SCIENCE, TECHNOLOGY AND INNOVATION

APPLICATION OF SMART GRID IN KOSOVO POWER SYSTEM

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Abstract: The expansion of the electricity market and the reorganization of electricity companies (production, transmission, distribution, etc.) require a supervision of electricity distribution network at all voltage levels. The main goal is supplying costumers with electricity in both quality and economical manner. This encourages us to establish the Smart Grid and SCADA system, so that the existing system will be monitored from the distance in a regular time and will be operated in order to carry out optimization, automation of control, and direction of key parameters of the distribution system. Further, the large number of facilities of all voltage levels, as well as, large number of planned and unplanned occurrences causes numerous operations and changes in the configuration of network distribution. Therefore, it is very important to supervise the distribution network from distance both, in technical and economical aspect. Accordingly, the automation of the network is the topic of all distribution companies in Kosovo too.

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Introduction

The basic idea of smart systems is old, but now new technology is highly efficient and can realise the ideas for the development of Smart Systems.

Smart grid is an electric grid that enables intelligent integration of actions of all users who are connected to it: generators, transmission networks, distribution networks, customers and those that together enable a stable, economically and safety of energy.

Smart grid is built upon Smart Metering, this would mean that smart-grid is not only meter reading but also can control entire electricity system, from production up to the consumer. In other words, smart meters are basic elements for creating smart grid. Smart metering, in general, involves installation of these intelligent meters at the costumers; from these meters we obtain the information, power in real time. These data are processed and returned back to the consumer.

The reliability of the electrical system (due to under-investment in the infrastructure), growing demand and the increasing difficulty of building new transmission infrastructures are the primary drivers for smart grid.

Worldwide science foundations and governments currently support the development and planned deployment of Smart Grids. Recent years, in Kosovo has begun to implement the smart system. The new substations 400/220/110/35/10 kV are obligated to have SCADA System.

In this paper the necessary investments in the installation and construction of Smart Grid are considered and the comparison of benefit and costs is provided. Relevant conclusions are presented to manifest the profitability of Smart Grid.

Monitoring and control of Kosovo power system

Currently, monitoring and control of distribution system is carried out in a hierarchical order from the Network Operations Centre (NOC) in Prishtina. Information Operations and instructions are transmitted from the Kosovo Operation Transmission System (KOSTT) Network Command Centre. Communication Equipment NOC/KOSTT include a reading-only presentation of high level system requirements published in the stalemate by KOSTT, phone, email, radio phones to communicate in both directions. NOC communicates with substations through telephone, fax, mobile phones, and in some cases through the radio communication in both directions. Execution of all the opening-closing operations of the region and monitoring the condition of the system is carried out manually in all substations except three stations where the local SCADA systems are implemented.

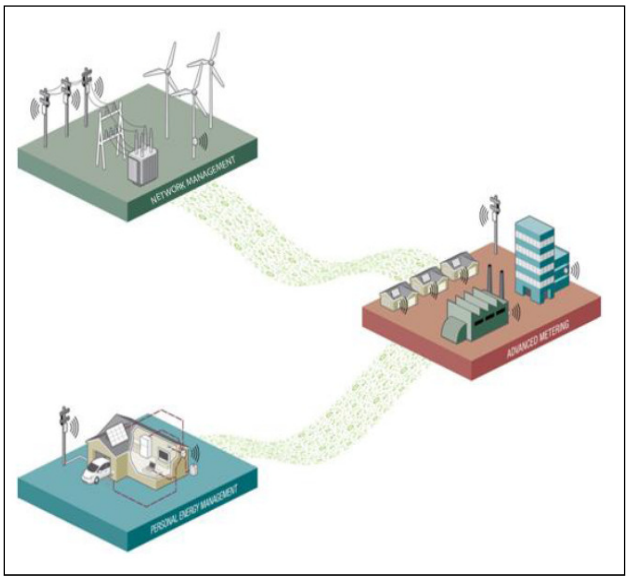
DMS/SCADA systems are important for real-time operations of modern power systems. The first step in implementing of such system consists in the establishment of acquisition data and control systems in relevant substations.

Currently, this feature is implemented in KOSTT at 400 kV and 220 kV voltage levels and the work is under way to accomplish in all SS 110 kV. Kosovo Energy Corporation (KEK) has visual access to the transmission of the SCADA but does not have access to use it for operational research purpose.

