# AMI Opportunities in the European Power Market

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The European power market presents challenges and opportunities for Advanced Metering Infrastructures (AMI) that differ from conditions in North America. High supply reliability in Europe has obscured the achievable contribution of demand-side techniques for reducing energy consumption. Meter reading is generally conducted only once a year, so that consumers remain unaware of the extent to which daily behavior and seasonal variations are affecting energy costs. The EU Directive on Energy End-Use Efficiency and Energy Services has been formulated to overcome these deficiencies, while the Directive on the Internal Market for Electricity allows wide configuration flexibility in meter usage. Power meters may be bought by private individuals, with installation, data collection, and maintenance performed by metering contractors.

EU-15 member states are not on track to reach their collective Kyoto greenhouse gas reduction target of 8 %. The elimination of carbon dioxide emissions has therefore become a crucial opportunity for AMI deployment. In addition to demand-side energy conservation, carbon dioxide emissions can be reduced by switching to natural gas or non-fossil suppliers. Groups of meter users may operate as cooperatives to implement aggregate power purchasing and $CO_2$ trading.

The availability of data intercommunication for sensors and transducers within range of the metering infrastructure permits multiple functions to be realized, including monitoring, supervision, and control applications. Göteborg, Sweden intends to become "the first and only ZigBee city in the world" using an Advanced Metering Infrastructure with a multiplicity of networked household and community services.

A "Smart Metering Map" maintained by the Energy Retail Association in London indicates that metering initiatives in Europe remain largely regionalized and dissociated. In Germany, the Organization of Municipal Utilities expects that only 25% of all households will be equipped with an intelligent power meter by 2015. The short-term replacement of existing meters for all remaining customers thus constitutes a viable marketing opportunity for contractors and suppliers. Additional potential ventures include the metering of renewable power fed into the public grid, for which a separate meter is employed to enable accounting independent of consumption. Using AMI meters instead would allow feed-in prognoses to be made in conjunction with weather data while also providing continuous equipment performance monitoring.

Regional circumstances and even geographical terrain may influence metering configurations. AMI can prove indispensable for controlling energy consumption in enhancing energy supply security. Under corresponding EU SmartGrids research objectives, the distribution networks of the future will serve customer-driven markets. The procurement of funding for appropriate projects may be facilitated by adopting standards and components supporting this objective. The flexible multifunctional capabilities of AMI can be employed in municipal, business, and residential environments. The reduction of energy consumption will diminish requirements for fossil fuel power generation and the greenhouse gas emissions it entails.

## The European Metering Infrastructure

The European power market presents challenges and opportunities for realizing Advanced Metering Infrastructures (AMI) that differ from conditions in North America in many significant respects. With the exception of Italy and Sweden,[1] European countries have largely adhered to power metering practices originated decades ago. Inexpensive electromechanical meters delivering cumulative data continue to be employed. Readings are generally performed only once a year for a number of reasons:

- European power meters are mounted indoors, necessitating utility companies to prearrange reading appointments by mail or mailbox flyers. The absence of a homeowner or tenant requires a revisit of the premises. The cost per reading is therefore significantly higher than for street-accessible meters.
- Excess capacities of generation and transmission as well as underground power distribution lines have resulted in high supply reliability that can obscure the potential benefits of demand-side management techniques for reducing grid loads by conserving energy.
- The expense of electronic power meters providing real-time feedback to customers is difficult to justify under the modest consumption of most European households that reflects a) the widespread absence of air conditioning, b) reduced dwelling dimensions compared with North America, c) improved appliance efficiency standards, and d) significantly higher prices for electricity (currently about 35 US cents/kWh in Germany) that motivate greater conservation discipline.

Under these conditions, billing has remained an annual accounting procedure with little influence on household power demand. Individual municipal utilities will occasionally invite customers to conduct their own readings and mail in the data using prepaid postcards to allow accurate monthly or bimonthly billing, but this practice has never gained wide adoption. In the majority of cases, a constant amount is invoiced at each intermediate billing interval on the basis of monthly costs during the previous year, with an annual correction made after the corresponding meter reading has been performed.

