BETTER OVERSIGHT AND MANAGEMENT OF ELECTRICITY USE WITH SMART METER

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ABSTRACT

Implementation of smart metering in the electricity sector has a potential to be a profitable investment thanks to consumers benefits coming from opportunity for energy consumption management which leads to more efficient energy consumption and savings and due to reduction of grid losses and reduction in the operational cost at utilities.
These opportunities as well as optimizing operating expenses and capital expenditure, increasing the need for new investments are desired direction for the implementation of smart meters by CEZ Group in Romania.

INTRODUCTION

CEZ Distributie is distribution operator in CEZ Group Romania and provides electricity supply to 1,409,782 customers in seven counties of Romania. CEZ Distributie has a key role to play for installation of smart meters in this region and is responsible for ensuring the system is able to meet reasonable demands for the distribution electricity in the long term. They are also responsible for economically operating and maintain a secure, reliable and efficient electricity distribution system.

The aim of this paper is:

- ❖ to show that the implementing smart metering systems leads to greater transparency to the client and provides a larger variety of information needed for future services;
- ❖ utilizing smart meters leads to improvement behaviour of consumers and leads to the involving of citizen-consumer in the electricity market;
- ❖ electricity consumption can be more easily tracked and smart metering improves the operating parameters and the operation of the electric grid, which helps to increase energy efficiency.

ROLL-OUT OF SMART METERING

Starting with 2013, CEZ Distributie began introducing the smart metering systems by developing pilot projects, continued in 2014 and 2015 and including approx. 35 000 clients, in:
a) urban and rural areas with electric networks in relatively good condition or recently refurbished/modernized that operate within the nominal technical parameters;
b) urban and rural areas with high values of technological consumption.
Implementation approach has a significant impact on the feasibility and profitability of smart metering projects. It is important to locate relevant piloting areas, to verify assumptions and to create an overview of the expected impact that a full implementation might have.
For the next period, CEZ Distributie wants the installation of more than 435,000 smart meters given the experience of mounted so far, that bring obvious benefits.

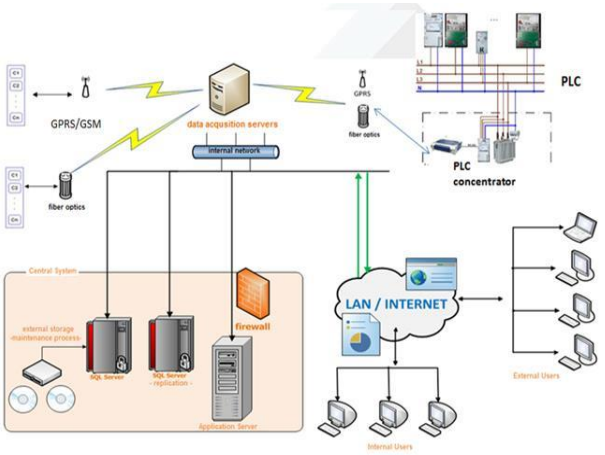

Fig. 1 System consists in 1 server installed in central point that gathers data from Data Concentrators (DC)

Smart metering systems (see Fig.1) include [1]:
a) metering subsystems containing at least meter, instrument transformers and equipment to secure access to the meter;
b) subsystems for transmitting information;
c) subsystems for information management from meters.
The smart metering system has 12 common minimum functionalities recommended by European Commission for smart meters in the case of electricity and 4 additional functionalities have been also included [2].
The most important of the minimum functionalities recommended are:

- ♦ Provides readings from the meter to the customer and to equipment that he may have installed;
- ♦ Updates these readings frequently enough (at least every 15 minutes) to allow the information to be used to achieve energy savings;
- ♦ Allows remote reading of meter registers by the Meter Operator;

♦ Provides two-way communication between the meter and external networks for maintenance and control of the meter;
♦ Supports advanced tariff systems;
♦ Allows remote ON/OFF control of the supply and/or flow or power limitation;
♦ Provides Secure Data Communications;
♦ Fraud prevention and detection.
♦ Provides Import / Export & Reactive Metering.
For the additional functionalities mention:
● Meter enables use of different technologies providing communication with the HAN network and other smart meters;
● System central application should store meter data at least for the period relevant for billing, complaint, collection;
● Smart metering systems infrastructure should allow installation of additional meters without the need for replacement of existing.

Implementation steps for smart metering systems

✓ Data concentrators & repeaters were mounted before meters installation;
✓ Meetings with electricians held for implementation steps presentation and maps distribution;
✓ Meter mountings started from the transforming station toward each border using BMCs and detailed information flow was established;
✓ Weekly configuration monitoring with immediate errors correction.

