

Application of „Smart Metering” in load diagrams analysis

Bogumiła Wnukowska, Wiktoria Grycan, Marek Kott, Bartosz Brusilowicz
Wrocław University of Technology
50-370 Wrocław, ul. Wybrzeże Wyspiańskiego 27,
e-mail: bogumila.wnukowska@pwr.wroc.pl, wiktoria.grycan@pwr.wroc.pl,
bartosz.brusilowicz@pwr.wroc.pl, marek.kott@pwr.wroc.pl

1. Introduction

In connection with necessity of increasing of energy savings and energy efficiency, which are priorities of the energy policy of European Union, it is expected that polish industries will reduce energy intensity of production processes and maximize efficient rational management of demand for electric energy. Activities of particular entrepreneurs have significant influence on National Power System, because they are shaping the national load curves. Irregularity of power consumption cause that, during the time of the biggest power demand, it is necessary to start additional, usually less efficient, energy sources. That is connected with not only higher costs of energy but also with power safety. Activities of entrepreneur should help in correction of global load diagrams by reducing energy usage in pick hours and increase in off-pick hours. One method of improving energy efficient consumption is rational management of demand for electric energy for example by technical improvements like: modifying manufacturing process, machine park upgrade or usage of automatics improving efficiency production process efficiency and also shaping energy use among others by analysis of load diagrams. From the point of view of energy consumption in a group of small and medium firms, there are possible two solutions: calculation through standard load profiles and, alternatively, installation of meter with registration of hourly consumption with suitable memory.

2. Smart Metering

The idea of smart metering i.e. intelligent measurements is to enable the communication between seller and energy recipient in a real time and enable recipient the current control of energy consumption based on information about actual price of energy. It is ensured by using new, smart equipment. According to indications of organization ESMA (European Smart Metering Alliance) smart meters should comprise following features: automatic transfer, automatic management and use of measuring data and bilateral communication (remote

transfer of information from meter and transmission of information to meter, for example remote power disconnection) (Fig.1). Through use of those meters, the full information about energy consumption can be reached, presented in a clear way. Thus, the following effects can be achieved effects in a form of: reduction of cost of energy supply, tariff's adaptation to individual needs of groups of clients, precision of calculations of consumed energy, reduction of energy consumption, technical simplification of seller's change procedure and improvement of quality of delivery and energy parameters such as correct voltage and frequency values [2,3,5].

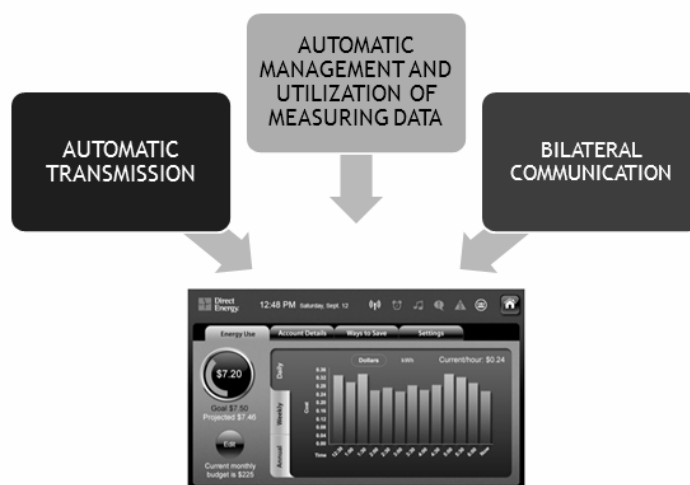


Fig. 1. Features of smart meters [5,13]

3. Smart Metering and customer

Every customer has installed meter in his house/building. Registered data is transferred through PLC (Power Line Communication), GSM (Global System for Mobile Communications), SDR (Software Defined Radio) etc to the data collection. They are also available for the customer. Then they are transferred to measuring's database and from this place or from customer's information system go to the client. Based on delivered information, customer can create and time modify in real his energy consumption. He can also analyze and choose right energy tariff, the most economical for him (Fig.2).This modification create shape of customer's load curves and also have influence on form of load diagrams for area of the country [6].

This kind of system gives information not only to customer but also system managers who know actual load and energy consumption. For the distribution system operator information is especially important because of safety of the system, forecasting future load value based on accurate data and facilitation of steal detecting (Fig. 2, Fig. 3).