The average European consumer therefore remains unaware of the extent to which daily behavior and seasonal variations are affecting energy costs. A “direct debit subscription” may additionally enable the invoiced amount to be transferred automatically from the customer's bank account to the utility company, thus enhancing customer oblivion to the monetary consequences of energy usage. In reviewing this practice, the Centre for Sustainable Energy in the United Kingdom has noted that "the direct debit customer has no need to read (or even open) the bill in order to identify how much to pay",[2] since payment is made completely without his participation. Such practices result in needless increases of power demand due to customer inattentiveness to ongoing consumption.

While high efficiency standards prevail in Europe for appliances and equipment, it remains impossible to predict the frequency and intensity of their operation, the observance of prescribed maintenance procedures, or deviations from specified performance. Without the regular feedback of usage data to the customer, potential sustained energy savings of 5 to 10% for monthly billing intervals[3] and possible greater reductions resulting from data feedback in real time will not be realized.

However, metering policies that leave current levels of fossil fuel power generation unchallenged have become anachronistic under the Kyoto Protocol. Strategies of the European Union for reducing $CO_2$ emissions as well as continuing energy price increases are now evoking responsive metering practices to support consumer decisions on resource usage. These efforts will culminate in the wide-scale realization of Advanced Metering Infrastructures employing electronic ("smart" or "intelligent") power meters equipped with internal data processing and network communication capabilities. The timetable for this transition, however, remains uncertain due to insufficient cost benefit analyses from pilot projects that often have not yet been fully implemented.

**Initial Ventures into Smart Metering**

Many first-generation smart meters introduced in Europe require logging onto the Internet for tracking electricity consumption on a computer monitor. The power drawn for the continuous display of meter data reduces the net energy savings that can be achieved. Equipping these meters with a local wireless data interface would enable low-power display devices to be used while diminishing the need for frequent data exchanges with the grid operator.

Both European and U.S. companies have been providing software packages for the smart meter designs presented to date. Many capabilities expected by utility companies have yet to be realized, however, such as remote connect and disconnect functions. Some meters are being distributed only to interested customers and thus do not constitute a contiguous metering infrastructure. Due to the exclusive relationship with the grid opeartor, furthermore, customers have no independent means of exchanging data via the meter Internet interface with other users for the purpose of cross-comparisons. This restriction conceals potential opportunities for eliminating individual deviations in consumption to achieve additional cost and energy savings.

One of the most innovative meter designs in Europe has been realized only as a video clip. This talking “intelligent meter”, used on the Internet to advertise green energy, speaks to the consumer on the need for identifying the origin of metered electrical power. Ultimately, a suitably equipped intelligent power meter might be capable of switching electricity suppliers automatically to secure lower rates or to satisfy the environmental expectations of the customer.

**Imminent Opportunities for Deploying Advanced Metering Infrastructures**

AMI implementation is predestined to contribute to the reduction of carbon dioxide emissions. Western Europe, where the first 15 member states (EU-15) of the 27 EU countries are located, is experiencing particular difficulty in attaining aggregate Kyoto targets. In its annual report for the year 2007 on greenhouse gas emissions, the European Environmental Agency (EIA) has noted:[4]

> “Based on past emissions, the EU-15 is not on track to reach its Kyoto target. Its 2005 emissions stand above a hypothetical line between base year and its target emissions under the Kyoto Protocol. Compared to base-year levels, EU-15 greenhouse gas emissions have been reduced by 2.0 %. This represents only one fourth of the total reduction needed to achieve the 8 % reduction target.”

The energy savings resulting from more frequent billing information and from AMI real-time feedback data could materially contribute to fulfilling the Kyoto obligations of many countries. In pursuing this objective, European Commission Directive 2006/32/EC on

Energy End-Use Efficiency and Energy Services specifies the use of “meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use”. Billing must be performed “frequently enough to enable customers to regulate their own energy consumption”. Under this requirement, the following opportunities may be assessed for near-term AMI deployment.

