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Optimization and Monitoring Energy Consumption from small Industrial Consumers

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***Abstract* – Urgent need for energy savings involves introduction of intelligent monitoring and control networks for industrial consumers, including small and medium ones. New functions of smart grid and energy storage quality monitoring systems make up the path for new consumption ways. This paper presents a system solution that optimizes electricity consumption from small industrial customers through local control and also introducing renewable energies in the presented solution.**

Keywords-component; monitoring system, energy consumption, smart grid, small industrial consumers.

I. INTRODUCTION

Increasing energy efficiency, renewable energy production and the accelerated development of Smart Grid technologies are set as priorities for energy companies and consumers worldwide. The European Union has set ambitious targets for 2020: 20% increase in energy efficiency, renewable energy used up to 20% and achieving smart electricity grids "smart grid" (Deloitte Energy Predictions 2011). EU document COM (2011) 202 "Smart Grids: From Innovation to Deployment" smart power grid defines as effectively integrating network requirements and actions of all users connected to it and ensure economic efficiency, use of renewable resources and high quality of delivered energy bi-directional communication between the producer and consumer, smart metering and monitoring systems of their own.

Currently, most intelligent, particular type products are intended in the area of production and transmission electricity not to consumption optimization in industrial plants for the beneficiaries. In consumer's networks, the equipment used is category specific for each smart grid system; the system contains only elements of data acquisition and data through operator commands, not any other intelligent systems. The requirements on energy management systems of the new standards such as ISO 50001 will have a positive impact on global energy consumption. This will happen by providing public and private sector organizations management strategies to increase energy efficiency, reduction of costs and improve energy performance.

One important strategy is to replace traditional linear network version with smart, interactive networks. Following consumers behavior, the structure of new systems are influenced by several factors: renewable energy - enabling users to act as their suppliers and to connect those sources dispersed network; active management of energy and energy saving active, maintaining power quality and not least, real-time network management that anticipates and adjusts the distribution of energy consumption accordingly.

The given paper is part of this area, aiming to bring new solutions for energy management in small industrial consumers, by presenting smart-grid network functions that allow local control of consumption without dispatcher intervention points.

II. CURRENT SOLUTIONS

During the last decade, several types of systems have been implemented: remote management for industrial consumers, consumption monitor of electricity and other forms of energy and SCADA systems.

In Romania, there are a few known examples of such application, of which we can remember: the systems implemented with National Instruments hardware and software to large industrial enterprises, centralized registration systems for electricity consumption of consumers geographically scattered or equipment applied in the energy system of production and transport of electricity.

As worldwide solution providers we have: secure monitoring (AlertMe), large-scale energy management (Agilewaves) or specific IT applications and web technologies (Google, Intel, Microsoft).

At this moment energy management systems on the market can be classified into two broad categories:

A. A counter (Figure 1) - global monitoring system that uses the meter to obtain information on power and total energy consumed without presenting specific values of individual consumers in the system. Because of its simplicity it is a low-cost device, and this makes the adopted solution be the most common at this time.

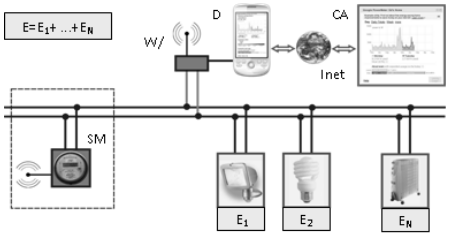

Figure 1. General structure of a counter system

B. Multiple meters (Figure 2) - is an adaptable electricity management system at a high cost, allowing each energy consumer to be strictly monitored (SM1, SM2, …).

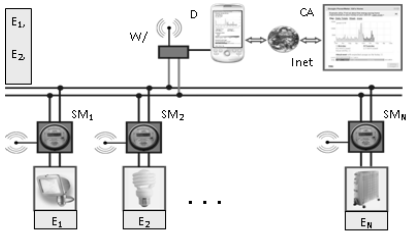

Figure 2. General structure of multiple meters system

III. Technical Solution for Energy Management Dedicated to Small Industrial Consumers

The intelligent "smart micro grid" system proposed in this paper is based on energy efficiency consumption for a small industrial consumer or middle one. Part of the solution contains multiple counters. It is based on a combination of hardware-software solution combining real-time acquisition detailed information regarding individual consumption for major groups of machines, their processing and rapid initiation of local commands to save energy. The real-time monitor and control are needed as actions to maintain power quality and efficient use of renewable energies.