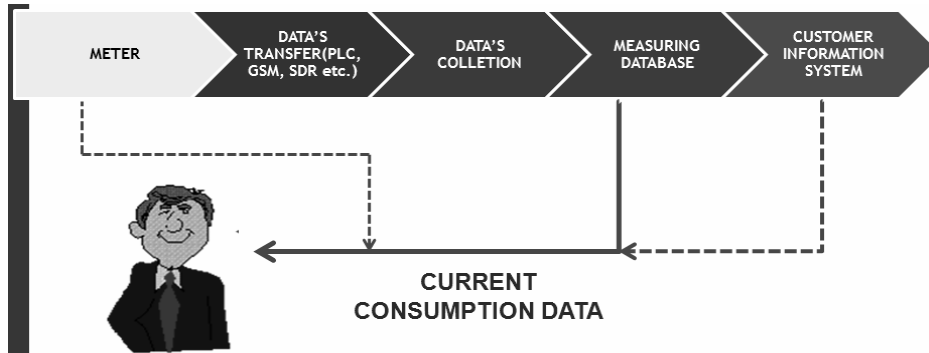


Fig. 2 Smart metering – customer’s information system [6]

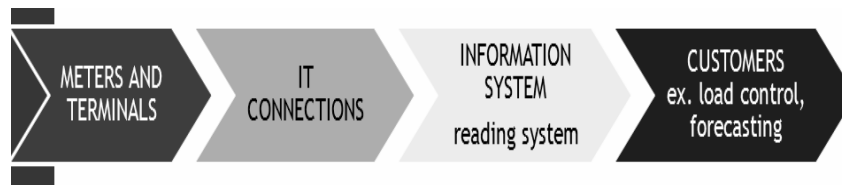


Fig. 3. Smart metering system [6]

4. Possibilities for entrepreneurs created by Smart Metering

Elementary and the most important advantage of implementation of smart metering network for companies is the possibility of financial savings connected with energy payments. Management of manufacturing processes based on actual energy price unfortunately isn't possible for every profile of production. However, savings obtained by load curve's equation during the off-pick hours by some of companies, should cause a general decrease of prices. That would be beneficial for every energy consumer [10].

The consequence of individual energy consumption management would be energy tariff adjustment to individual needs of recipients. Also a change of energy seller would be highly facilitated and more available for larger group of interested customers.

Moreover, because of that kind of solution, the billing system based on forecasts can be eliminated, that repeatedly are different than real consumption. In this situation client would pay only for real energy consumption, found with a high precision.

Smart metering would be also source of information about earlier consumption. Those data could be helpful for entrepreneur for analysis of manufacturing process, work organization and estimating of single product's cost.

A way of presentation of measurement is also important. Data presented graphically would be more legible and clear than numbers for larger group of

clients. Therefore, monitoring of energy consumption wouldn't be as complicated and laborious as it is now.

The smart metering network would be also a source of information about the risk of emergency breaks in power supply. This could be helpful for firms to reduce to reduce losses connected with deficiencies in energy supply.

Figure 4 shows benefits and applications of smart metering infrastructure. The information read from meter is used for calculation and invoicing is available for client through customer service. A customer has possibility of energy consumption management based on data received from customer service, retail sales and system technical support. System technical support is more efficient because it has access directly to the measurements read from meter.

Also management of energy quality and energy consumption and energy sales network work better because of easier information flow.

