based on distribution system state as well as demand in power market. Thus it should cost more to use distribution network in times of congestion than in times of low utilization.

In sum we see substantial benefits for all from the smart network in operation. These benefits include end users and distributed self-generators who reduce costs and improve reliability, all users who benefit from reduced spot market clearing prices, the ISO-NE system as a whole that can benefit from load response that as it improves over time can serve to influence positively very short term ISO tasks such as Automatic Generation Control (AGC) distribution utilities who benefit from deferral of new construction due to improved utilization and load deferral, and New England ecological as a whole through improved efficiency and reduced emissions from the smart network.

2. Smart Metering:

A pilot for residential and small commercial users to study real time smart metering and begin implementation should be pursued. We have attached information on our proposal for such a pilot. This pilot can proceed through the initiative of the distribution utilities or through the regulatory efforts of the NUPUC. The pilot will provide needed information for future smart metering development. In the abstract we cannot accurately judge what will work and what lessons are to be learned from implementation.

3. Fuel Use

The question of the use of district heating and cooling in high load areas to dramatically increase system efficiency should be considered when planning and assessing utility fuel use and optimization. The increases of use efficiency through cogeneration are potentially vastly superior to increases in electrical efficiency.

Following are detailed discussions of a proposed pilot smart metering program submitted to the NHPUC by Roy Morrison and Pentti Aalto under NHPUC investigation DE 06-061.

Smart Metering for Consumer Response: Outline for Pilot Phase I

This paper provides an outline for Phase I of a proposed pilot to test the technology and performance of a smart metering and load response system using 5-minute ISO prices. Such a system will benefit not only participants, but also users in general and the ISO system as a whole since control takes place within the ISO response time window.

We discussed a generic system in our conceptual Smart Metering Proposal (following) presented to the NHPUC in May to help inform hearings to be held in accord with Section 1252 of Energy Policy Act of 2005 (EPAct) that addresses Time-Based Metering and Communications or “Smart Metering”.

Here we outline the specific technology proposed for a small Phase I test for 10 volunteer residential and/or small commercial users. We will test a two way paging system based smart metering and load control system. The test will evaluate communications, the interface with the metering system, onsite system interconnections, load control methods, data gathering and transmission of energy use and cost, pro forma bill preparation, communication with end users, system performance in terms of dollars saved and load shed.

We have assembled and tested the basic prototype of such a system using a method for extracting the 5 minute ISO price, Skytel paging communications, and a

Motorola Create-a-Link II controller connected to user meter and controlling user load. The Pilot Phase I will examine performance, interconnection, and standardization issues needed to move from working prototype toward effective large scale.

The lessons from Phase I will be applied to Phase II of larger scale (e.g. 100 to 500 users) suitable to demonstrate the ability of the smart metering system to serve as the basis for a smart metering optional service for residential and small commercial customers.

We welcome response from all interested parties to this outline proposal for Phase I. We will then further detail the Pilot Phase I and Phase II including preparation of a budget. Phase II will include examination of user recruitment and cooperative organization and servicing of participants (as in Chicago smart metering project.)

Pilot Phase I follow the basic steps outlined in our conceptual proposal.

Phase I NH Smart Metering pilot project will:

• Extract ISO 5-minute NH zone pricing signals;

• We will explore modifications to price information as appropriate to cover other costs (such as ancillary services and capacity charges);

• Transmit price information to customer receiving/control equipment;

• Control customer load automatically based on preset price trigger levels;

• Monitor power use information from the customer meter; calculate the ongoing cost of power used, and record the cumulative value of electricity and dollars;

• Transmit resulting use and dollar totals periodically to a central facility for processing and billing.

NH Smart Metering and Load Control Pilot Phase I

Technology and Procedures

1. Extract 5-Minute ISO-New England Zonal Prices

• Our central office computer is programmed to scan once per minute the ISO-NE Current 5-Minute Marginal Price Page. This page includes the total ISO system demand, and for each of the eight zones and the NE-ISO hub it lists the 5-minute Locational Marginal Price (LMP) and its components: energy, congestion, and marginal loss.