KEK is currently preparing new substations and those which are upgraded with local SCADA at SS so that when DMS/SCADA system is developed, it will be more easily to incorporate into SCADA with minimal expenses. The following objects have been prepared so far: SS Besiana, Pristina 5, Vushtrria 2, Peja 2 and Gjilan IV and finally application of this system is expected to be implemented in Palaj, Gjilani V, Business park and Dumosh. According to budget planning and financial possibilities, will be implement DMS/SCADA system also in Bibaj and Peja 1.

Communications with the main command centre from different substations should be implemented together with different DMS applications, which will be necessary for the operation of distribution system in much more effective and transparent manner.

FIGURE 1. MAIN SCHEME OF SMART GRID SYSTEM



The structure of data centre will have sufficient security and support of these monitoring centres, and should also be implemented as part of this project

Smart Grid System consists of three groups (Figure1): it begins with Smart Metering System; it continues with the Personal Energy Management and the Network Management supports it.

Smart metering system

A smart meter, is an advanced meter for home energy monitoring, as well as for gathering data for remote reporting and control. Smart Metering equipment and advanced software enables real-time communication between control centre and consumers. With Advanced Metering the energy flow (optimization of energy flow) and load peak reduction can be controlled.

Multi-energy solutions can cover all energy forms, leading to preservation of the transportation cost and energy consumption. This group includes all consumers: large, medium, and small ones.

A smart meter records consumption in intervals of an hour or less and communicates that information via some communications network back to the utility for monitoring and billing purposes.

Personal energy management

The customer can receive real-time information about consumption of electricity, water and heating gas, electricity tariffs, and if there are sources of energy (through solar panels etc.) i.e. how much energy is entered in network and the cost saved or earned. This creates an increased awareness about saving money and energy.

Network management

Network management means managing of power flows in distribution system, including all domestic production and the income/outcome from the interconnection networks.

Development strategy of advanced metering infrastructure

The Network Operations Centre (NOC) is constantly working on the development strategy for improving the measuring point, which is based in the following:

- It is decided the replacement of measuring points at household consumers and small businesses;
- In the strategy of improving the measuring points is also estimated that multifunctional measurements with remote monitoring are unique and necessary choice;
- There is a pilot project ongoing for Automated Meter Reading (AMR) which according to the analyses provided a significant results in both commercial/financial and technical aspects;

- The multifunctional meter points are justified and analysed focusing on two points: (1) expected benefits from replacement of measurement points with AMR; and (2) analysis of the impact of increasing accuracy in measurement.

Smart Meters are installed in the whole territory of Kosovo. Figure2 shows the number of smart meters for each district separately.

In 2007, the remote command and reading centres for multifunctional meters for reading in Pristine within Distribution Division were established. This service does the parameterization of meters, modems, communication architecture, meter management and maintenance of the entire communication system. All this is accomplished through devices: modems, GSM / GPRS, PSTN modems, powerful servers (Figure 3).