Benefits obtained by installation smart metering systems

For our clients [3]

✓ Streamlining electricity consumption and costs saving. For the first time, due to smart meters, the customer can make decisions to reduce electricity consumption and the associated costs, having at disposal information in real time;
✓ Access to advance tariff structures, that vary on hourly / daily / night / season, depending on the customer's consumption requirements;
✓ Facility of switching process in the context of the opening of the electricity market in Romania;
✓ Is ensured, on consumers request, the data recorded by meters on electricity consumption thereof and there is made available to them that they can use to compare different offers alike;
✓ Consolidation the end customers' ability to access information on their individual meter and billing of energy consumption;
✓ Customer support for active participation in electricity markets;
✓ The security of smart meters and the data communication is ensured, also the privacy of end users is ensured in accordance with relevant European Union legislation on data protection and privacy;
✓ Consumer information on technical data of smart metering systems, required and optional features, the communication mode with the management information subsystems.
From our practical experience of CEZ Distributie, following the implementation of pilot projects on smart metering systems resulted that the readings are very accurate information which cannot be variable or low.
Smart metering systems provided an insight developed by acquisition read values as it follows:
✶ Self-readings have a programmable resolution throughout the day and can be performed once, 2, 3, 4, etc. times throughout the day at different times;
✶ Momentary values are from the moment of reading and can be requested manually by an user or automatically by scheduling orders for instantaneous values;
✶ Load curve enables both monitoring the evolution of the index and energy consumption over a period of time with programmable resolution at 15, 30, 45 or 60 minutes.
✶ All acquired data from the meters are stored for large periods of time (several years) in a central server.
✶ The delivered reports were developed in order to specify the source of index (self-readings, load curve or momentary values).

For CEZ Distributie, our distribution operator

■ One of the biggest benefits of implementing smart metering systems is to reduce the losses in distribution networks and especially commercial losses. It is generally acknowledged that in Romania technical losses are not yet optimized, primarily due to aging network and poor monitoring of assets [4]. In many areas, in order to install a smart metering systems it is necessary to restore or change major parts of the low voltage electricity network connectors in order to have good results and a proper monitoring. In these many cases the costs of installation are significantly higher than the cost of the smart meter itself.
The losses can be monitored and accurately calculated, not estimated as before, because it can benefit from measured data obtained in real time for electricity consumption.
Before implementing smart metering systems, the electricity meter readings were made at long periods of time (weeks-months).
In this case, we can estimate the technical losses in the main axis of the low voltage network with a formula (1), as it follows [5]:

$$\Delta W = \frac{R}{U^2} 1{,}03^2 W_P^2 \left(1 + \frac{W_Q^2}{W_P^2}\right)\left(\frac{0{,}2}{k_u} + 0{,}8\right)\frac{1}{T}\left(0{,}58 + \frac{0{,}42}{N}\right) \quad (1)$$

The symbols are:
R represents the electrical resistance of the line section;
U represents the electrical voltage;
Wp represents the sum of all energies measured over the study period at all consumers on that particular phase, connected downstream the section[1] being analysed;
the ratio Wo/Wp can be considered the one obtained from the measurements achieved in the transforming station;
the load curve filling index can also be estimated based on the measurements in the transforming station, or the following guiding values can be used, according to the type of consumer:

ku = 0.6, for industrial consumers;
ku = 0.4, for domestic urban consumers;
ku = 0.3, for domestic rural consumers.

T represents period of time;
N = $n_1+n_2/3$, where n_1 is the number of three-phase consumers, and n_2 the number of single-phase consumers.

After implementation smart metering systems, the consumers have installed smart meters. The smart meter allows recording the values of the active and reactive energy at time intervals of 15 to 60 minutes. The transforming stations are equipped with balance meters, which measure the total losses based on the difference between the energy measured in the transforming station and the sum of all energies measured on the consumers' meters.
The calculation of technical energy losses on each section and phase can be very accurate, using formula (2) based on the following equation [5]:

$$\Delta W = R \sum_{1}^{N} \frac{P_j^2 + Q_j^2}{U_j^2} t_j \quad (2)$$

The symbols are:
R represents the electrical resistance of the line section
P represents the active energy
Q represents the reactive energy
U represents the electrical voltage
The meters are connected to a computer, and the software allows determining the technical losses in a very short time.
The commercial losses will be calculated by the difference between total losses and technical losses.
Obviously it can calculate more accurately and rapidly the technical losses and the commercial losses.
Following the implementation of pilot projects, reducing commercial losses reached more than 50% in some areas (see Fig.2).

- Reducing of time period for execution of an order of disconnection / reconnection: from relative large time, estimated sometimes in days, at reduced time, between 5 seconds and max. 5 minutes.

Given that any order for disconnection / reconnection represents a vital point in managing of electricity consumption efficiently, each order of disconnection / reconnection is accompanied by an order for read of instantaneous values, so will know exactly by the system and / or user, that index of the client has been disconnected or reconnected.