• When we detect any change in this ISO-NE data, we record the new data in a database.

• Computer sends price and time information to the paging network for transmission to user receivers. (If necessary to add additional pricing data it can be added by the central computer.)

2. Skytel Network Transmits Price and Time Signal

• Skytel paging system sends price and time signal to each of the user receivers.

•Skytel system for the purposes of the Pilot is a secure and timely method of sending information to users.

3. Motorola-Create-a-Link II Controller

• Signal received by Motorola Crate-a-Link II transceiver using the Reflex 50 communications protocol. (Control Sequence in 4. below.)
• Control board is sophisticated programmable system with central processor and memory designed for control and communications using a two-way transceiver. The control board has:
-- eight input/output channels including two high capacity channels
-- two analog to digital inputs
-- board temperature sensor
-- battery backup with sensor monitoring battery voltage
-- transceiver to send and receive data
-- volatile and non-volatile memory to prevent data loss
• Controller uses one of input/output channels to receive consumption data over a hard-wired path from the pulse meter. The controller is programmed to properly account for value of pulse and record in data file.
• Controller either hard wired to controlled load devices or connected to house wiring using X-10 controller for "wireless" control.
• Controller uses low voltage, and is properly fused to protect meter, controller, and residence.
• Controller located either outside residence or small business near the meter box or inside the residence or business.

4. On site data and control scenarios

Basic Data Flows

• Controller receives and stores 5-minute ISO price and time data from Skytel signal.
• Controller receives stores pulse input from electric meter and values electricity based on most recent 5-minute price.
• Controller stores cumulative data on kilowatt-hour use and $ value.
• Controller transmits cumulative price and use data to central office as desired.

Basic Control Scenario

• Controller compares price signal with price set points chosen by user and sends signals from one of its I/O channels to control user device either through hard wired connection or X-10 "wireless" controller using the house wiring.
• On/Off Control, for example, turn off one of two water heater elements in response to price, to duty cycle air conditioners, to turn on/off onsite generators.
• More complex control can be done in the future, for example, to reset air conditioning or heating temperature setting based on predetermined user selection, to preheat water or space or precool space during times when 5-minute prices and control scenarios indicate.

5. User Billing and Communications

• User kwh use and cost data sent periodically to central office.
• In Pilot Phase I users can request a limited number of remote control setting changes that will be sent by central office computer to user receiver.
• User in Pilot Phase I will receive detailed information concerning their power use and prices they were exposed to and load deferrals and time duration and price savings analysis.
• We will examine additional ways of measuring savings.

A Note on Utility Role and Rate Treatment of Smart Metering

The role of distribution utility is crucial in making smart metering work, whether in the pilot or beyond. We want to work cooperatively with participating distribution utilities and explore compatibility and proper integration with their system and identify problem areas that need to be addressed.

In the long run we believe it maybe logical and in the public interest for the utility to be charged with installing and maintaining the hardware involved in the smart metering network, and that such hardware and maintenance become part of the rate base.

Smart metering based on 5-minute pricing has a benefit for all users by being able to influence price in congestion times, reduce system peak, and act within the ISO response time window. Such a system if widely installed could have substantial benefit for all in terms of reducing costs, pollution, need for new generation.

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Smart Metering for Consumer Response
A Conceptual Proposal by Pentti Aalto and Roy Morrison

The use of "smart metering" represents an opportunity to benefit the residential and small commercial electric customers who use smart metering; all electric customers by reducing peak load and price; and the ISO system as a whole providing fast consumer response.

This paper is a conceptual proposal for the development of a smart metering pilot program for residential and small commercial electric users using real time pricing and metering, two way communication between the central office and meters, and the ability to automatically execute load control based on ISO 5-minute zonal prices.

