BRIDGE WITH TOMORROW SMART HOUSE & SMART GRID

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ABSTRACT

Deregulation and privatization are posing new challenges on high voltage transmission and on distribution systems as well. System elements are loaded up to their thermal limits, and power trading with fast varying load patterns is contributing to an increasing congestion. In addition to this, the dramatic global climate developments demand for changes in the way electricity is supplied. Innovative technologies and concepts will emerge as we move towards a more dynamic, service-based, market driven infrastructure, where energy efficiency and savings can be facilitated by interactive distribution networks. A new generation of fully interactive Information and Communication Technologies (ICT) Infrastructure has to be developed to support the optimal exploitation of the changing, complex business processes and to enable the efficient functioning of the deregulated energy market for the benefit of citizens and businesses. The architecture of such distributed system landscapes must be designed and validated, standards need to be created and widely supported, and comprehensive, reliable IT applications will need to be implemented. The collaboration between a smart house and a smart grid is a promising approach which, with the help of ICT can fully unleash the capabilities of the smart electricity network.

1. INTRODUCTION

The residential, Small Office/Home Office (SOHO) and commercial building sector together is responsible for over 50% of Europe's electricity consumption. The current electricity distribution system treats home and working environment s as consisting of isolated and passive individual units. This severely limits the achieved energy efficiency and sustainability, as it ignores the potential delivered by homes, offices, and commercial buildings which are seen as intelligent networked collaborations. In order to achieve next-generation energy efficiency and sustainability, a novel smart grid ICT architecture based on Smart Houses interacting with Smart Grids is needed. This architecture enables the aggregation of houses as intelligent networked collaborations, instead of seeing them as isolated passive units in the energy grid. Within the European Commission co-funded research project Smart House/Smart Grid (www.smarthousesmartgrid.eu), a consortium of leading parties in ICT for energy takes a fundamentally different and innovative approach.

The general infrastructure to be used in order to accommodate the scenarios considered in the Smart House/Smart Grid is abstractly shown in Figure 1
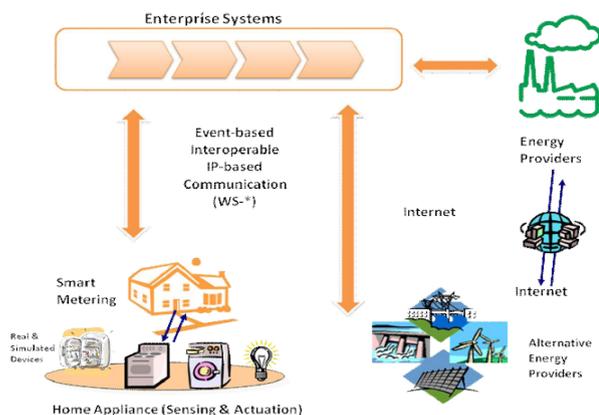

Figure 1: Overview of the Smart House/Smart Grid ICT infrastructure

A key issue is the integration of devices, communication between devices, and integration/communication with the enterprise systems. Information generated at the point of action (device level) is used by other devices, by higher level systems that aggregate and process them, as well as by global services. In that sense, there is an "information bus" where the meaningful information is available for entities to consume. Furthermore, several other technologies can be used beyond basic communication technologies in order to simulate and predict behaviour of such systems, or to provide further system capabilities.

2. THREE MAIN TECHNOLOGIES OF SMART HOUSES WITH SMART GRIDS

1. In-House Technology

In-house can be defined as all processes that run behind the meter, and includes not only residential households, but also small office environments. Kester [2006] identifies the following desirable technology developments for energy management behind the meter:

2. House / Grid-to-Enterprise Technology

Large number of messages triggered by various types of events are sent from the meter to the meter data management system, and further on to the business application system.

The AMI value creation chain (see Figure 2) illustrates one example of communication between the meter infrastructure and the backend system: after the collection (and consolidation) of all relevant consumption and / or meter reading data from the single meters, the information is transferred to a raw database in which the records are stored.
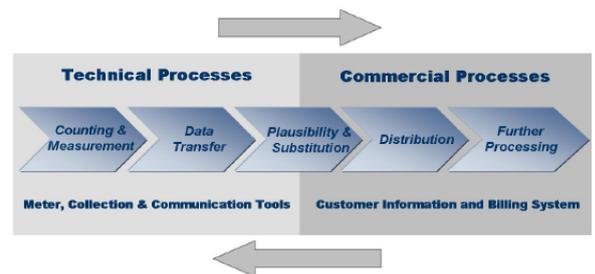

