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Review Article

Smart Meter and Turkey

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Abstract

Smart meters are developed measurement devices that provide much more information to the consumers and that provide the intervention opportunity compared to the conventional energy meters. A smart meter design is dependent on the requirements of the electricity distribution company and the customers. In this study, various features and technologies that can be integrated with the smart meters are explained. Summary information on various problems that can be encountered including design of smart meters, difficulties, distribution process, use and infrastructure of smart meters was given. In addition, various applications and advantages about smart meters that can be encountered in the future in our country were mentioned. Information about promotions and investments made in smart meters in many countries in the world was given. Furthermore, the study aims to contribute to the academic and electricity market sector in term of the introduction of smart meters in developing countries such as our country.

Keywords: Smart meter, Smart grid, Distribution network.

1. Introduction

World population is growing fast, and cities are becoming densely populated. In 2025, it is anticipated that the world population will reach 8 billion. In 2035, it is estimated that energy consumption in the entire world, will be 40% more. And in 2050, it is expected that 70% of the world population will be living in cities. In today's world, we are entering into the process in which more people are living in cities in terms of consumption, and therefore more energy is needed. As is in the entire world, the most important agenda topic in our country, is energy need and the effective use of energy. There are serious disadvantages in Turkey on the issue of energy efficiency (Cengiz & Karakaş 2015:123; Ceylan 2014). Today, Turkey is at 22nd place among the countries that consume the highest electrical energy. The energy that Turkey consumes annually, corresponds to 119,5 million ton petroleum, and Turkey is 6th largest energy market in Europe. It is estimated that the increase in electricity demand in Turkey, will be approximately around 6-5.7.5% per annum, between 2014-2024. With this ratio, Turkey is ranked number two after China, when it comes to electricity consumption demand in the world. This ratio is only 1,6% in Europe. The average leakage loss rate in Turkey's electric networks, is around 15%. An average payment of more than $41 is made for per house annually due to leakage loss electricity only. It is anticipated that, in 2023, our electrical energy requirement will double in contrast with the present day, and reach approximately 500 billion kWh. In order to meet this requirement, currently installed power in our country today, must be doubled at least. The share of renewable energy resources must be increased and the standard of developed countries in energy efficiency, must be reached. In this direction, as a result of the privatization of distribution companies, legal decomposition requirement, and increasing competition and technological requirements; the need for smart-meters has come to the forefront.

Smart-meter is as device that measures the customer's energy consumption, and that informs the electricity company in contrast with other meters. There is a duplex communication in smart-meters; and their real-time energy consumption information including voltage rating, phase angle, phase frequency and secure data transmission, can be read. Thus, information on the system, can be collected (Cengiz et al. 2015:551).

In a smart-meter system, there is a meter, communication infrastructure, and control devices. Thus, it is possible to receive consumer information from the distribution network, to establish communication with other meters, and to measure the electricity consumption. Smart-meters can be limited to the amount of maximum energy consumption, and this procedure can be terminated when desired. A smart-meter perceives the system data by means of various control devices and many sensors. In future electricity distribution networks, the performance of smart-meters and monitoring their energy utilization properties will play an important role. Thanks to smart-meter system, energy consumption data of all the customers, will be collected regularly, and the service company will be able to advise to its customers about costs, taking the consumption into consideration. Smart-meters can be programmed in order to control the household appliances and other devices. In addition to this, smart-meter integration will help the servicers improve the distribution efficiency and power quality, and it will also help them detect any unauthorized consumption and electricity theft (Afgan et al. 2002; Efe & Cebeci 2013:204; Efe 2015; Efe& Cebeci 2015:42; Rüstemli & Cengiz 2015; Rüstemli et al. 2015). In Figure 1, we can see the smart-meter and its operating logic.