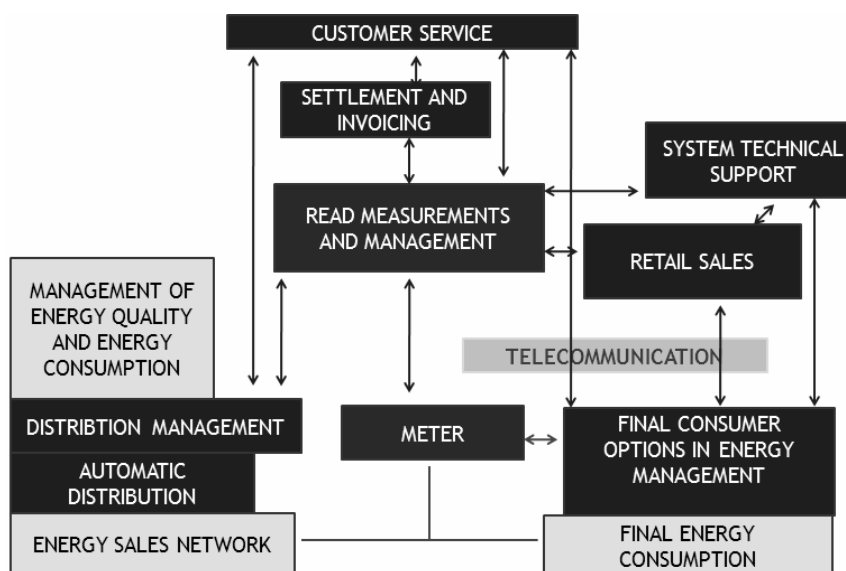


Fig. 4. Applications and benefits of smart metering infrastructure [6]

5. Functioning of Smart Metering in Europe

The European Union country where smart metering implementation is the most developed and where it started is Italy. In this country the process of implementation started in a year 2001. According to the regulations, until year 2011 all devices should be “smart”. The reason of investment in this system was age of previous meter devices and also problem with illegal power consumption and its detection ability. The smart meter implementation in Italy was undertaken by Enel, the dominant operator in this country, with over 27 million customers. Between

2000 and 2005 Enel deployed smart meters to its all customer buildings. However, user's interest of system is negligible. There are taken efforts on implementation of monitors and consumer displays, which could encourage customers to higher activity in individual energy consumption management. In Italy the initiation of smart metering is regulated by resolutions of Office of Energy and Gas (number 292/06 and 235/07) [1, 14, 17].

In Spain operator implementing smart metering is Endesa (ownership of firm Enel), that has 13 million of customers. By the end of 2010, Endesa should have 150,000 smart meters, which will mean a significant step towards smart grids. In June 2010 Endesa was the first company to introduce smart meters to the power grid in Spain in Malaga (project 'Smartcity' creating an energy efficient city with the support of Endesa). Endesa's remote management plan assumes the installation of the new meters in homes of the company's domestic customers in Spain in less than six years. The plan involves investment of over 1,600 million Euro and will create 2,000 jobs. According to the regulations of Ministry of Economy and Tourist all energy meters should by smart until the year 2018 [16].

There is a significant expansion of smart metering in Northern Europe. In 2003 Sweden declared to require a change of all electricity meters for monthly readings by 2009. Soon activities started in the other Nordic countries. Vattenfall, Fortum and E.ON decided to implement smart metering network in Finland, as well as in Sweden. Expansion in Denmark has started in 2004 with several ambitious projects. Norway was more cautious, but in June 2007 the Norwegian energy authority NVE decided that it would recommend a new legislation imposing smart meters to expanded in 2013. Since August 2007, almost all of the distribution system operators in Sweden have signed contracts for AMM (Automated Meter Management) solutions. According to regulations in Sweden, smart metering network should fully work in households. Unlike in Italy, there is a pretty interest in smart metering of users in Sweden but still there are no regulations about consumer's information forms [1].

In France operator which has 96% of the market is implementing smart meters because of operation cost's reduction, minimization of stealing of energy, load measurement in a real time and making the network management more effective. Until the year 2014 50% of installed meters will be changed to the new-smart meters, and until 2016 95% of all installed meters will be smart. Pilot installation includes 3x100 000 smart meters until September 2010 [1, 17].

In Holland it is planned to implement smart meters till 2018. Since 2011 smart meters will be obligatory in all new buildings. In years 2011-2013 pilot plants will be implicated. Since Year 2013 all changing meters should be replaced by smart meters. In this country there is a problem with operator's concerns about profitability of the project [1, 14].

Smart metering system will be also implicated in Germany (2020), England (2020), Greece (2018) and Portugal (2018) where regulations are developed. In Europe there are still countries like Poland or Slovak Republic which need a big step for smart metering implementation [14].