Figure 2: AMI value creation chain (SAP)

4. SMART GRID TECHNOLOGIES

Smart Meters
Other Sensors
Voltage Control
Capacitor Control
Outage Detection
Weather Conditions
Demand Control/Response

Distribution Substation SCADA
Automated Switching
Distributed Generation
Geographic Information Systems
Outage Management Systems
Work Force Management
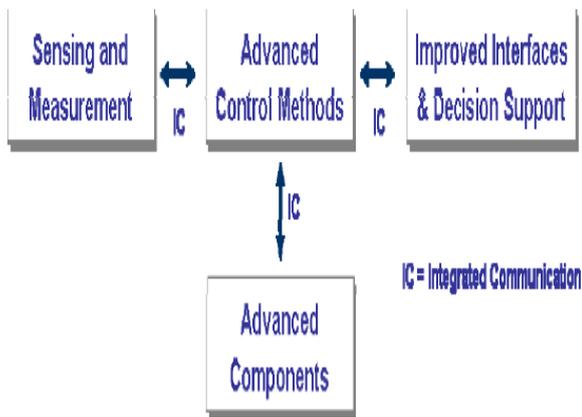Plug-In Electric Vehicles

Figure: 3 Overview of smart grid technology

3. SMART METER
A smart meter generally refers to a type of advanced meter (usually an electrical meter) that identifies consumption in more detail than a conventional meter; and optionally, but generally, communicates that information via some network back to the local utility for monitoring and billing purposes (telemetering).

A. Technological Capabilities
The drive for high-resolution energy usage data from which to forecast load demand or optimize service led naturally to an investigation of individual appliances and their relative contribution—both in time and amount of draw—to the overall load. Traditionally, this meant the installation of cumbersome and rather intrusive monitoring equipment within customer homes, often involving "a monitoring point at each appliance of interest and wires . . . connecting each to a central data-gathering location."1 In the early 1980's, researchers at MIT turned the research on its head with the development of the non-intrusive appliance load monitor (NALM), which "reverses this balance with simple hardware but complex software for signal processing and analysis."3 In order to disaggregate a customer's electricity usage profile into its constituent appliance events, researchers began compiling libraries of appliance load signatures that could be matched to signals found within the noise of a customer's aggregated electricity use. Though initially thought a daunting task to work backwards from an appliance's demand to the identity of the appliance itself, the load signatures of various appliance categories are surprisingly unique, and an impressive amount of detail concerning customer usage habits could be discerned from NALM-generated information.

NALMs were ever research tools, set up to monitor only a small number of customers in order to facilitate load forecasting and management. However, smart meters allow for the collection and communication of highly detailed electricity usage information in much the same way as did the NALM. However, unlike NALMs, smart meters are being deployed throughout entire electricity distribution networks. Indeed, the Federal Energy Regulatory Commission (FERC) recently reported that, all told, 52 million smart meters would be installed throughout the country over the next five to seven years.5 Smart-metered information, collected at levels as fine as one-minute intervals, can be disaggregated into its constituent appliance events, allowing both consumers and utilities (and anyone else with access to the information) to see exactly what makes up an individual household's electricity demands:
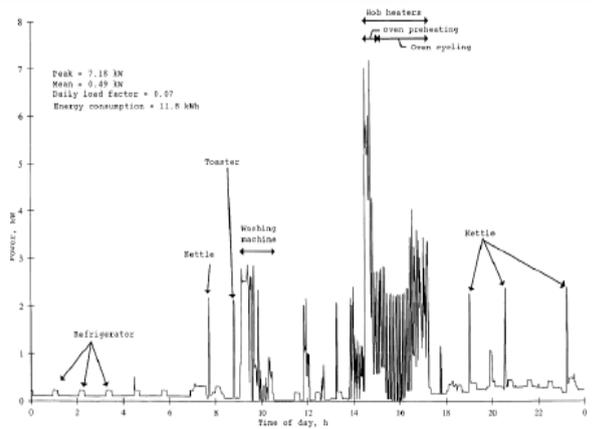

Figure: 4 Household Electricity Demand Profile Recorded on a One-minute Time Base

As analytic tools evolve, even information collected at significantly longer intervals—e.g. every fifteen or thirty minutes—can be used to pinpoint the use of most major household appliances. Such detailed information about the in-home activities of electricity customers can thus be used to piece together a fairly detailed picture of an individual's daily life or routine. Furthermore, as plug-in hybrid electric vehicles are deployed and customers engage in electricity sales on the grid outside of their homes, an electricity usage profile may become a one-stop-shop for tracking behaviours even outside the walls of the residence. Cataloguing and analytic methods advance, and thus the huge volumes of data about electricity usage soon to be unleashed, rather than seen as overly burdensome and expensive to make use of, are likely to be found treasure troves of information.