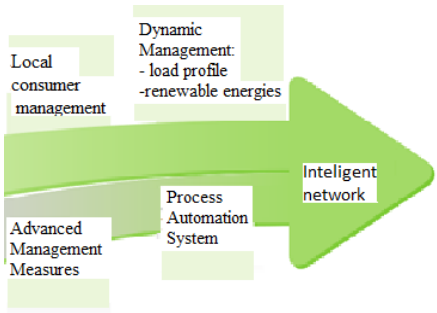

Figure 3. System functions for ensuring the role as an intelligent network

A. An advantage of the proposed system is the possibility of a differentiated structure, depending on the electrical network on which is implemented:

- with local control and monitoring functions;
- with extra storage power quality by compensating local power factor and harmonic filtering.
- with extra input from solar and wind renewable energy.

Among the usefully implemented functions into the provided smart grid system, we can mention:

- using the "interval metering", provides a real-time memory at intervals of up to 5 seconds;
- the supply of demand function for real-time measures quantities of provided measurements: *u(t), i(t), p (t), q(t), f(t),* phase and/or in phase angle between current and voltages etc. These quantities are essential for the smart grid because they can be used in various local or centralized decisions.
- control function for power quality ensures implementation of local control without the need for additional field equipment;
- integration of storage facilities powers quality and reduction in consumption of electrical energy by introducing local renewable sources

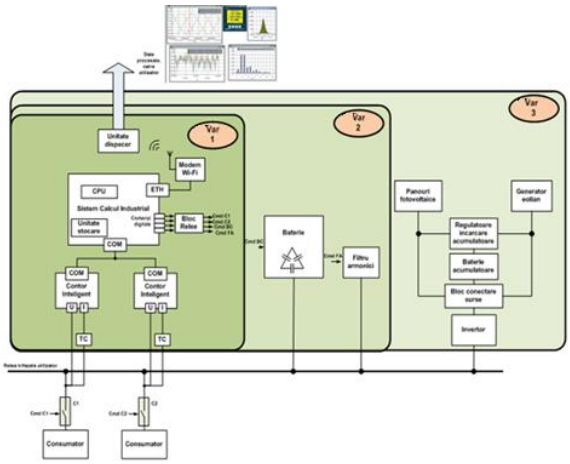

Figure 4. System architecture with its constructive types

Newer system architecture is shown in Figure 4. We can observe specific functions incorporated by those three variants. Variant B correction circuitry further comprises local power factor, and harmonic filtering and variant C brings additional renewable energy sources to the table.

IV. Hardware and Software Implemented Structure into the System

In Figure 5 is shown the wiring diagram and its implementation with specific equipment of variant A.

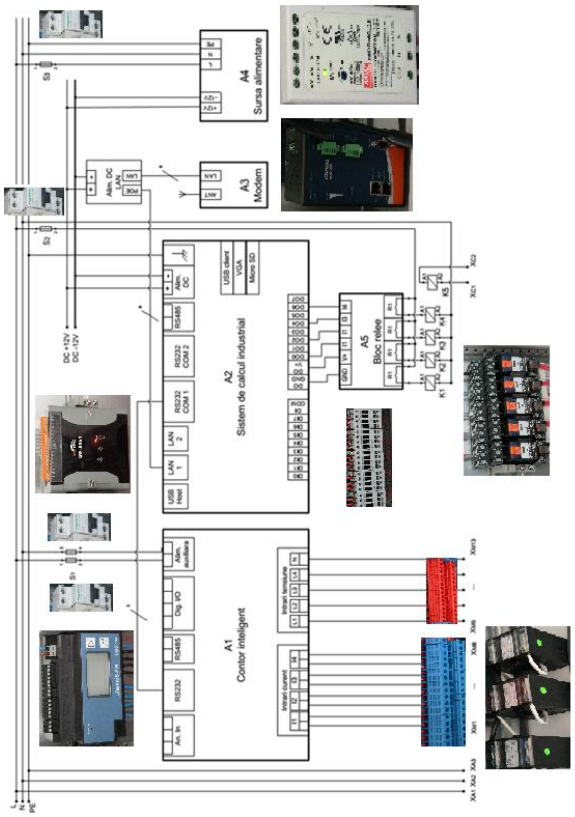

Figure 5. Variant A of the system

A practical realization of the embodiment is shown in Figure 6.

Figure 6. Variant A practical implementation of the smart grid system

Taking notes amperage through current transformers (CT). The smart meter connects a local network RS485 industrial computing system. It has local control functions for the consumer using block relays and data transmission to the point of dispatch by Wi-Fi model used for wireless communication via TCP / IP.

Keeping local power quality is achieved by equipment shown in Figure 7.