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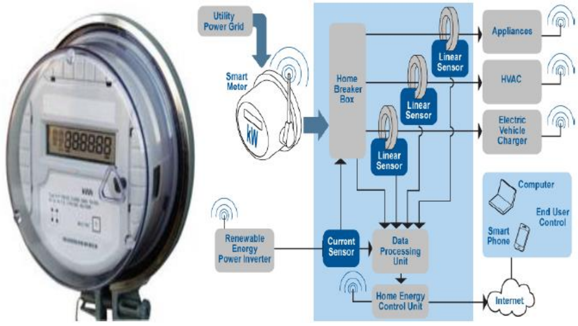

Figure 1. Smart-meter and its operating logic

2. Communication in Smart-meters

For communication process in smart-meters, communication devices and communication network must have the quality to meet the complicated requirements. Smart-meter system manages the data transfer between the smart-meter and other network elements. These data are classified, and because these information are related to private life, access to these information must be limited to the least possible personnel.

Communication standards and protocols must be formulized so that the data transmission within the network can be safe. Because these data give detailed information about energy consumption, they are also important in terms of manipulations and miscalculations. Thus, it is possible to see the information about the energy flow direction between the device and, other energy system components and the energy used by the customer. These information are secured by enciphered identities given to a device which has been assigned to a smart-meter or a customer. The selected communication network must perceive the power cut via a smart-meter, and must convey the information to support distribution automation (Efe et al. 2015; Efe & Cebeci 2015; Cengiz 2013; Cengiz 2014).

Bluetooth might be a possible option for the communication of control signal, and for reaching energy consumption data. Power Line Carrier (PLC) – Data Transmission via a Power Line and Broadband Power Line (BPL) – Broadband Power Line communication, and data transmission such as TCP/IP, are other possible options. It can be used for wireless modem, current internet connection, communication via power lines, RS-232/485, Wi-Fi, Wimax and Ethernet data uploading processes (Mcdaniel & Mclaughlin 2009). In Figure 2, communication status in a distribution network with a smart-meter, is displayed.

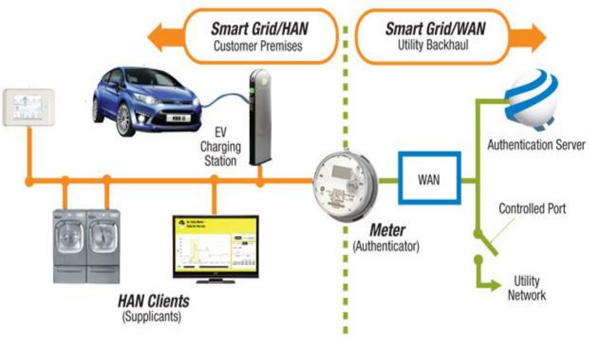

Figure 2. Communication status in a distribution network with smart-meter

3. Negative factors affecting smart-meter integration

Due to the creation of next-generation networks, smart-meter integration will become the most important problem in the future. Instead of re-establishing the network, modernization of the current network might be an alternative solution. In terms of the network's operating capability, technical advantages and R&D, smart-meter integration might be regarded as the most important solution for managing the current network. However, design and maintenance of the current network will bring many problems and challenges. In order to combine the current system with the new technology, it is required to fill the suitable infrastructure deficiency, and to insert the smart-meters into the network. The increase in customer's network, will make the system more complicated. Energy consumption and data collection is a continuous process that is conducted automatically (Mcgranaghan et al. 2008; Cengiz & Mamiş 2015:2172; Cengiz & Mamiş 2015:21). In this context, several privacy and security risks might occur. Moreover, it might be possible to reach the address information, information about people, and information on the tools that are used. Administrator rights are required for the selection of the parameters to be transmitted, and for reaching these information.

4. Things that smart-meters bring in the system

By means of a smart-meter system; labor flow, labor management, and management of a systematic billing, is provided. Thanks to smart-meters, SCADA systems can be improved, and alongside various advantages such as the control of power system; operational decisions might be taken when necessary, in order to minimize the cuts and losses. Particularly thanks to micro networks; it might be possible to reduce the energy costs of smart-meters, to carry out error analysis, demand control and power analysis. Smart-meters can be used for correct billing, for planning emergency stop maintenance, for finding out the cause of failure, and for correcting such error. In addition to this, it is possible to detect the presence of smart-meters, and unwanted harmonic components stemming from the system (Ipakchi & Albuyeh 2009; Cengiz et al. 2015:8; Cengiz & Mamiş 2015:24)

Manual reading, is a process that requires continuity and more cost. In traditional measurement system, the meter is read manually. The entire process can be simplified by a smart-meter and a proper communication mechanism. With the installation of a smart-meter; energy reliability, energy conservation and continuity is ensured. Smart-meter provides information for the consumers on the amount and cost of energy consumption and, it can also provide guidance about saving.

