THE SOLUTION OF TELEMETERING MPORTED ELECTRICAL ENERGY IN “ELEKTRODISTRIBUCIJA BEOGRAD”

D.Bogdanovic, Elektrodistribucija Beograd, SCG
N.Arsenijević, Elektrotehnički fakultet, Beograd, SCG

1 INTRODUCTION

As a power utility company, “Elektrodistribucija Beograd**”** (EDB) imports electrical energy from the power system of EPS (Electrical power industry of Serbia) in 24 sites within its territory. Those points are mostly placed in transformer stations 110/35 kV/ kV and 110/10 kV/ kV. In the first ones, metering equipment (current and voltage transformers) are installed on the voltage level of 35 kV , and in the second ones on the level of 110 kV.

This paper describes new system of electricity metering and data collecting, developed owing to large progress in telecommunications technology. Chapter 2 is about electricity meters in mentioned points. Those meters are connected to power registrators described in Chapter 3. Data transmission and collecting is shown in Chapter 4. Metering equipment must be capable of determining active and reactive energy flows (as required) during each demand period across each defined metering point.

2 METERING POINTS IN THE SYSTEM OF TELEMETERING

Basic metering is realized by impulse static meters connected by cables to current and voltage transformers. These meters correspond to power transformers or power lines in transformer stations 110/35 kV/ kV and 110/10 kV/ kV. Their registers are still being read manually as a check of telemetering, at the first day of every month. The accuracy class of the meters is 0.5. The last generation of impulse meters is equipped with four impulse outputs, four digital outputs and two digital inputs. Such meters incorporate more than 500 kB of flash memory used for the load profiles, voltage quality data and register storage. Load profiles are backed up by a battery in the event of power supply failure and are also available in the memory in case of battery failure. Each meter has at least one impulse output, leading to the power registrator by wires . There are 2-4 meters in one transformer station being point of importing energy from the EPS gride as shown on Fig 1.

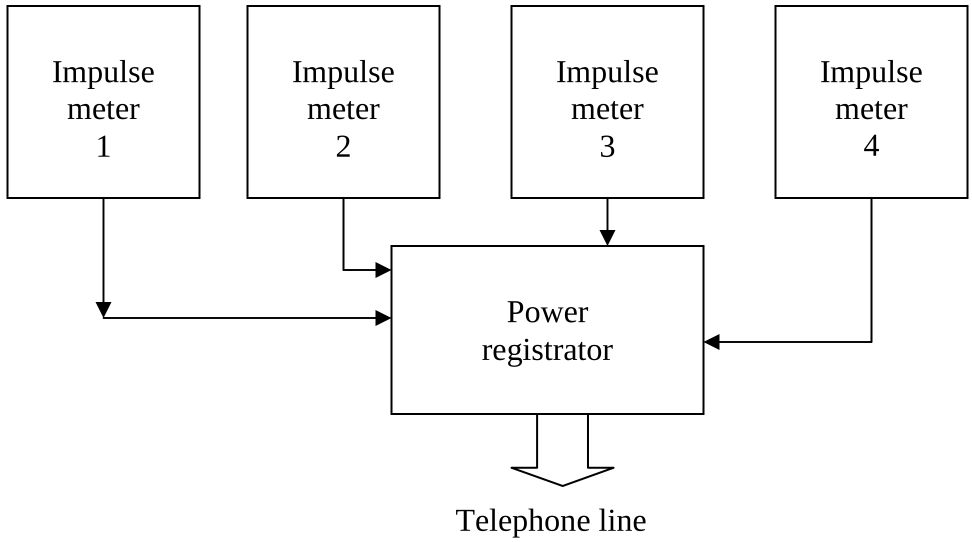

Fig.1. The structure of a metering point in the system

As it can be seen on Fig.1. the metering is concentrated within each metering point. The basic motive for concentrating metering is the cost of the maximum demand, taking the biggest part in the monthly bill for electrical energy. The structure of the monthly cost (C) is:

$$C = c_{avt} \cdot W_{avt} + c_{amt} \cdot W_{amt} + c_r \cdot W_r + c_v \cdot P_v$$

