Challenges with the Implementation of the AMI at Elektro Ljubljana

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Abstract

Slovenian distribution companies are—pursuant to the Slovenian Regulation [1]—currently implementing the Advanced Metering Infrastructure (AMI) which means that all energy meters will be replaced by advanced meters by 2025 which most of them transmit the measuring data remotely via PLC communication technology. Elektro Ljubljana currently faces a certain delay in obtaining measuring data which could endanger the fulfilment of AMI's objectives. Elektro Ljubljana therefore decided to run the pilot project "PLC Network Monitoring" to assess if data quality monitoring can not only offer support in determining the causes for delayed data transition but also whether it can help eliminating them.

Index Terms

AMI (Advanced Metering Infrastructure), PLC (Power Line Communication), CBA (Cost Benefit Analysis), BV (Billing Value), PLC network monitoring, DSM (Demand Side Management), TS (transformer substation), success readout

I. INTRODUCTION

Slovenian power distribution companies have started to introduce the AMI in accordance with the Decree on measures and procedures for the introduction and interoperability of advanced electric power measuring systems [1]. The Decree's requirement is to install advanced meters with the corresponding communication equipment and software by 2025. Elektro Ljubljana adopted the AMI Company Deployment Strategy [2] in compliance with the Decree.

II. THE QUALITY OF SMART METER DATA OBTAINED WITH THE USE OF PLC COMMUNICATION

Elektro Ljubljana's AMI at the end of August 2018 included 153,477 metering points that are equipped with advanced meters with a PLC communication interface corresponding to the CBA analysis [3] which identified the PLC technology as the most adequate and economically efficient communication mean. Figure 1 shows deployment of Elektro Ljubljana's AMI from the beginning.

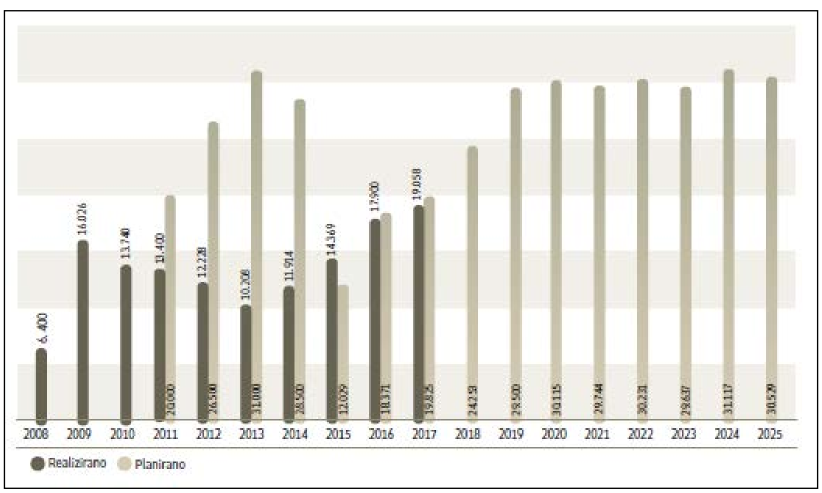

Figure 1: Number of established and planned AMI Metering Points in the Elektro Ljubljana Service Area per year [4]

The quality of the acquisition of measure data obtained by the AMI using PLC communication can be evaluated by the success in obtaining the measurement data by individual time windows:

- S_{d-30} (%) – represents the share of advanced PLC meters from which we managed to obtain at least one measure data for each meter and record the data in the database in the measuring centre;
- S_{d-1} (%) – represents the share of advanced PLC meters from which we managed to obtain at least one measure data for each meter and record the data in the database in the measuring centre;

As an example, Figure 2 indicates the quality of the obtained daily billing values (BV) data on 28 June 2018.