Transformers located at a distance, cause voltage fluctuations and load instability during power distribution. By means of smart-meters, it is possible to analyze and control the fluctuations occurring in low-voltage networks. Moreover, smart-meters can provide the information for the user about the required load and the control of maximum load request. Smart-meter peak, checks the user's maximum load requests during loading, and it protects the system by cutting the energy off in the event that the limit is excessed by a customer.

Current network systems are designed for a unidirectional power flow. In other words, meters that are used in the current network, are equipped with the proper meters by means of which the distribution company can sell the electricity to the consumers. In this case, in the event that the consumers generate energy from any other source, they will not be able to sell this energy to the distribution company. If a smart-meter is used instead of the current meter, both energy purchase and sale will be possible, therefore bi-directional power flow will be provided. In addition, by the integration of additional devices into the smart-meter system, it is possible to enhance the capabilities of the measurement technology. For instance; Geographical Information System (GIS) can be integrated into the smart-meter system in order to acquire detailed information about the geographical position of a potential failure. Thus, electricity companies will be able to reach a solution in a shorter time when detecting and correcting the failures. In other words, thanks to smart-meters, electricity companies will be able to reply the electricity cuts and failures more quickly, and thus, power cut duration can be reduced to 4-6 minutes on average.

In a smart-meter system, the electricity company creates a central checkpoint, and it directs the smart-meter in order to control and run the domestic appliances for the customer within the framework of the plan determined. Smart-meter application enables the servicers to change their current tariff plans, and to recognize new tariffs (Cavoukian et al. 2002; Cengiz & Mamiş 2015:12 pages). Therefore, it will be possible to recognize the important arguments and new dynamic tariff plans that provide benefit for the customer.

In addition to utilization rates and real-time pricing schemes; thanks to the introduction of prepaid smartcard system, the servicers will be able to present a reasonable tariff to their customers.

In consequence, smart-meters in the light of all these information;

- Reducing Operational Costs: It helps reducing the costs of collecting the meter information of distribution companies, and the costs of reading meters which is based on labor force. In addition to this, by monitoring the cuts remotely, it also reduces the transport costs of distribution companies that occur in response to subscribers' phones or failure reporting.
- Protection of Revenues: By providing real-time and more precise invoice details, it removes the need for monthly estimation of invoice. For the sake of revenue protection, this model supports both the pre-payment systems and the systems that include cutting off the electricity of the subscribers who haven't paid their bills. Finally, it supports the application of "Energy Theft Detection", in order to reduce the distribution companies' losses.
- Demand Management: Collects data from the network and the subscribers individually for advanced pricing policies of electricity distribution companies, in accordance with pricing for the use of daily electricity and/or pricing according to critical peak ratio. In addition to this, it also enables the subscribers of distribution companies to see their own consumption amount, and to change the load ratio.

5. Contributions of smart-meters for developing countries

In many developing countries, conventional energy meters are used to invoice the energy that is consumed by the customers. Opportunities that are brought by smart-meters, such as providing ease of use for domestic appliances, checking non-technical losses, providing enhanced load sharing, improving the power quality, and monitoring the network, should be introduced to developing countries. Because, the non-technical loss of servicers is approximately 20 billion dollars annually all around the world (Hosseini et al. 2013; Cengiz & Mamiş 2015:10). Moreover, along with the increase in non-technical losses, theft and irregularity in invoicing also make it difficult to carry out a real and transparent measurement. However, gigantic budgets are required to establish smart network and smart-meter systems. Thanks to public service companies or public incentives, it might be possible to invest millions of dollars in this infrastructure.