A Growing National Commitment to Smart Metering

Section 1252 of the Energy Policy Act of 2006 (EPAct), addresses Time-Based Metering and Communications or “Smart Metering” and requires that states determine whether electric utilities should “ provide and install time-based meters and communications devices for each of their customers which enable such customers to participate in time-based pricing rate schedules and other demand response programs.” (See NHPUC notice DE 06-061)

In Illinois, the Community Energy Cooperative, operating in ComEd territory, has conducted a successful "Smart Energy Pricing Plan" project for over 1,400 customers. The Illinois legislature recently passed unanimously and sent to the governor SB 1705 requiring utilities to offer residential customers real time pricing in 2007, and contract with an independent organization for implementation.

The NH Smart Metering Pilot Project Proposal

In New Hampshire, we propose the development of an appropriately sized smart metering pilot for participating utilities that will test a system of communication, control, and billing that will produce better real time performance at low enough cost to allow the system to be used with residential and small commercial customers. The pilot can begin small, e.g. 100 volunteer customers, and expand, if successful, to 500 to 1,000 members.

The pilot will employ a system we have developed and tested, using existing networks to transmit almost real time price signals to the customer. The price transmitted to the customer is used to both control load and calculate the value of each kilowatt-hour used. The resulting kilowatt-hours and dollars are periodically transmitted to a central facility.

In operation, the NH Smart Metering pilot project will:

- Extract ISO 5-minute NH zone pricing signals;

• Modify price information as appropriate to cover other costs (such as ancillary services and capacity charges);
• Transmit price information to customer receiving/control equipment;
• Customer equipment automatically controls load based on preset price trigger levels;
• Customer equipment monitors power use information from the customer meter; calculates the ongoing cost of power used, and records the cumulative value of electricity and dollars;
• Resulting use and dollar totals are periodically transmitted to a central facility for processing and billing.

The results of the pilot can be applicable to a number of different metering systems. We will use technology that we have developed and used on an experimental basis. We recognize that this is one of many methods that could be used to accomplish this task.

Advantages of the 5-Mintue Pricing Model

Instead of interval metering and hourly pricing, we are proposing a method of 5-minute price communication to the customer. This method provides 5-minute almost real time price signals used for billing and automated control. This facilitates not only optimized control, but also consumer choice of predetermined price points and control strategies. This is likely to be of substantially greater appeal than, for example, central office controlled on/off duty cycling of air conditioning.

Five-minute pricing provides superior information for both pricing and control. Hourly pricing is after the fact. Day ahead pricing provides the ability to plan, but doesn't necessarily reflect actual market price and grid conditions. Actual power dispatch is done on nearly instantaneous basis. Our 5-minute pricing signal is a proxy for the actual dispatch value.

Five-minute Pricing:
• Allows prices to be applied to power as it is used;
• Allows the customer to respond to the actual billing price;
• Allows the customer response to fit into ISO 10-20 minute dispatch widow to achieve balance with neighboring systems;
• Provides general economic benefits as power consumption is reduced in high price times where small reduction in load can cause relatively large reductions in price.

Pilot Implementation

We propose working with the NHPUC, utilities, and other interested parties to develop and then implement the pilot five-minute smart metering program. The pilot will examine operation of the system, track participation, costs, savings and effectiveness, the suitability of particular technologies to different applications, the integration with existing and proposed utility metering technologies, organizational and implementation issues.

Funds for this broadly beneficial pilot should be provided from Systems Benefit Charges or through other means deemed appropriate by the NHPUC.

Pentti Aalto has extensive experience in developing and testing this particular prototype of smart metering systems. Roy Morrison has extensive experience organizing consumer energy cooperatives and developing innovative electricity policy measures.

We note further that we are founders and Board members of the non-profit United Sustainable Energy Cooperative, Inc. The cooperative can serve as a suitable non-profit entity serving the pilot and its participants.

We thank you for your attention and wish to discuss this matter further.