UNBUNDLED METERS CAN BOOST SMART CITY PROJECT

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ABSTRACT

Collaboration between public administration and the Distribution System Operator in the same area is essential to any Smart Grid project.
The example described below was started four years ago and had some hurdles to overcome. One of them is the availability of metering data to all involved participants. New features proposed by unbundled smart meter project were tested on site to overcome that situation. During 2015 several such meters were installed at city hall premises for online monitoring (1s sampling rate) of consumption and other parameters. This led to a clear view of energy saving methods and energy footprint of different activities.
Early results show that the unbundled smart meter will have definitely a major role in further developments of Smart City Project.

INTRODUCTION

The city of Sibiu in Romania has a total of 147.240 inhabitants, being one of the most important Romanian cultural centres, designated 2007 European Capital of Culture. With its position advantage set up on a traffic knot on the fourth Pan European Corridor, including an international airport, Sibiu is one of the ”examples to follow” cities in Romania with a remarkable economic development potential. The Municipality is a signatory member of the Covenant of Mayors with its Sustainable Action Plan under completion. Sibiu has developed investment projects financed by pre-accession and Structural Funds, focused on increasing the energy efficiency and reducing the CO2 emissions, now being committed to implement a smart city concept, considering the latest developments, historical and cultural heritage.
Cooperation between local government and Electrica (Distribution System Operator in the area) has a tradition of over a century in Sibiu. Throughout this period, this collaboration resulted in mutually beneficial industrial development of the city based on the existence of an important energy hub in the region.
At the initiative of the Romanian Energy Center in 2012 the project Smart City Sibiu was started in partnership with Sibiu City Hall, Electrica Sibiu and a number of major companies in the energy and information technology including: Adrem, ECRO, Energobit, Siemens, Siveco and Tractebel.

The start was actually made on 03.20.2013 by signing the Memorandum of Understanding between the City Hall and CRE. On 16 October 2013, the Local Council of Sibiu approved the Action Plan on Sustainable Energy - SEAP Sibiu, which aims to implement a pilot project to validate the concept of "Smart city" in Sibiu.
The Distribution operator Electrica will have a broad involvement in this project by implementing new energy technologies.

THE SIBIU SMART CITY PROJECT

The sustainable development of the targeted urban area "HIPODROM" in Sibiu is approached in an integrated manner by the implementation of new, green, efficient and easy to use technologies and services in the field of energy systems, transport systems and data collection, management, processing and integrated monitoring systems (ICT).
The selection of HIPODROM district for the case study was made by considering the following:

- The political and professional engagement at the level of Sibiu City Hall and the interest in developing the south region of the city, by implementing a pilot smart city concept and scaling it at district and city levels
- The need to promote and stimulate the sustainable energy development of Sibiu Municipality, as signatory of the Covenant of Mayors
- By the power of example once the carbon footprint will be reduced at the chosen perimeter level, further results will be possible by replicating and scaling up the concept implementation process at municipality level

The final result will be a smart district model, safer and cleaner, with a low consumption of primary resources and neutral in terms of CO2 emissions.
Replication and up-scaling of the pilot project will be also possible both in other districts and at Sibiu Municipality level leading to:

- Increased energy efficiency
- Sustainable use of resources
- Reduced CO2 emissions
- Citizen empowerment and engagement
- Higher living standard and increased information & education level for the targeted public
- Boosting the cooperation between municipality, industry, education, CDI environment and consultancy companies
- New opportunities of urban twinning

Figure1. Smart City Sibiu Modules

In this respect, the concept of Smart District HIPODROM was approached in an integrated manner and covered the following steps: current status diagnosis; key actions/measures; planning for the following modules (Figure 1):

1. Energy efficiency - in public buildings and street lighting, including integration of renewable energy sources RES
2. High-efficiency cogeneration
3. Efficient public lightning
4. Electro-mobility
5. Energy storage
6. Infra-SocioMetrics energy
7. Energy inframetrics
8. HUB – Integrated information system - ICT planning and management systems

DSO AS PARTNER FOR SMART CITY PROJECT

Electrica Distribution Transilvania Sud Branch Sibiu will participate in the Smart City Sibiu project. This complex project will lead to improved quality of life and local economic development, performance and to energy efficiency, carbon reduction through digital technologies. There also will provide citizens with online information in order to increase interactivity with public service providers in urban areas to reduce costs and save resources.