By means of enhanced communication capability and enhanced software tools, smart-meters increase the distribution efficiency. Integration of smart-meters, has made it easier to store the distributed power of production tools. In the near future, it is anticipated that the total energy demand will double the current demand [12]. Considering this, many developing countries do not have the sufficient capacity when it comes to additional resources. In order to fill this gap; current production capacity can be managed, current load can be checked upon the customer's requests, and the increasing illegal electricity use, can be prevented.

6. Smart-meter and its use on global basis

When its disadvantages and applications are taken into consideration, we can see that smart-meter systems are used by large-scale distribution countries all around the world. For instance, Austin Energy is one of the largest electricity companies in USA, with approximately 400.000 customers it has. In 2008, the company has started to distribute smart-meters to the houses of approximately 260.000 customers. Houston- centered electricity company Centerpoint Energy, distributed smart-meters to 2 million customers until 2012, in Houston-Metro and Galveston regions. The targeted application of smart-meters in USA, requires an investment of 50 billion. Enel company in Italy, third largest company in Europe, has started to distribute smart-meters to 27 million customers, thus, world's largest smart-meter distribution project has been executed. In Canada, Ontario government has planned to distribute smart-meters to approximately 800.000 customers after 2007, including houses and small-sized enterprises. In 2000, Korea; Electric Power Corporation (KEPCO) has launched the application of AMR (Automatic Meter Reading) based energy measurement system for industrial customers. In present day, this meter transmits the energy consumption information of approximately 130.000 high voltage consumers. Using these smart-meter systems, KEPCO provides value-added services for approximately 55.000 of its low-voltage customers. In Australia, Basic Services Commission Victoria has obligated the establishment of meters for nearly 2,6 million electricity consumers.

Any kind of structure which includes the human labor factor, is open to outside effects. Provincial and company managers around the world who are well-aware of this fact, are heading towards the smart networks. All processes are now managed by smart networks, especially for the effective use of resources such as electricity, water, natural gas etc. Smart systems provide added value when improving the productivity, reducing the costs and increasing the savings regarding the use of energy resources. Smart network systems constitute the infrastructure of important energy projects in today's many advanced markets (Amın & Wollenberg 2002;Cengiz et al. 2015:300). In 2012, there were 186 million active smart-meters worldwide. It is anticipated that 1,7 billion smart-meters will be used in 2022. For instance, infrastructure works of cities such as Amsterdam and Barcelona; or project SOGRID launched by ERDF for 35 million meters in France; Enel project for 32 million meters in Italy; Enel Endesa meter project for 13 million meters in Spain; Southern California Edison project in USA and, electricity and gas meter project for 53 million meters in UK, show the importance placed by the world on smart networks.

7. Conclusion

In this study, smart-meter was analyzed from several significant perspectives. In the study; alongside the advantages to be brought in the power system regarding the company's use of smart-meters, the customer's perspective was also taken into consideration. Different potential communication networks were provided for smart-meter communication. In addition to this; many difficulties, needs and problems encountered in its design, development and installation, were discussed. Developing countries' need for smart-meters was explained. Finally, as a result of the privatization of distribution companies, of the need for legal disintegration, increasing competition and technological requirements; it was realized that the need for smart-meters in Turkey's distribution sector, has come to the forefront, and it was indicated that the distribution companies and other stakeholders must be ready for this change and transformation.

Any kind of structure which includes the human labor factor, is open to outside effects. Provincial and company managers around the world who are well-aware of this fact, are heading towards the smart networks. All processes are now managed by smart networks, especially for the effective use of resources such as electricity, water, natural gas etc. Smart systems provide added value when improving the productivity, reducing the costs and increasing the savings regarding the use of energy resources.

While smart-meter integration is a high cost process, it might also cause security problems like theft, as a result of monitoring the customer's instantaneous electricity consumption. High cost problem can be resolved by local and mass production on national basis. And, in order to prevent the misconduct that might occur with regard to security, an automation system to which only a limited number of personnel can reach, must be used. Moreover, reliable communication protocols must be applied in these systems that are open to such remote intervention.

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