FIGURE 2. THE NUMBER OF SMART METERS INSTALLED FOR EACH DISTRICT

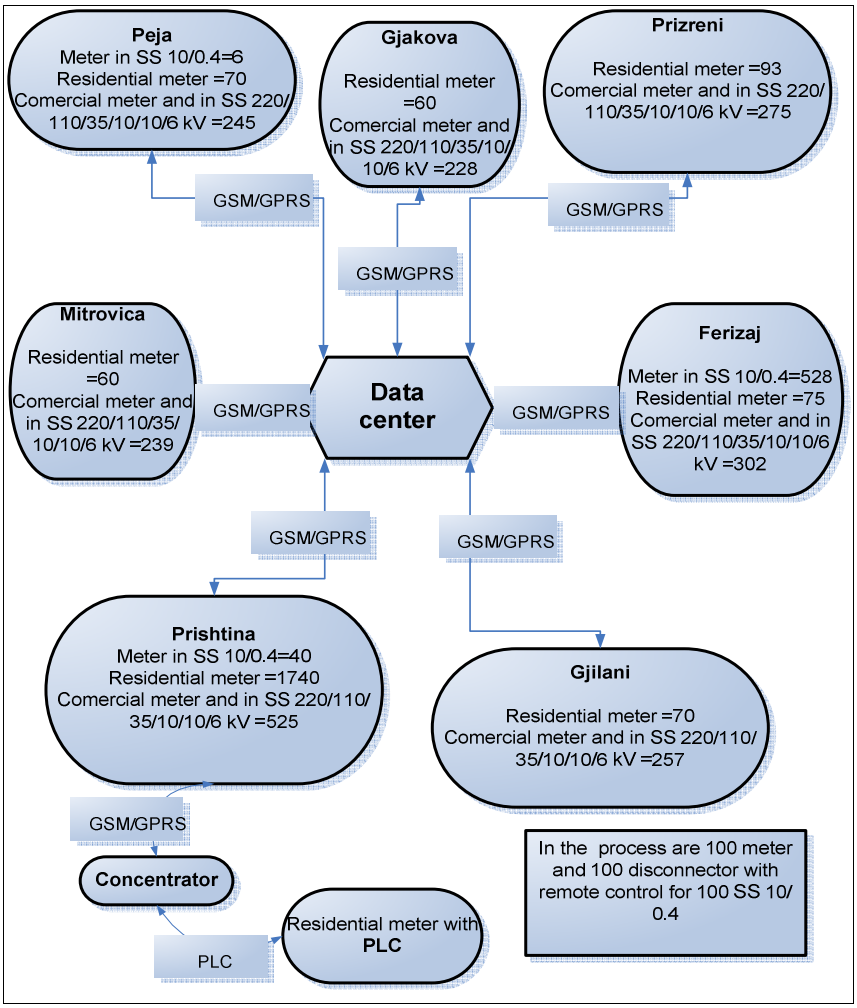
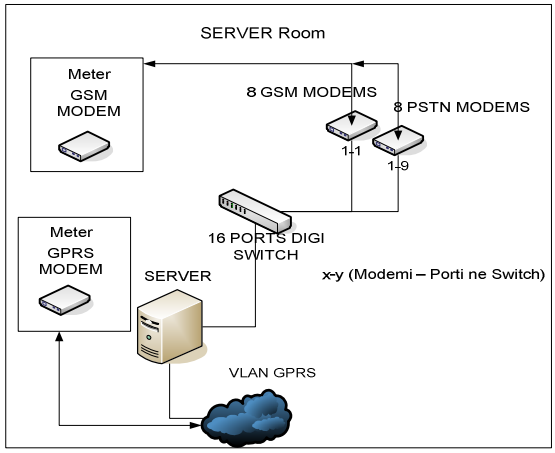