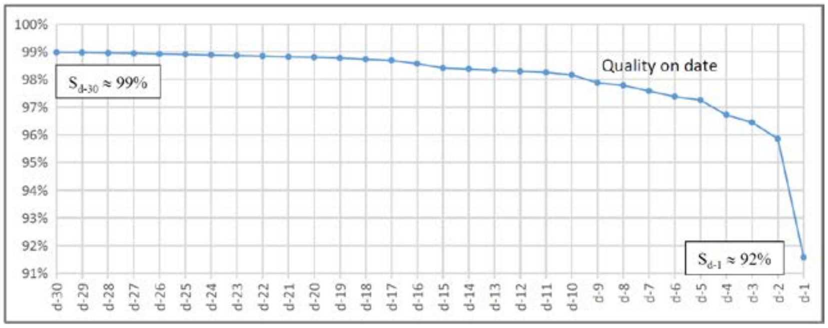

Figure 2: Quality of advanced meter data on 28 June 2018

In the 30-day time window, we obtained near 99% of the daily accounting data (BV) from the overview of the state of the measure data records and in the 1-day time window, only about 92% of the daily accounting data. It is clear that due to the time delay in the acquisition of measure data, we are facing a data deficit. The worst result is in the case of selecting the shortest time window of 1 day, when we are missing more than 10,000 accounting data; in the case of selecting a longer time window, the measure data deficit rapidly decreases and approaches the expected quality of measure data acquisition.
In practice, insufficiently obtained account data result in approximately 0.7% of the meters using PLC communication that enable remote communication having to be checked for their operation on a monthly basis.

The requirements pertaining to the quality of PLC communication and the availability of the measuring data in “nearly real time” have recently been turning more stringent. The expected requirements for the past day include the capture of over 98% account stands and more than 99.5% for the 30 day behind (requirements pertaining to the measurement-communication equipment [5]).

Based on the used technology and the reoccurring network disturbances, we determined that in order to reach such norms, we have to not only increase the volume of work but also execute control over the operations of PLC communication in order to locate the problematic measuring points and to determine the areas of communication overloads/escalations due to poor data capture.

As stated in the CBA analysis, the implementation of the AMI shows many benefits, not only for the distribution companies but also for the end customers. Distribution companies constantly face new ideas or even requirements the AMI should meet, such as:

- near real-time measurements and usage information transfer;
- execution of DSM (Demand Side Management),
- monitoring of energy quality on individual metering points,
- new way of calculating network access charges,
- dynamic rating, etc.

Nevertheless, it is necessary to understand that each additional requirement means the capture, transfer, and handover of measurement data to a remote measurement centre, which demands a certain amount of time and processing which, further on, additionally burdens the communication system.

III. DATA QUALITY MONITORING

Since delays in obtaining measurement data in the measuring centre’s database is crucial for the quality assessment of the received data, Elektro Ljubljana has decided to execute the pilot project “PLC Network Monitoring” [6]. The aim of the pilot project is to assess whether data quality monitoring can support us in determining the causes for the delayed data transmission and if it can also help us to eliminate the causes for the delayed transmission.

For the needs of the pilot project, the research was carried out in two directions:

1. Profiling the entire database in order to search data classes with different a quality of measure data on a given date

Since the AMI, using the PLC communication, is based on the communication groups of PLC meters connected via electrical conductors to a single TS (with a PLC concentrator that collects and transfers data to a measurement centre), we were interested in whether the different sizes of communication groups differ in the quality of measure data. To this end, we have created two classes of communication group sizes, namely:

- TS<400 PLC meter;
- TS≥400 PLC meter;

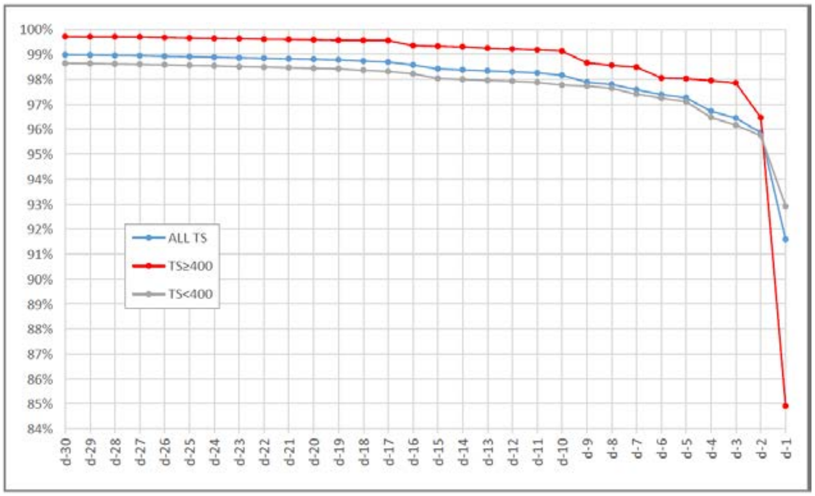

Figure 3: Quality of advanced meter data on 28 June 2018

Figure 3 shows that, in this particular case, a communication group with more than 400 PLC meters per TS is mostly delayed in obtaining data in a time window of 1 day, therefore, in order to improve the quality of the data acquisition, it is necessary to focus on TSs with more than 400 PLC meters.
Similarly, we can profile the data according to other different criteria or combinations of criteria:

- Manufacturer and type of meters;
- PLC technology;
- Topology of the network;
- Groups by location (DE or NADZ);
- Groups or individual TSs, etc.