The areas in which they develop smart city technologies include administrative services, transport and traffic management, energy consumption, sanitation, water supply and waste management.

It should be noted that South Transivania Electrica Distribution has already made serious efforts in ensuring the technical infrastructure for the Smart City project such as DSM/SCADA and Distribution Automation for network operation and AMI/AMR systems for smart metering development.

The remote control system for the transformer substations is in operation since 2004 and includes, in addition to the centralized stations developed in the 80s, upgraded transformer substations with integrated protection / remote / control equipment.

Distributed automation (SCADA-DMS, SAD) includes substations, reclosers and remote control of switch disconnectors. Today about 45% of manoeuvres for the operative management of the MV network are performed by remote dispatcher as folows:

- 9 out of 11, HV / MV transformer substations, are included in the remote operation DSM /SCADA platform.
- about 80 controlled reclosers and 120 remote control switch disconnectors are included in the Distribution Automation platform for MV networks

Electrica is also involved in permanent extension of automatic meter reading systems for electricity. In the near future large-scale implementation of Smart Metering projects are foreseen. There are already several smart metering systems installed (AMR, AMI) at city level as follows:

- about 3000 three-phase meters included in AMR systems, in different Sibiu districts
- 4000 single-phase electronic meters in Hipodrom district, allowing the integration in AMR system after adding a communication module

SAP management software and other specific ICT applications already implemented are dedicated to SDEE Sibiu fixed assets management and for the energy management.

All of these systems use modern communication and computing are based on next-generation architecture and represent the foundation for Smart Grid systems.

Electrica is participating in all SMART CITY Sibiu project modules but is having a very important role especially in Module 1,3 and 4.

Module 1 - Energy efficiency is expected to determine the energy contours of Sibiu and the Hipodrom area with a resolution allowing real-time monitoring of the effects of applying new technologies. This involves the implementation of smart metering systems at a scale sufficiently large to enable the following functionalities:

- Optimal energy profile analysis for each building, identify measures to increase energy efficiency in existing buildings;
- Identify opportunities to use renewable energy sources (solar: photovoltaic panelsor solar panels, heat pumps);
- Dissemination of results on energy consumption in buildings;
- Energy labeling of buildings (Energy Performance Certificate) after performing an energy audit.

Such data will be used identify measures to increase energy efficiency. Anticipated results will consist of energy savings of about 60-100kWh/sqm/year (35%-50% compared to the current situation), while reducing

emissions of green house gases 10 to 20 kg CO2/m2/year. The Public Lighting Module 3 aims to create an adequately public lighting implementation by harmonizing the environmental factors with the human factor: population, user, citizen.
The proposed system will provide:

- Centralized real-time management of the lighting system
- low maintenance costs.
- Dynamic lighting correlated with the city's rhythm (Dynamically changing the luminance level, and / or illumination as a result of monitoring the vehicular and / or pedestrian traffic)
- Interactive lighting without compromising public safety enhances the feeling of belonging.
- Extended life of lighting equipment

In January 2016 this concept was put in operation for a main street inside Hipodrom district.
Module 4 is supporting the use of electric vehicles by creating a public charging infrastructure;
Charging stations will be installed in public parking satisfying both functions as charging electric vehicles and the parking meter, thus ensuring that the equipment is used even if electric vehicles have not reached a critical mass;
Charging stations will be equipped with smart meters for billing purposes.

METER MEASUREMENTS AS ENABLERS FOR CITY ENERGY SERVICES

During early stages of deployment it became obvious that one of the key points for project success is represented by energy meters technical and communication capabilities. Even if DSO is currently using smart meters integrated in the AMR system, the reading intervals and volume of measurements are not suitable for all functions required in the modules presented above. Another issue is the availability of communication ports to different users.