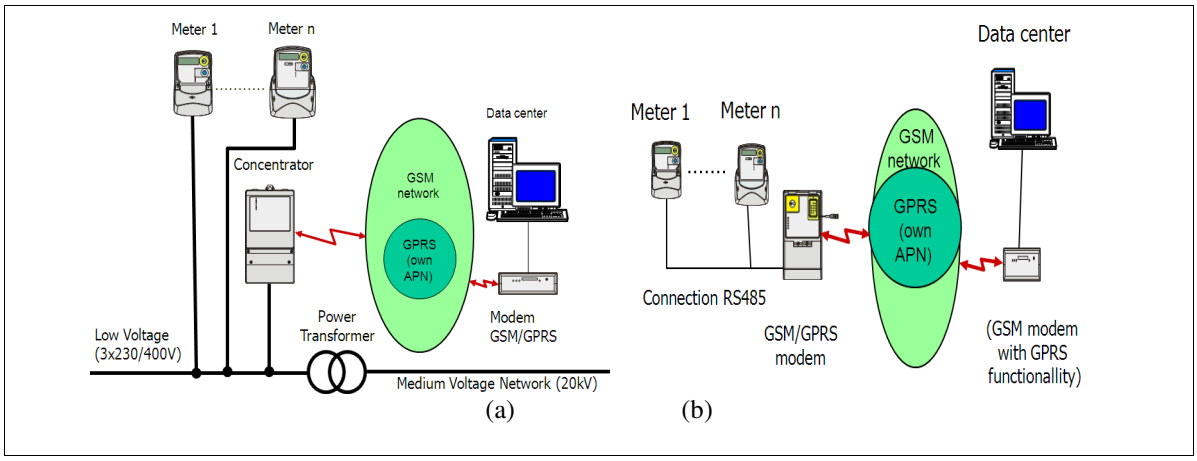
FIGURE 3. COMMUNICATION OF WITH SMART METERS WITH REMOTE READING CENTRE



Smart meter can communicate through different topologies. In case of 10/0.4kV substation, the concentrators are installed and the smart meters with remote reading are installed to customers who are connected to these SS. The meters communicate with Concentrators via 0.4 kV power line (PLC - power line communication) while concentrators with remote reading centre communicates through GPRS network (Figure 4, a). These meters also possess the remotely controlled power switches, so it will be possible to connect or disconnect the costumer due to their debt or to apply a load shedding on the network.

In SS 220/110/35/10/6 kV substation the smart meters are installed at all feeders, transformers fields and at the feeding line of substation. Meters are connected to the modem through the RS 485 connection, while modem with remote reading centre communicates via GSM / GPRS (Figure 4, b). Through the scheme the loaded energy, maximal load of lines and substations, the balance of each individual substation as well as the entire power system, the energy fed to the customers and the technical losses for each substation and for each district separately, can be calculated with accuracy.

FIGURE 4. COMMUNICATION TOPOLOGIES OF SMART METERS WITH REMOTE READING CENTRE
a) Communication topology with PLC meters
b) Communication topology through along SS 220/110/35/10/6 kV



Distribution Division is developing the project of smart meter installation in all available 10/0.4 kV substations. This project is very important to reduce technical and commercial losses. The project is expected to be completed in early 2012.

After equipping mentioned costumers, the collection has been increased significantly. Analysis of losses during the period 2008-2009, the impact of installation of AMR metering give the reduction of Commercial Losses (non technical) from 27.03 % to 4.22%, the reduction of total losses from 33.58 % to 13.72% and the reduction of delivered energy per customer from 5,489.16 to 4,492.30 kWh.

Costs and benefits estimation

The study estimates the costs and benefits of smart meters implementation project in three years period taking into account the load forecasts, capacity costs, and smart meter costs. The study estimates the operational benefits that would accrue as it replaces the existing metering infrastructure with smart meters, which allow for two-way communication between the consumer and the utility. Some of the issues that will directly affect this are:

- Maintenance of meters which are read in manual mode incurs high cost to the company
- Principal priority is to establish measurement sensitivity which can reduce losses up to 5%
- Reduction of site visits to be made in the case of manual meters when it is required by consumers.
- Reduce the fees required by citizens and other business entities.
- Reduce costs required by the workers of the company relating to different cases of disasters that could happen during their site visits, and disconnection
- Possibility for remotely switch-on of customers, when an abnormal operation occurs that will reduce the outage time and will increase the quality of service standards and avoid penalties for lost of energy.

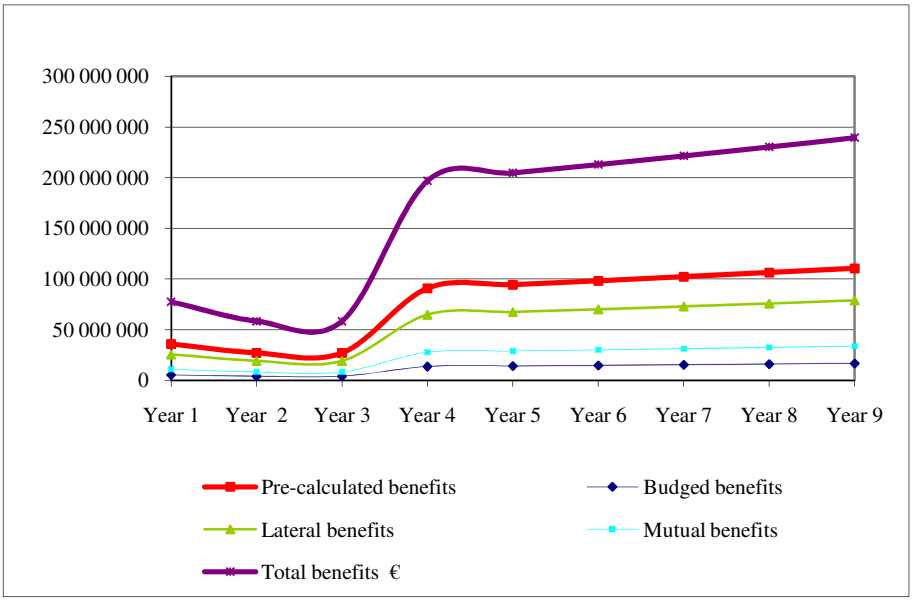
Cost-benefit calculation is conducted according to data analyses from calculation table of the consumed and lost energy (Table 1).