Where:

c_{avt} - the price of an active energy kWh in higher tariff period, W_{avt} - imported active energy in higher tariff period, c_{amt} - the price of an active energy kWh in lower tariff period, W_{amt} - imported active energy in lower tariff period, c_r - the price of a reactive energy kVarh, W_r - imported reactive energy, c_v - the price of the maximum demand kW, P_v - maximum demand during the month

The simultaneous maximum demand (max ΣP_i) for EDB is much lower than the arithmetic sum of maximum demands in individual meters (Σ max (P_i)) :

max $\Sigma P_i \leq \Sigma$ max (P_i)

As EDB pays the monthly bill to EPS as any other customer in the tariff category “High voltage consumption” concentrated metering was solved in the past by electromechanical power registrators. The total maximum demand for EDB was determined by load profiles marked on the paper ribbons as a portable medium.

The referred standards for present static meters are IEC 60687, treating alternating current static watt-hour meters for active energy (accuracy class 0.2 and 0.5), and IEC 61268 , treating alternating current static watt-hour meters for reactive energy. These meters are tested and calibrated according to standard IEC 687.

3 THE POWER REGISTRATORS

The replacement of electromechanical power registrators by static ones made system for telemetering possible. The remote metering of load flows in the Operating centre of EDB was obtained by measurement transducers. A static power registrator is a device with at least eight impulse inputs, obtaining load profiles from the impulse meters as well as their sum on its display, portable media and telecommunication port. With an interval period of 5 seconds and 8 channels configured; the depth of load profile recording is of 40 days, matching monthly period of reading. The integration periods are programmable from 1 to 60 minutes, but as quarterly hourly metering is accepted in this country, it has to be 15 minutes. In all the channels the registrator is capable of recording the demand values for active and reactive energy, with a storage capacity of 96 periods per day. It's way of connecting to impulse meters is shown on Fig. 2.

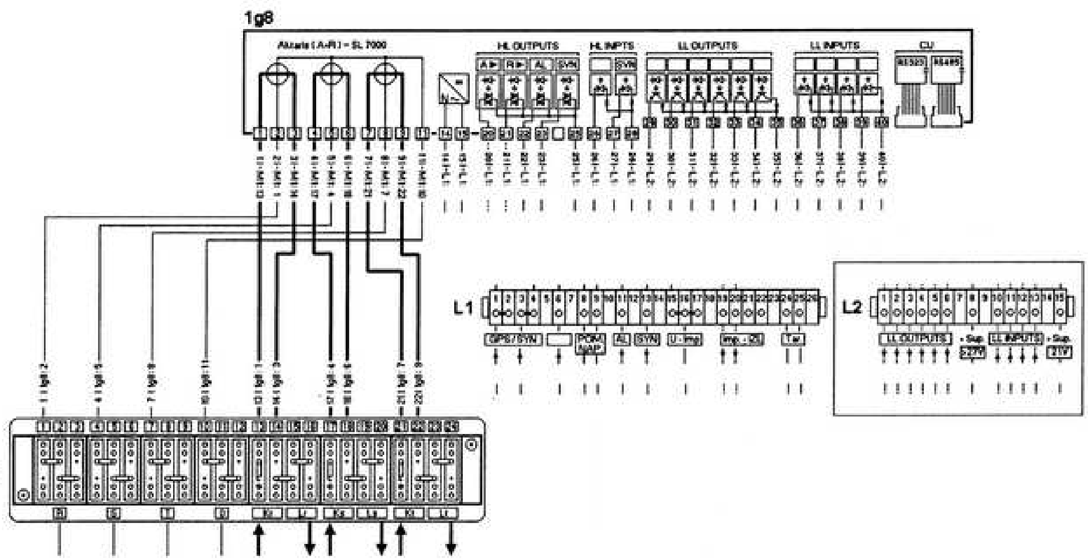

Fig.2. Connecting the power registrator

The stored demand values are integer values of kW or KVar, or impulse counts. The accuracy of the energy values derived from demand values are within +0.1% (at full load) of the account of energy measured by associated meter. The value of any energy measured in a demand period shall be carried forward to the next demand period. Any read operation shall not delete or alter any stored metered data. The register shall provide any portion of the data stored upon request by the data collection system.