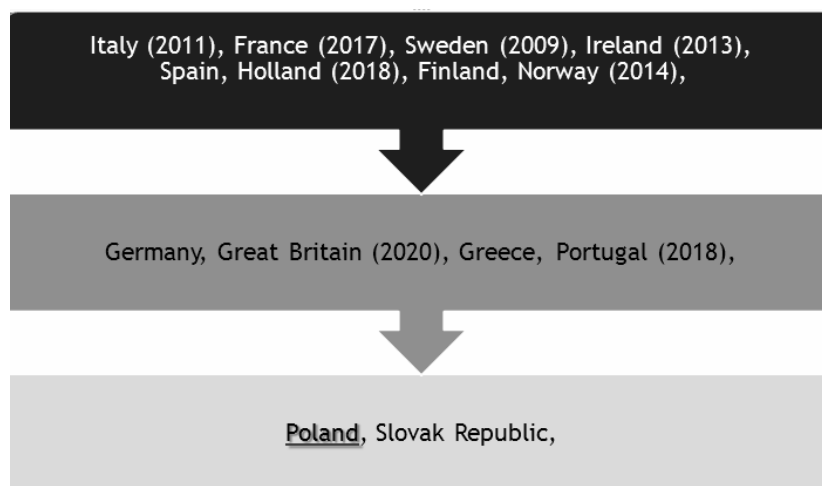


Fig. 5. Implementation of smart metering in Europe [6]

6. Regulations for Smart Metering in Poland

Poland is obligated to smart metering implementation by European Union directives [8]:

- Directive 2006/32/WE (obligation of implementation until 17.05.2008) tells that obligation of Member State is to ensure final recipient of energy, gas or CO (carbonous oxide) the possibility of acquisition in competitive, individual prices meters precisely giving information about real energy consumption and informing about real time of energy use.
- Directive 2009/32/WE (obligation of implementation until 03.09.2012) tell about conditional duty of implementation by the Member States of the intelligent meter's system that allow for active participation of consumers in energy supply market.
- “Energy Package” (2007/C 305/01) that obliges European Countries to increase to 20% the participation of Renewable Energy Sources, increasing by 20% the energy efficiency and reducing by 20% CO₂ emission until the year 2020 [9].

There is also internal commitment in Poland: Declaration on implementation of smart metering to the polish power system (signed by President of the federation of consumer, president of consumer associations, Chairman of the Forum for electricity and gas, President of KAPE (Krajowa Agencja Poszanowania Energii –

The Polish National Energy Conservation Agency) and President of URE (Urząd Regulacji Energetyki – The Energy Regulatory Authority).

Still, there is need for creation of regulations describing smart metering implementation. Several issues has to be characterized such as dates of implementation, operator's commitment, guidelines, description of meter's features etc.

7. First steps in Poland

Despite no regulations of smart metering operators attempt with pilot programs. In Poland actually work several of pilot installations of remote reading of individual customer's meters operating from tens to almost 2 000 of meters. Those implementations are unfortunately only pilot projects. But still, the development is noticeable [13].

Energa Operator works actually on choosing application supplier, communication solutions and meters. They plan to install 100 000 meters until the first term of 2011. Energa's project assumes covering 25% of country with system and installation of smart meters to more than 3 000 0000 customers. All projects will be realized until year 2017. Average cost per one measurement point will be under 400 zł that is about 100 €. Energa estimate that their client will save thanks to the project 2,7 billion zł what is 675 000 000 € during 20 years [4].

Energia Pro has started his own project in 2004. First actions were and still are based on centralization of informatics systems and standardization of rules of measurements of measured data canvassing. For Energia Pro the first need was unification of operator's measures with OSP (power system operator), neighboring distribution system operators and TPA (third party access) clients. The next step will be the separation of measures data from billing, because the billing system cannot be used for measures management. There are also pilot projects with changing meters to smart by particular clients [12].

8. Potential problems connected with Smart Metering implication in Poland

The idea of smart metering seems to be promising and forward looking but it is also connected with numbers of organization and technical problems.

First of all it is necessary to create regulations specifying the requirements on devices, readings, client's information system and also methods of encouraging clients to effective energy use, for example by creating a system of new tariffs. Those tariffs should induce the consumer to buy energy in off-peak hours and, respectively, bonus for energy consumption in those hours. Information about new possibilities is also significant. It is very important that the information is passed easily, with simple and understandable language. Even elders and less educated customers should see benefits for themselves from smart metering system.

Otherwise, the idea of smart metering system implementation can meet the barrier of reduced demand and only the increasing demand can create supply of technical devices [7,15,17].