**AMI Opportunity 1: $CO_2$ Remediation**

EU Directive 2006/32/EC stresses “the mitigation of $CO_2$” for the “prevention of dangerous climate change”. In addition to demand-side energy conservation, carbon dioxide emissions can be reduced by switching to suppliers employing natural gas or non-fossil generation.

Directive 2003/54/EG on the Internal Market for Electricity commensurately requires the origin of power deliveries to be shown on bills. Meters may ultimately be used as platforms for electricity purchases by exploiting their intercommunication capabilities.

The achieved avoidance of fossil fuel usage may be mathematically converted to greenhouse gas equivalents. The conserved energy that results from interactive metering techniques can then be translated into the active contribution of consumers to climate protection strategies. Price stability and supplier-side efficiency ensue from consistently repeatable results. AMI will thereby establish enduring public influence on the power industry, since even now European consumers routinely manifest preferences for particular utilities, pricing policies, and generation practices by switching suppliers.

**AMI Opportunity 2: Collaborative Metering**

National regulations implementing Directive 2003/54/EG have enabled European customers to buy their own power meters from third parties. AMI-capable meters may reduce dependency on the grid operator by enabling user collaboration in virtual space. Metering contractors provide installation, data collection, and billing services. Groups of meter users may operate as cooperatives to implement aggregate power purchasing and $CO_2$ trading. Open standards can stimulate the development of added applications for greater functionality. Meters might be sold like cell phones with service contracts to insure adequate return on investment for these applications.

**AMI Opportunity 3: Networked Services**

The availability of data intercommunication for sensors and transducers within range of the metering infrastructure permits multiple functions to be realized, such as:

- Metering of electricity, heating energy or gas, water, wastewater
- Environmental monitoring
- Surveillance, fire alarms, leak detection
- Remote supervision and control of appliances and equipment

Göteborg, Sweden, which intends to become “the first and only ZigBee city in the world” under the direction of its municipal utility company, is pursuing AMI realization with a multiplicity of networked household and community services.[5] Other cities and suburbs will be able to emulate this example or develop alternative solutions appropriate to their specific circumstances.

**AMI Opportunity 4: Filling the Gaps**

The Energy Retail Association in London has compiled a “Smart Metering Map”[6] to maintain a running account of advanced metering projects throughout the world. It is noted that some projects may apply to gas or water, or that older AMR technology may be used in certain cases. Metering initiatives in Europe remain largely regionalized and dissociated. At the beginning of 2008, the following project status was indicated:

- Highest penetration: Italy, United Kingdom, Scandinavia
- Initial projects: Netherlands, Germany, Slovenia, Austria, Serbia, Czech Republic, Russia
- Definition phase: Spain, Portugal

This compilation makes apparent the broad scope of available opportunities for additional ventures. In Germany, for example, the Organization of Municipal Utilities (Verband kommunaler Unternehmen VKU) expects that only 25% of all households in that country will be equipped with an intelligent power meter by 2015.[7] The short-term replacement of existing meters for all remaining customers thus constitutes a viable marketing opportunity for contractors and suppliers. This prospect is enhanced by the growing support of consumer and environmental organizations as well as of national and local governments for efficient energy usage.

**AMI Opportunity 5: Metering of Renewable Energies**

Electrical power that is generated by renewable sources (wind, solar, hydro, biomass, and geothermal) and fed into the European grid is usually metered independently of consumption to enable separate accounting. Utility companies are legally required to provide fixed payments (known as feed-in tariffs) for electricity received from these sources, insuring a profitable return on investment. The ensuing costs are redistributed equitably to all customers. By applying this principle in Germany since the year 2000, renewable power generation has tripled to approximately 17% of total usage. Rrenewable power feed-in legislation has already been enacted in18 European countries and Turkey.[8]

More than a half-million conventional power meters are currently being employed in Europe for solar energy feed-in. Thousands of additional installations are being realized monthly. Using AMI meters instead would allow feed-in prognoses to be made in conjunction with weather data while also providing continuous equipment performance monitoring.