In the event of a metering equipment power supply failure, the registrator shall protect all data stored up to the time of the failure and maintain the time accuracy in accordance with timekeeping function. The registrator is set to coordinated universal time (UTC) with the facility to switch annually to day light saving time (DST). No switching shall occur for quarter hour data. Time adjustments may be performed as required by communications with the data collection system. The commencement of each demand period shall be accurate to within +0.1% except where time synchronization has occurred in that period.

The data are simultaneously stored on the portable medium (magnetic cards). The memory of these cards are enough for over two months. The cards are still used for monthly billing. All data communications equipments conforms to the relevant International Telecommunications Units (ITU) standards and recommendations for data transmission over telecommunications systems. The registrators conform to “Technical references for electronic registrators of power and energy” (GSE 75/91) and “Directions for type testing registrators of power and energy” (GSE 7/91). The registrator is installed such that metering installation is protected from direct local or remote electronic access by suitable password and security controls. Each registrator has a telephone modem, enabling data transmission.

4 DATA TRANSMISSION AND COLLECTING

The telephone modems built in the power registrators enables remote interrogation by means of dial-up telephone. The commuted telephone lines allow different functions, accordingly using the stable network of Serbian Telekom. Central data collection is situated in the Operating centre of EDB, connected by corresponding telephone modem. Besides its telephone number, each metering point has an intranet address, so the data can be interrogated by a personal computer connected to the server. Meter data collection system remotely interrogates metering equipment to extract data at appropriate intervals as set out by the relevant meter operator. Previous system of load registering and control on line was realized by measurement transducer, not connected with the revenue metering . By the actual program in a personal computer connected to the EDB server, it is possible to create a load profile diagram, like on the Fig.3.