Among the technical difficulties, security of system of consumer's data is important and is to protect the whole system against unauthorized access. Not without significance are also costs of implementation of technology connected with smart metering. The costs are estimated on 339 zł/system with one-way data transmission and 467 zł/system with bidirectional transmission with possibility of realization of extra functions including meters management, connecting/disconnecting of power. There appears also a question about who would take the costs.

Also making decision about choosing the technology of data sending could be a problem. There can be used PLC, GSM, LAN (Local Area Network), Wi-Fi(Wireless Fidelity) and there can also be created a new network. PLC and LAN are cheaper solutions because of their capacity (LAN) or availability (PLC), GSM is also worth of being considered. Choosing right technology would be connected with area, conditions, costs, existing infrastructure.

Important is also the need of creation of database which will process, collect and share information from meters and other receivers of those data.

9. Summary

Poland is challenged with implication of the idea of smart metering connected with whole technological infrastructure with the same name. Capabilities of smart networks seem to be impressive. They can give consumers numerous benefits; become a source of savings for firms.

It is obvious that there is a need of smart metering implementation. It can significantly reduce energy consumption *inter alia* by easier consumer's access to his actual data about energy use. By accessibility to tariff's plans and approachable consumer's panel, client will be encouraged to increase of energy efficiency because he will see the real money in it without unnecessary formalities.

There is a long way to come, technological and formal, to implement smart network. It is good that operators develop and apply new technologies, making them available for their clients. We are in a good position, because we can observe other countries, more developed in implementation of smart metering, and learn on their mistakes. It is a huge chance for our country and entrepreneurs.

Entrepreneurs, as the consumers who will be forced to pay for new technology and new possibilities, have a good reason to get to know smart metering better to fully use new opportunities. The example of Italy shows that awareness of the client is almost as important as the new technological solutions.

References

- [1] Babś A.: Przegląd reprezentatywnych wdrożeń inteligentnych systemów pomiarowych w Europie, Instytut Energetyki Oddział Gdańsk, Warszawa 24.03.2010.
- [2] Burgess J., Nye M.: Re-materialising energy use through transparent monitoring system. *Energy Policy* 36 (2008), pages 4454–4459.
- [3] Butler D.: Energy efficiency: Super savers: Meters to manage the future. *Nature* 445, pages 586-588 (8 February 2007).
- [4] Elektro systemy: Enera instaluje 100tys. Inteligentnych liczników, nr 8(127)/2010, page 18.
- [5] ESMIG (European Smart Metering Group for Europe): Smart Metering for Europe A key technology to achieve the 20-20-20 targets, 21 January 2009.
- [6] Grzejszczak Paweł dla PIPER: Wdrożenie inteligentnego opomiarowania - główne aspekty prawne, konferencja „Zaawansowane systemy pomiarowe smart metering w elektroenergetyce i gazownictwie”, Warszawa 23.03.2010.
- [7] Malko J., Sieci inteligentne – zasady i technologie. *Rynek Energii* 2009, nr 3.
- [8] Majchrzak H.: Perspektywy rozwoju inteligentnego opomiarowania w Polsce, konferencja „Perspektywy rozwoju inteligentnych sieci energetycznych-technologiczny przełom w polskiej energetyce i szansa na wypełnienie celów pakietu klimatycznego”, Warszawa, Sejm RP, 27.10.2009 r.
- [9] Opinia Komitetu Regionów „Pakiet energetyczny”, *Dziennik Urzędowy Unii Europejskiej* (2007/C 305/01).
- [10] Smith R.: Smart Meter, Dumb Idea? *The Wall Street Journal Business* April 27, 2009.
- [11] Szkutnik J., Smart metering jako decydujące uwarunkowanie wdrożenia strategii DSM w Polsce, *Rynek Energii*, nr 1/2010.
- [12] Zazina R.: Inteligentne pomiary, *Wulkan* nr 01(17)/2009, pages 4-8.
- [13] <http://earth2tech.files.wordpress.com/2009/12/energy-usage.jpg>, 30.08.2010.
- [14] <http://www.guardian.co.uk/>, 30.08.2010
- [15] <http://www.kape.gov.pl/>, 30.08.2010
- [16] <http://www.sourcews.com/malaga-seville-barcelona-now-have> , 30.08.2010
- [17] <http://www.ure.gov.pl/portal>, 30.08.2010