**AMI Opportunity 6:  Regional Growth**

Regional circumstances often influence metering configurations. Municipal projects in the Netherlands combine electricity with gas metering owing to the general usage of domestic natural gas. In the United Kingdom, the Energy Retail Association is developing regional franchise models for AMI introduction.[9] Metering networks in Austrian and Balkan states are frequently distinguishable by the geographic terrain in which they are located. In Germany, networking projects are being developed in relation to particular regions that include "Smart W@TTS" in Aachen, the "Model City Mannheim", and the E-DeMa Rhein/Ruhr model region that links cities with rural communities.

Growing EU fuel import dependency - predicted to exceed 60% by 2030[10] - is stimulating numerous efforts to improve regional energy security as a condition of sustained economic growth. AMI can prove valuable for controlling energy consumption in conformance with the assumptions under which financial risk assessments have been made for safeguarding the energy supply.

**AMI Opportunity 7: Smart Grids**

The European Commission is pursuing a holistic approach to energy security by developing a “SmartGrids” technology platform.[11] Future utilities will be operating in virtual space to support this objective. This virtual electricity market will be equipped with Internet-based information and trading capabilities, making it possible to purchase and deliver power to agreed points or nodes. Suppliers may select from conventional generation, renewable energy sources, or energy storage to satisfy demand.

Under declared SmartGrids research objectives,[12] the distribution networks of the future will serve customer-driven markets. Following a strategic route toward supply integration, research related to customer responses is presently being conducted on cost-effective techniques of smart metering, smart appliance integration, smart homes, and building automation.

Grid-oriented tasks include the integration of smart combined heat and power (CHP), fluctuating energy sources such as renewable generation, and multi-metering configurations. Transaction platforms for virtual market places, energy data management, billing, and customer care are likewise being investigated.

**AMI Opportunity 8: Project Funding**

AMI-supported applications frequently involve intercommunication with building interior devices. Particular household appliances may be activated in response to grid power prices to promote low-cost operation. Personal data links can enable critical equipment to be supervised and controlled via cell phone, the Internet, and in-home displays. Manufacturers will be granted warranty access to appliances (dishwashers, freezers) and climate control equipment (furnaces, air conditioners) to maintain specified performance.

European governments are interested in promoting such applications in the interest of economic development and for conserving energy. The procurement of public funding for appropriate AMI projects may be facilitated by including:

- Open gateway standards compatible, for instance, with “IKT” (Information and Communication Technology) projects in Germany conducted under the “E-Energy” program of the Federal Ministry of Economy and Technology.[13]
- Electricity Display Devices (EDD) for the Department for Environment, Food and Rural Affairs (DEFRA) in the United Kingdom.[14]
- Cooperation with European manufacturers to develop remote maintenance routines for home appliances and climate control systems.

**Outlooks for European Advanced Metering**

An advanced power meter with intercommunication capabilities is actually a microcomputer capable not only of measuring the usage of electricity, water and heating energy, but also of collecting data from a local sensor network and issuing transducer commands. The multifunctional capabilities of AMI can be employed throughout municipal, business, and residential environments. Reductions in homeowners and commercial insurance resulting from the enhanced security of property could enable multifunctional metering capabilities to be implemented at reduced net cost to the consumer. The conservation of natural resources would constitute an added economic benefit realized in proportion to the responses of consumers to efficiency-related data received as feedback information.

The European Community is resolved to reduce $CO_2$ emissions by 20% between 1990 and 2020, a goal that EU Industry Commissioner Günther Verheugen predicts will “make energy more expensive for the consumer and industry”.[15] In providing greater usage transparency, however, AMI can deliver enduring reductions of energy consumption, diminishing requirements for fossil fuel power generation and the greenhouse gas emissions it entails.

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