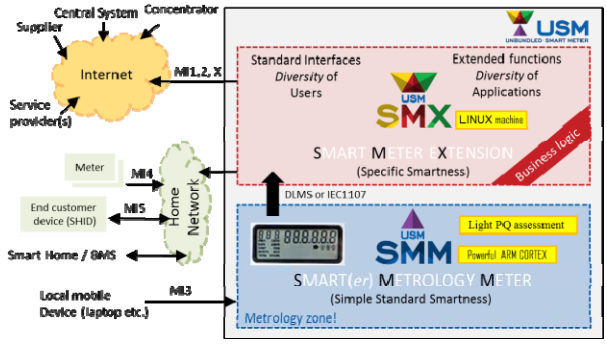

Figure 2 Unbundled Smart Meter (USM) concept

Both difficulties can be overpassed if the so called "unbundled smart meter" is used. It architecture is shown in figure 2.
In order to show the potential of USM measurements, as enablers for various Energy City Services (ECS) we present below some of our records made at the electricity network limit between the DSO and Sibiu municipality (to be named MP), as an example of energy metering point with valuable information to be used.
Figure 3 below presents the active and reactive powers recorded at MP.

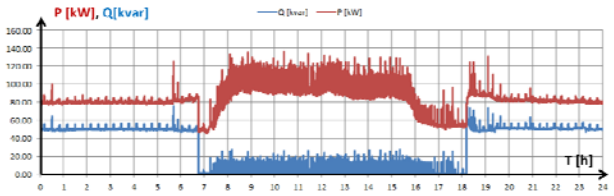

Figure 3 - P, Q of the municipality

It can be seen that the municipality has a special schedule for lighting the building and it surroundings during the night and that the lighting technology require also high reactive power during the night period. It can be also seen that the normal activity during the day has a raising ramp of around one hour and a falling ramp of around two hours.
Figure 4 below shows the power factor during the same day. It is a way to see in the same time P and Q together.

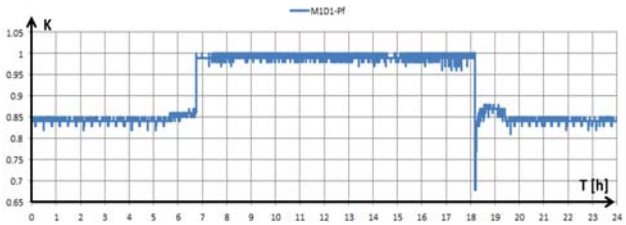

Figure 4 - Power factor

It can be observed that during the day K is more or less ideal (near K=1), but during the night it is very high. Moreover, the start-up of lighting in the evening brings for short period a value of K near 0.65. It is clear that assistance of the DSO on energy behavior can help both the municipality and the energy network, which is affected by this consumption profile.
Figure 5 shows in the same day the behaviour of voltage on all three phases.

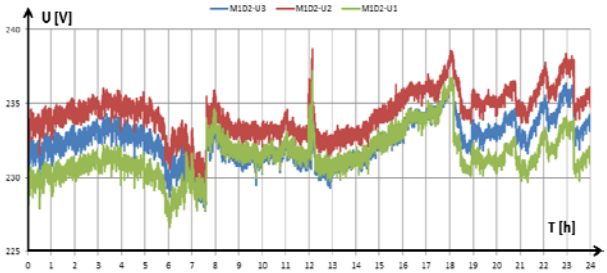

Figure 5 - Three-phase voltages

It can be easily observed that phase 2 has the highest value in most of the time, thus showing a lower load on it and also a relatively constant voltage asymmetry.
Figure 6 enters in the details of the asymmetry, by showing currents on each phase (secondary values, for a nominal value of 5A) and also the I0 current.