The monitoring of the quality of the measure data of the entire network or individual classes of communication groups helps us to identify problematic communication groups, from which the measure data is obtained with delay. When problematic communication groups are identified, we can more easily select appropriate solutions and take measures to improve the quality of the measurement data.

2. Comparison of the performance of acquisition of measure data between communication-related groups of meters by individual days

And we were also interested in the success of measurement data obtained from each individual TS for the previous day in the period between the start of the day at 00:00 and the end of the day at 23:59. We monitored the acquisition of daily account data in order to determine the measurement data. The selected TS No.1 serves as the reference. On the other hand, TS No.2 and TS No.3 experience delayed measurement data capturing at certain measuring points.
Table 1 depicts the level of success each separate TS had in obtaining the data on individual dates that represent the observation intervals of the data acquisition. In the case of TS No.1, we managed to obtain all readouts for all selected time periods (dates), which means we achieved 100% readout success for all 285 PLC meters. In the case of TS No.2, we reached between 90.1% and 93.4% readout success for 243 PLC meters during the same time periods, which can be evaluated as successful. In the case of TS No.3, we reached between 73.3% and 81.4% readout success for 296 PLC meters during the same time periods, which can be evaluated as unsuccessful.

TS №1	26.6.2018	20.6.2018	12.6.2018	4.6.2018
ALL PLC meters	285	285	285	285
Success PLC	285	285	285	285
Success PLC %	100,0%	100,0%	100,0%	100,0%
TS №2	**26.6.2018**	**20.6.2018**	**12.6.2018**	**4.6.2018**
ALL PLC meters	243	243	243	243
Success PLC	226	219	226	227
Success PLC %	93,0%	90,1%	93,0%	93,4%
TS №3	**26.6.2018**	**20.6.2018**	**12.6.2018**	**4.6.2018**
ALL PLC meters	296	296	296	296
Success PLC	241	225	238	217
Success PLC %	81,4%	76,0%	80,4%	73,3%

Table 1: Success of Measurement Data Capturing

A similar approach could enable us to analyse the data even more thoroughly, and to observe the delay of the data measured on each measurement point on individual lines or power network facilities which could provide us with a way to determine the source location of the electrical disturbance/interfering devices. And vice versa—a successful elimination of the interfering devices (or the neutralisation of the disturbances using PLC filters) immediately induces more successful readouts throughout the following intervals of measurement data acquisition.

IV. PLC MONITORING AND ORGANIZATIONAL CHALLENGES

We successfully recognize problems with quality of PLC communication and start different projects to evaluate models and software solutions. Further we will have to develop and test efficient algorithm methods which will be easily and understandably integrated in the systems of Elektro Ljubljana. Software systems will have to analyse certain areas with installed meters, evaluate a problem (transformer substation escalation of unsuccessful readings), lead field workers to start and resolve the problems, archive a cases with solutions and report to the responsible entities in the company about the progress.

However, neither high tech nor perfect software solution will not remotely solve the problems. That’s why the field labour forces will have to be retrained and qualified them to understand what to do at the field, how to understand the results of their action (at least on basic level) and how to fix it.

V. CONCLUSION

The execution of the data quality monitoring pilot project demonstrates the relevance of the system implementation for the entire electrical network. Statistical analyses will help us to understand the problems and resolving approaches and hopefully to prepare our organization to the level that at final step advanced meters will be manageable and will meet the requirements that was presented for better, more robust and highly sufficient energy grid.

REFERENCES

[1] Uredba o ukrepih in postopkih za uvedbo in povezljivost naprednih merilnih sistemov električne energije, Uradni list RS, št.79/2015 z dne 23.10.2015;
[2] Elektro Ljubljana, Strategija uvajanja NMS, september 2016;
[3] Korona, DNV KEMA Energy & Sustainability, Analiza stroškov in koristi uvedbe naprednega merjenja v Sloveniji, končno poročilo, marec 2014;
[4] Elektro Ljubljana d.d., Letno poročilo družbe Elektro Ljubljana za poslovno leto 2017, maj 2018;
[5] Sodo d.d., Razpis za dobavo merilno-komunikacijske opreme, tehnična specifikacija, 23.1.2017;
[6] Elektro Ljubljana - BRS, Poročilo o izvedbi pilotnega projekta “Monitoring PLC omrežja”, junij 2018;