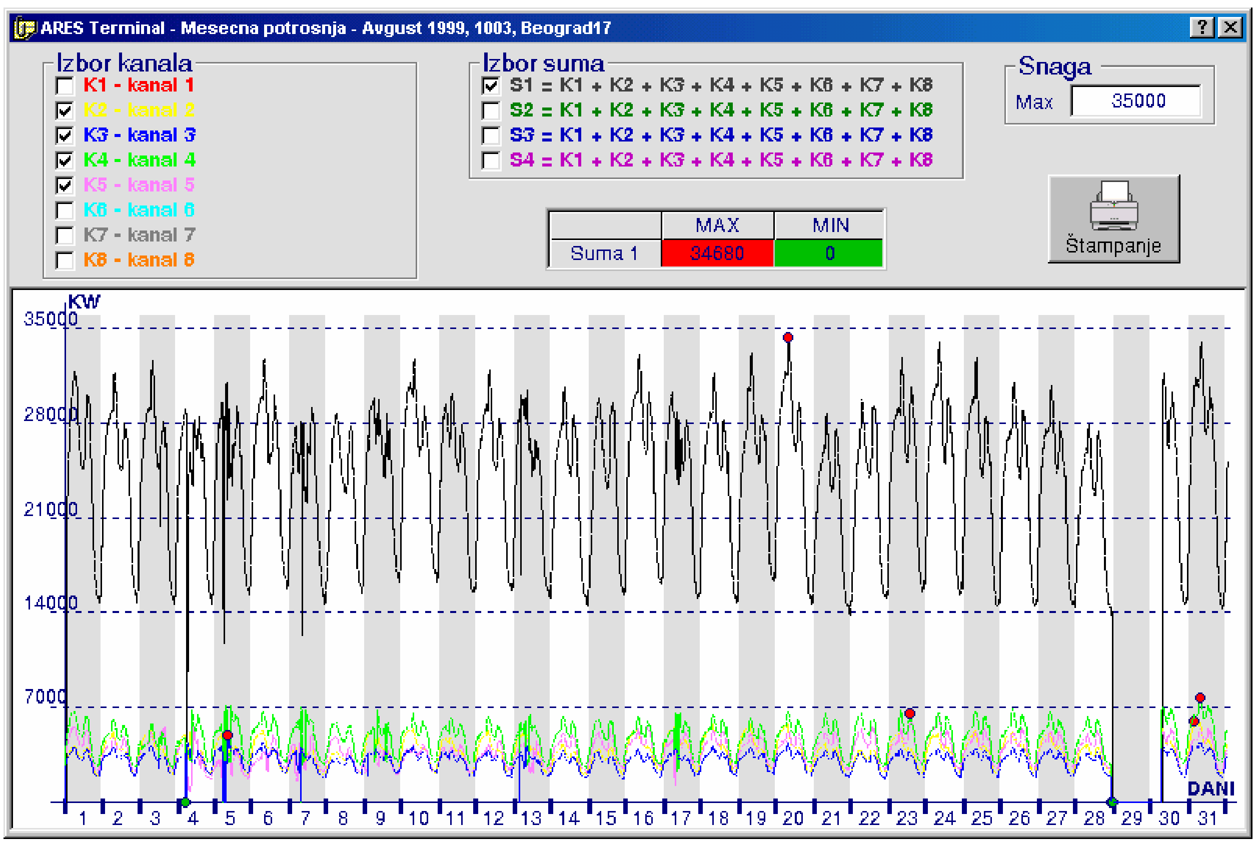

Fig.3. The load profile diagram for a metering point

The collected metering also enables showing the diagram ot the consumed energy, as shown on the Fig.4.