The study concludes that the benefits of smart meters project exceed the costs. Figure 5 shows the cost-benefit estimation for three years period implementation of the project and six years financial turnover. However, in all cases, additional benefits would accrue as customers participate in specific smart meter-enabled program offerings, including household energy use information delivered to customers in real time via in-home devices and web portals; dynamic pricing; and direct load control with measurement and verification.

TABLE 1. THE CONSUMED AND LOST ENERGY

Note	No. of customer and load	No. of customer and billing	Technical losses	Commercial losses	Lost energy	Total energy losses	Damage from lost of energy	Increased expenses	Σ
Total	385 500	385 500	3.4%	2.0%	1.8%	7.2%	0.8%	0.6%	8.6%
Annual total energy	4 237 712 686	4 237 712 686	144 082 231	84 754 254	76 278 828	305 115 313	33 901 701	25 426 276	364 443 291
Energy for customer /year	10 992.77	10 992.77	373.75	219.86	197.87	791.48	87.94	65.96	945.38
Conversion in € for customer /year	560.63	560.63	19.06	11.21	10.09	40.37	4.49	3.36	48.21
Price by 0.051 €/kWh	619.27	619.27	6.19	7.43	7.43	21.06	3.72	3.72	28.49

FIGURE 5. THE COST-BENEFIT ESTIMATION



The project of smart meter installation has had a good impact also in reduction of the technical losses. An analysis of meter self expense as a result of measurement error, unmarked of several small loads and losses in electric meter itself is done. From this analysis of measuring points, by taking into account the own expenses and sensitivity, and by cancelling their subjective effects which are very large, it can result that the technical losses will decrease for 1.4% of total energy received.

In the future it is foreseen that all measuring points will be digital and remotely reading. The database server will be connected with:

- billing server, where it will prepare automatically the bill;
- ABC module (module for comparison between the energy billing and energy expenses of the costumers);
- module for the calculation of technical losses;
- different applications for network analysis, and
- dispatch centre.

Evaluation of the project should also be viewed in the future perspective where the calculation of every euro spent will be justified for each step of the project.

Some of the issues that will directly affect this are:

- Information about energy consumption, tariffs the costumers may receive at any time,
- With smart grid can provided reading accuracy at any time that would help in reading improvement, reducing associated costs and the elimination of inaccuracies that occur during manual reading of meters. This is through the reduction of errors that appear in the monthly accounts would affect the reduction of expenses. Also complaints will be significantly reduced.
- Increased income that will result from the use of smart grid will be visible.
- Installation of smart grid would prevent the capital expenditures caused due to removal of the manual meters

- Reduce costs required by the workers of the company relating to different cases of disasters that could happen during their site visits, and disconnection
- Smart grid will provide data that can be used for various researches regarding loads. This would impact directly on the elimination of costs that would be made for site visits and research regarding load distribution, and symmetries of the system (R,S,T).
- Smart grid will provide visibility of electricity consumption that directly would enable better electricity management.

Conclusion

The introduction of distribution automation is very complex and highly discipline-related task for which there is no universal approach. Based on the experience of energy companies in developed countries it can be concluded that the most rational way is the introduction of smart metering and control system on many levels and stages.

The smart meters provide operational benefits by eliminating or avoiding the cost of reading meters. However, they also open a gateway to benefits on the customer side of the meter. Even without dynamic pricing, smart meters allow utilities to offer customers a variety of programs that would lower their energy costs and reduce greenhouse gas emissions. With dynamic pricing, these benefits rise considerably.

To realise the control of energy flow through all voltage levels, it must be continued with the implementation of Smart Grid in Kosovo.

Telecommunications subsystem should be designed based on concrete analysis of the consumers as the optimal version or combination of telecommunication technologies.

In order to lead and execute the work for automation on distribution networks it is required to create professional teams who will perform the supervision and coordination during implementation of the system.

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