No.	Transformer station (TS)	Before modernization		After modernization		Evolution losses [%]	
		Losse/ day [Kwh]	Losses [%]	Losses/ day [Kwh]	Losses [%]	Quantity	Percen-tage
1	Craiova TS179	200	25.8	38	6.1	-81	-76
2	Carceni 1	60	16.2	15	4.8	-75	-70
3	Carceni 2	34	7.5	18	4.4	-48	-42
4	Cordun	141	19.3	52	10.3	-64	-47
5	Satic 1	37	13.4	11	5.6	-70	-58
6	Satic 2	227	41.7	18	5.8	-92	-86
7	Satic 3	4	7.9	3	3.8	-32	-52

Fig.2 Results after the modernizing networks and the implementation of smart metering systems

- Reductions on meter reading and operations with 2,63 €/metering point.
- Reductions on operational and maintenance costs with 1,45 €/metering point.
- Ensuring the monitoring networks - the information brought by a meter on events occurred upon it satisfy a wide range of issues such as:

• Fall / reset voltage;
• Below/over nominal voltage_R/S/T;
• Communication error meter - PLC;
• Opening / closing the plaque borne cover;
• Update tariff plan and update clock.

- The system development is planned - once installed, the system can be extended indefinitely by adding data concentrators in the transforming station. For each data concentrator there will be need only the configure of the communication ways which will be read, so after the configuration of data concentrators, each installed meter will be automatically discovered by the concentrator to which it is assigned.

For CEZ Vanzare, our electricity supplier

CEZ Vanzare as electricity supplier may apply advanced tariff structures that lead to optimization of electricity consumption billing to the consumer. In the context of the total liberalization of the electricity market in Romania, this benefit is a big opportunity for electricity suppliers.
The character bidirectional of the system allows both gathering information from the meter in order to invoice energy consumption and updating of defining values in energy billing, such as tariff, or sending a data packet

[1] section = a part of the length electric line

(software) which will update the tariff in accordance with customer needs.
Depending on customer needs in a certain area and by type of activity or activity periods can configure a wide range of tariffs to meet the needs of efficient energy consumption for each client.
Thanks to smart metering systems dynamics, updating information can be done both individually (per each meter each type of tariff) and en mass (for several meters the same type of tariff).
Last but not least, it is accomplished the development of markets for energy services and energy demand management.

For electricity producers connected to the networks of CEZ Distributie

- Appropriate modification of the customers behaviour to mitigate peak consumption in a period with greater consumption and fit to the production curve will reduce the cost of production capacities and lead to decreased transportation charges.
- Better integration of distributed generation, including micro production to the consumer home.
- Prosumers have the possibility to sell the excess electricity at a price that reflects its value in the market.

Challenges to implement smart metering systems

With the implementation of smart metering systems, we are aiming to reach targets much needed globally, such as:

- Pressure on costs: optimizing operating and capital costs and increasing need for new investments in the desired direction;
- Environmental issues: pressure to reduce pollution resulting from the production of energy and the transition to green energy, which leads to the reduction of carbon dioxide and nitrogen oxide emissions.

Social acceptance and consideration of data protection

Social acceptance is one of the most important success factors for implementation smart metering systems. An important aspect of social acceptance is to ensure the protection and security of confidential data.
Confidentiality ensures that the data processed by the operators are visible only to the authorized parties, without disclosing to any third party without the prior consent of the consumer.
Integrity ensures data reliability because data recorded by smart metering system are used for billing purposes and should be assured the processing, the timing and the completeness of the information.
Availability of data - at any time to the parties entitled to process the data.
It is necessary to implement an information program and empowerment for the consumers, including ways and means of involving consumers and consumer organizations during the possible installation of smart meters, and to communicate the following:
(i) change the point of energy efficiency and easy to perform on the use of energy;
(ii) information on energy efficiency measures.
It has to explain what a smart meter is, how it works, why smart meters are needed and where to go for impartial advice on smart meter functionalities and benefits.
The obligation is to inform and appropriate assist the consumer when installing a smart meter.

CONCLUSIONS

Due to smart metering, it will increase the customer satisfaction and the quality of distribution service.
The concept of smart metering has the support of energy and the environment policies, promoted by the EU and also promoted nationally.
Our company considers it necessary to invest in technological innovation with planning for medium and long term, with the condition cost-benefit analyses of the investment to be positive.
Energy efficiency will play a crucial role in perspective; there is need for a greater focus on consumer access to smart meters and other smart technology to reduce their electricity consumptions, to receive all data regarding the consumption and to store the consumer data for certain periods.
It must create all conditions for the consumer to be an active participant in the energy market.

REFERENCES

[1] Order of Romanian Energy Regulatory Authority no. 91/2013 on *The implementation of smart metering systems for electricity*, with subsequent amendments
[2] Recommendation (2012/148/UE) of European Commission concerning the preparations for the introduction of smart metering systems
[3] L. Predescu, 2014, "Smart metering systems implementation in Romania", *Presentation at Seminar organized by Austrian Energy Agency*
[4] A.T.Kearney, 2013, "Study on Smart Metering in Romania"
[5] G. Comanescu, L. Predescu, 2004, "Estimation of the Active Energy Losses in the Low Voltage Distribution Networks from the Rural Areas", *Presentation at Regional Conference on Electricity Distribution Montenegro*