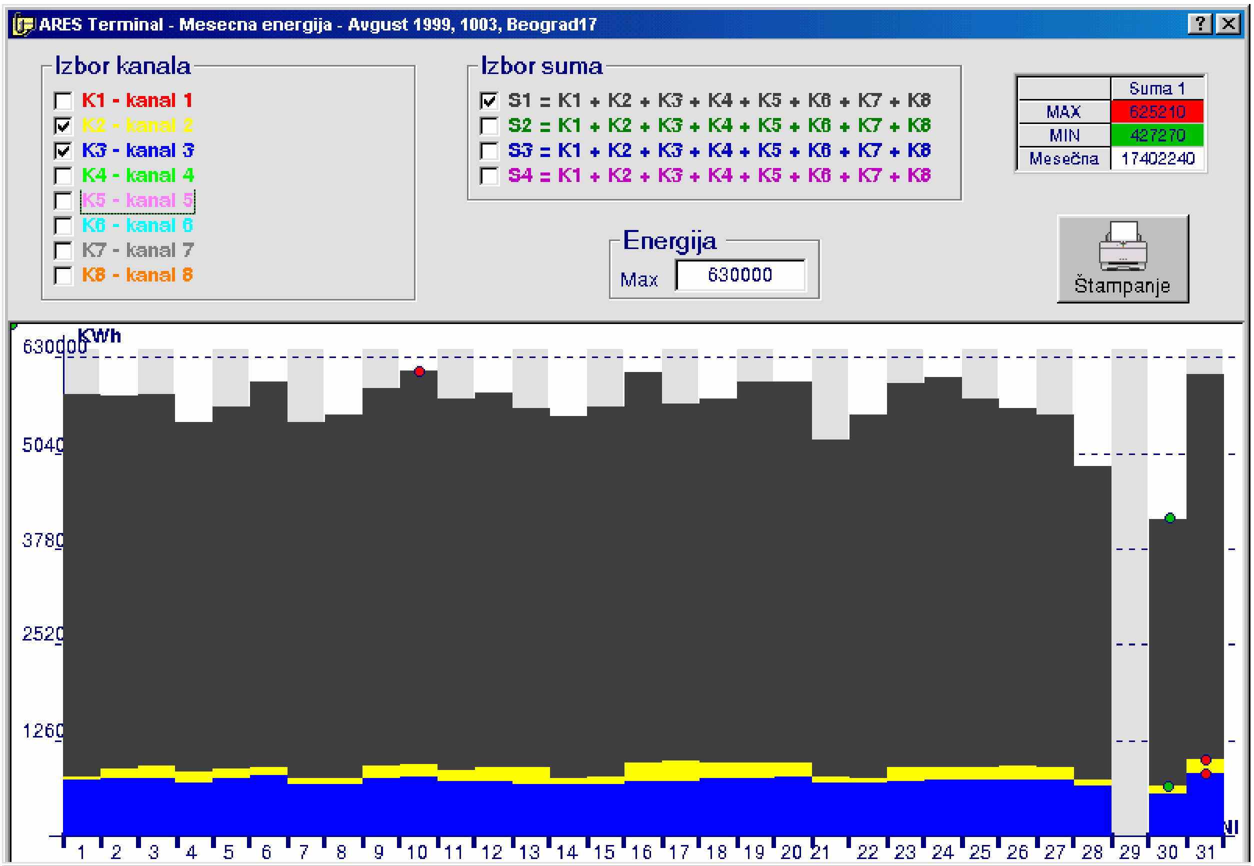

Fig. 4 The diagram of the imported energy

The data will be validated and substituted or estimated data will be provided where appropriate by the relevant meter operator. In the event of failure of communications facilities, meter data shall be read by a locally attached device and transferred to the central data collection system. The difference between the latest manual meter register readings and previous manual meter register readings shall be calculated and compared with the electronically recorded total energy for the time interval involved.

Metering equipment should be installed such that metering data held in the metering installation is protected from direct local or remote access by suitable password and security controls. To prevent unauthorized access to the data in the metering equipment a security scheme, as described below, shall be incorporated for both local and remote access. Separate security levels shall be provided for the following activities:

1. Level – Password for read only of the following metering data, which shall be transferable on request during the interrogation process:

- metering point ID;
- demand values;
- maximum demand for kW or KVar per month;

- alarm indications;

2. Level - Password for:

- corrections of the time and date;
- resetting of the maximum demand;

3. Level - Password for programming of:

- displays, tariff schemes;
- the passwords for levels 1, 2 and 3;

4. Level - Password for removal of metering equipment covers necessitating the breaking of a seal for:

- calibrating of the metering equipment;
- programming of the level 3 and level 4 password.

In addition to the function specified for each level it shall be feasible for undertake the functions at the preceding or lower level. All data communications equipment shall conform to the relevant International Telecommunications Union (ITU) standards and recommendations for data transmission over telecommunication systems.

5 CONCLUSION

Where quarter hourly metering is installed and is being read remotely and being used for billing purposes, this data shall also be used for other analysis. This system of data transmission, compared to previous one with measurement transducers, appears to be much more accurate and reliable. By means of a personal computer it is possible to follow meter registers as well as the load profiles. With a corresponding program for summing load profiles, total energy consumption and maximum demand of EDB could be determined for every month. Besides this processing, important for monthly billing the data collected in this way make various kinds of post acquisition processing and load flow analysis much easier.

Although existing system significantly facilitated and accelerated the data transmission, its improvement is possible. Installed electricity meters are equipped by communication modem RS485, which enable their direct connected to communication lines, excluding power registrator. This way, the data transmission would be more accelerated, as well as their acquisition. Next step would be the connecting of described system to the SCADA and GPS system of EDB.