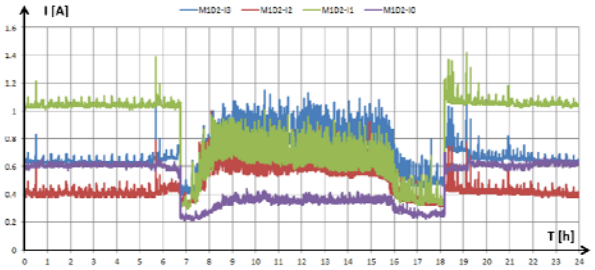

Figure 6 - Currents I1, 2,3 and null

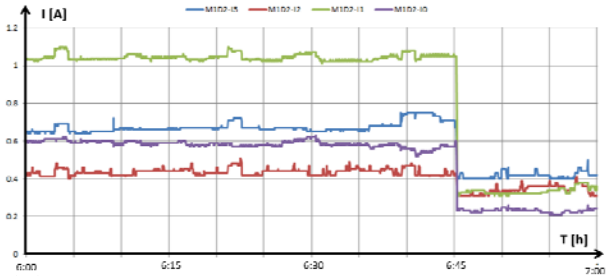

Figure 7 - Zoom of previous figure on 6:00-7:00 interval

Figures 8 and 9 are comparing trends for active power and voltage level during weekend and working day. Such detailed insight can be very helpful for DSO to develop proper plans for voltage regulation especially in case of household renewable resources large scale implementation.

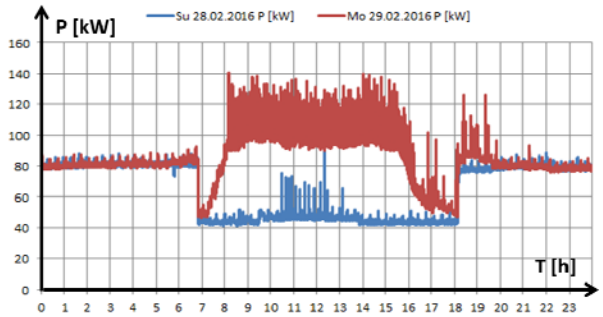

Figure 8 - Active power P in weekend and in a work-day

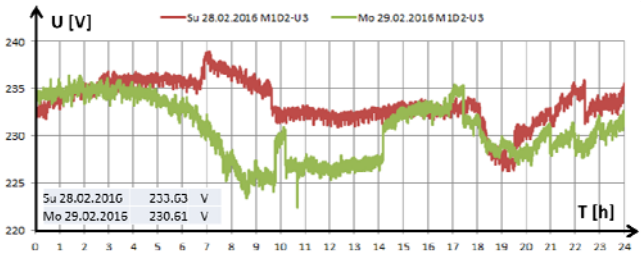

Figure 9 - Voltage level V in weekend and in a work-day

CONCLUSIONS

Sibiu Smart City project will ensure efficient use of energy to attain the medium and long term objective of SUSTAINABLE DEVELOPMENT.

The most important component of the project, however, is social. The partnership formed between the participating entities and the involvement of the citizens, will enable a coherent and efficient urban development both economically and socially with responsible use of available resource

There are major benefits of the Smart City Sibiu project for all partners involved:

- Reducing energy costs by optimizing energy resources.
- Monitoring of energy flows and free and transparent access to data will increase the citizens awareness as responsible and active members of the community;
- Providing basic information (real-time and statistical) to the business community to facilitate new business ideas and models;
- Monitoring some (energy) performance indicators of the city (i.e. KWh consumed / person / year, MWh / year of renewable generated energy, the generation / consumption report per city etc.);
- Support for architects, urban organizations and local businesses to ensure the development towards sustainability (sustainable development).

All objectives mentioned above need reliable and accurate information.

The unbundled smart meter will have definitely a major role in further developments of Smart City Project because it can provide this kind of information to different users simultaneously.

The experience gathered during first month of implementation can even prove important in the addition of new functionalities to the unbundled smart meter. One example could be the assessment of some PQ parameters.

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