B. Information Uses
The information collected by smart meters and other smart grid technologies has many uses. Much of the development and investment surrounding smart grid have focused on those information uses that would best serve electric utilities. Essentially, an electric utility could capitalize on the information to facilitate more efficient network management, peak load reduction, load shaping, and any number of other such uses. However, a growing industry of "edge services"—services provided to the electric consumer or that are focused on the last mile of electricity distribution—have developed, and with them an impressive new set of uses for smart grid information, ranging from the bill control and demand-side load management to efficiency consulting and energy savings contracting.

C. Electric Utility Information Bundling and Resale
The many things determinable from smart grid information analysis, and the many edge services and other ancillary parties that have a reason to seek it out, suggests that smart grid information has value.

4. SENSOR- GRID
- Sensor-Grid is the integration of two parallel technologies; the Grid technology and the wireless sensor technology.

- Like giving eyes and ears to computational grid.

- Real-time information about phenomena in the physical world can be processed, modeled, correlated and mined to permit on the-fly decisions and actions to be taken on a large scale.

Definition of Sensors
- A sensor is a device that produces a measurable response to a change in a physical condition, such as temperature or thermal conductivity or to change in a chemical concentration.

- A device such as photoelectric cell, that receives and responds to a signal or stimulus (such as heat or pressure or light or motion etc.).

- A device, usually electronic, which detects a variable quantity and measures and converts the measurement into a signal to be recorded.

Features of good Sensor
- Must be sensitive to the measured property.
- Insensitive to any other property.
- Should not influence the measured property.

These are some factors which could really cause the crash of whole Sensor Grid network, if badly perform.
Bringing Sensor and Grid together

- Both of them will benefit
- Grids
- "Resource sharing & coordinated problem solving in dynamic, multi-institutional virtual organizations"
- Get Eye to see the world (so that it can sense and assist)
- Sensors
- Off load their processing, storage, archival, analysis, etc. requirements to the Grid.
- Sensors + Grids = Sensor-Grid Sensor-Grid - Integrated sensor network and grid architecture
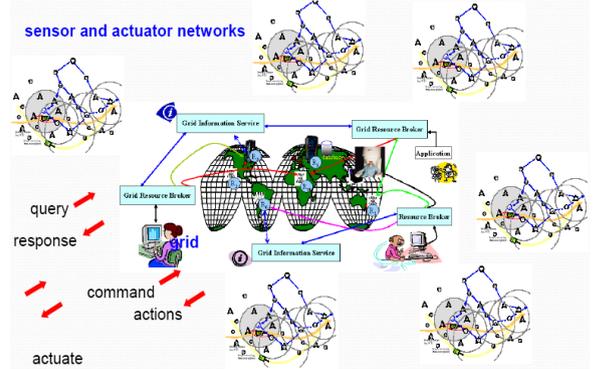
Sensors + Grids = Sensor-Grids

- A Sensor Grid integrates wireless sensor networks with grid infrastructures to enable real-time sensor data collection and the sharing of computational and storage resources for sensor data processing and management.

- It is an enabling technology for building large scale inf-rastr-uctures, integrating heterogeneous sensor, data and computational resources deployed over a wide area, to undertake complicated surveillance tasks such as envi-ronmental monitoring.

REFERENCE   [1] International Conference on Electricity Distribution, Koen KOK, Stamatis Karnouskos, David Nestle, Aris Dimeas, Anke Weidlich, Cor Warmer, 11/06 2009.|[2] Smart Grid Concepts, U.S. Commercial Service Webinar, Joe Miller Modern Grid Strategy Team Lead, September 16, 2009.|[3] Deliverable D1.2, Technology Trends for Smart House/Smart Grid, 02/02/09.|[4] George W. Hart, Nonintrusive Appliance Load Monitoring, 80 PROCEEDINGS OF THE IEEE 1870, 1871–72 (Dec. 1992).|[5] Christopher Laughman et al., Advanced Nonintrusive Monitoring of Electric Loads, IEEE Power and Energy 56 (Mar. /Apr. 2003).|[6] See F. Sultanem, Using Appliance Signatures for Monitoring Residential Loads at Meter Panel Level, 6 IEEE Transactions On Power Delivery 1380, 1380 col. 1 (1991).|[7] Federal Energy Regulatory Commission, Assessment of Demand Response & Advanced Metering 2008.