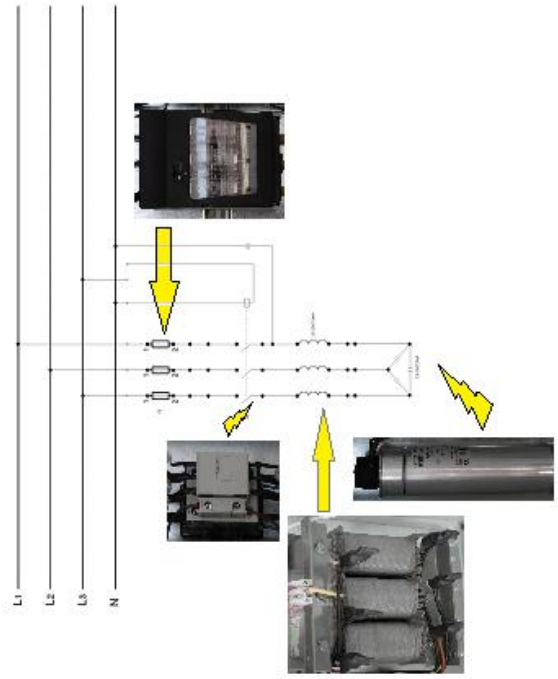

Figure 7. Additional functions are provided by variant B.

Practical realization is shown in Figure 8.

Figure 8. Variant B implementation of the smart grid system

Option C contains specialized components for production and injection of electrical energy in the network obtained from renewable sources (solar, wind) – Figure 9.

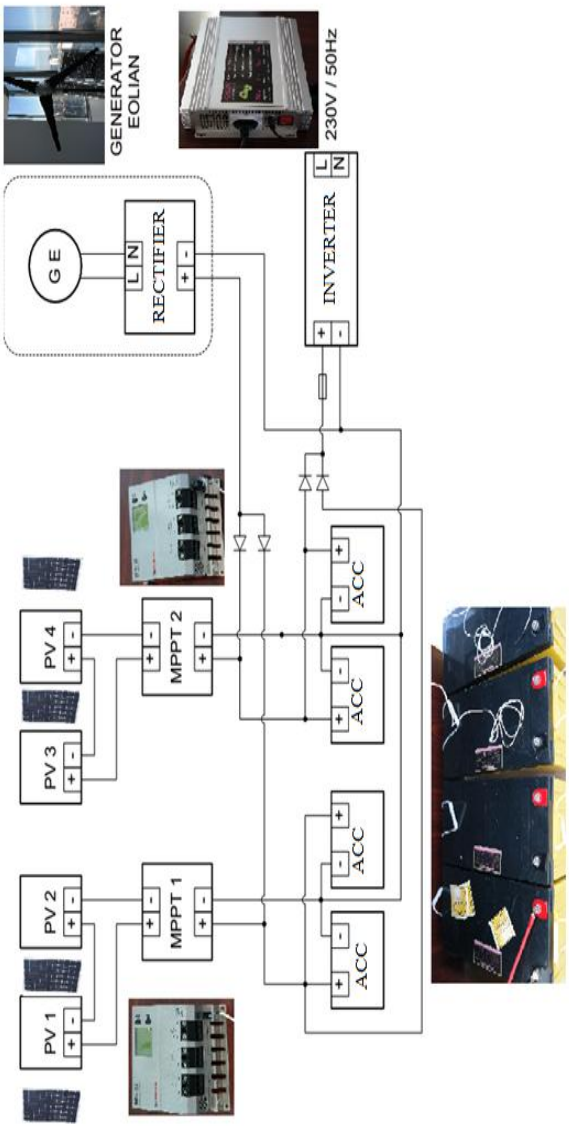

Figure 9. Additional function - variant C

The software that will be used to monitor and control the local point has the following functions:

- reading monitored parameters from the measuring equipment;
- transfers of specific parameters to dispatch;
- stores the measured values during operation and also archive it if there is no connection with the dispatcher (max. 48 hours);
- control commands are given to consumers by internal rules.

The software runs on Windows CE operating system architecture.

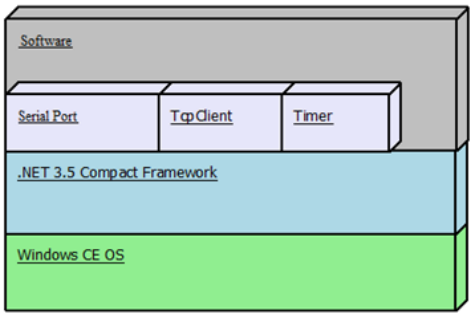

Figure 10. Local application software structure – central point system

V. CONCLUSIONS

Optimizing power consumption is the goal of all local networks and beneficiaries, including those in the category of small and medium enterprises. Even if we have solutions for large industrial customers to transport and distribute with complex monitoring systems, energy consumption optimization systems for small consumers cannot be achieved due to the lack of support for technical solutions with competitive prices. This paper presents such a solution with appropriate local monitoring and control of electrical networks for small industrial consumers, which brings the new implementation of smart grid functions and automatic storage power quality. The user can choose a system variant that allows integrating electrical energy production based on renewable sources.

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