System Optimization On Smart Grid

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ABSTRACT: *Electric energy is used in every facet of life. It has become compulsory to take away the electric energy to all points where the people live and put it at people's disposal, after that of to manage the process and the infrastructure for efficient use of energy. Energy efficiency has become more of an issue due to the fact that the need is less than the demand, the cost of the energy is getting higher because of the lack of resources and the greenhouse gas venting as the increase in usage of the energy, causes global warming. The solution of this is productivity growth. Towards the productivity growth, in this study supplying system optimization with Secondary Phase Load Balancing (SPLB) and Conservation Voltage Reduction (CVR) is analyzed.*

***Keywords* -** *Distribution grids, smart grids, smart meters, system optimization, power grids*

I. INTRODUCTION

The expression of productivity is "Energy Density". It is called as "the amount of energy consumed per gross national product" or "the amount of energy consumed to produce one dollar-service or product". It is regarded that the countries that have the least consumption are the countries that use the energy most efficiently. If the energy density is low in a country, the product or service is produced with less energy. The energy consumption per capita in Turkey is about one of five, on the other hand the energy density is double the amount of OECD average. In other words, Turkey uses double the amount of energy used in OECD countries to produce one unit good or service. In Turkey, to produce a product, one and a half amount energy used in EU countries and a double the amount of energy used in OECD countries is used. According to the 2010-2014 Strategic Plan of Ministry of Energy, reduction of primary energy density at the rate of twenty percent up to 2023 considering 2008 is aimed [1]. Towards all these studies about productivity, in order to increase productivity, the rational solution is to use optimization skill which will be brought to the system with smart transformer used in smart grid systems. SPLB and CVR increase productivity by contributing system optimization.

II. SMART TRANSFORMER SYSTEM

Smart Transformer System (STS) renders distribution transformer suited to developed technologies. While doing this, it bases on features of Smart Grid (SG). These features are two ways communication at high performance, sensors placed in distribution grid and software platform. Smart Transformer solution redounds plenty of ability to distribution companies in the fields of Automatic Meter Infrastructure, System Optimization.

Smart Metering systems reaches important information at meters by communicating in two way with electronic meters and report this information to the center by analyzing the information with the aim to increase productivity in distribution companies. STS supports AMI (Automatic Smart Meter Instructor) solution or the fact that present AMI solution of the company should be used to improve interface communication [2, 3]. In addition to data gained for income measurement, AMI solution performs the applications specified below:

- Robbery Fastening: It fastens energy robbery by comparing the total energy registry measured on meters with the amount of energy getting out of the transformer. In case of a difference between the measurements, it sends a signal from the transformer to the center and reports that one or more subscriber robs energy with the time and place information.
- Secondary Phase Load Balancing: incorporation of meter data to this system enriches this application. By this means, the system can make suggestion about load balancing for the distribution company.

The thing procuring the features of distribution management, advanced wealth management, electric distribution automatisation and interruption management are feeder and substation. By this means, the electric distribution companies can make their maintenance proactively and tighten their security. Some advantages in this field are like these:

- Under favor of automatic trouble shooting and reporting, the time of finding the envisaged trouble's place will be shorten.
- With the real-time maintenance messages from the network and grid units connected to SG, the company's interruption, maintenance, repowering processes will be easy and company's labor productivity about weather (eg. Storm) can be grown.
- As the callings to customer services will decrease, the call center employees will be able to report subscribers immediately, rightly and realistically.
- Field service support will decrease visually.

STS distribution transformer provide system managers convenience in such fields as excessive load determination, distribution transformer trouble determination, temporal voltage unbalance determination, line trouble determination, finding the point of trouble, interruption, maintenance, repowering determination, distribution automatisation and energy quality tracking.

System optimization is an application maximizing the flow of energy productivity towards all of the subscribers in the grid. It contributes to decreasing the amount of carbon emission. The wide scale results of these systems are obtained by the optimization of the voltage used in the system, this can only be possible by decreasing line losses on load balancing between circuit-phase and decaying current needed on electricity lines by optimizing power factor. System optimization minimalises the total amount of energy serviced to the subscribers. Thus, such applications contribute the decreasing of the amount of hazardous carbon emission by decreasing the transmission and production costs. STS optimization applications.

2.1. Conservation Voltage Reduction

CVR is the method of reduction of voltage distributed and conservation of energy in the electric distribution system. Most subscribers consume less energy at lower voltages. The aim of CVR is to decrease energy consumption and keep the voltage used by the subscribers at the minimum level in accordance with Energy Market Regulatory Authority (EMRA) and the features of the equipment used by the subscribers. This should be done within the frame of VAR/Voltage regulation application. By this means, present independent Voltage and VAR systems do not obstacles CVR effects and do not coincide with them.

CVR is a system that decreases the voltage up to the required level so as to conserve the energy in the distribution system. CVR application, as a part of Smart Transformer solution, has the advantage of gaining the values of real-time instant voltage from the censors placed on the distribution transformer and checks the Load Tap Changer actively (or makes the recommended checks). As a result, it keeps the voltage average at the minimum level and provides energy conversation substantially.

It provides the opportunity to picking up voltage at anywhere at the grid instantly and to check if the voltage at the distribution lines is between the EMRA limits. Thus, energy conservation is provided. Different from the other methods decreasing the system load CVR, does not take any information or input from the subscriber. The censors are placed to the system strategically like Smart Transformers' part and provide a rich database that can give instant information about feeder network. CVR is Smart Grid solution's advanced perception unit that can communicate at high speed.

It provides the information supporting the Data Communication Interface that provides status elucidating such as Download Transformer Equipment (load-plug changer-LTC and its controllers, Metrology, data loggers and devices) feeder current, active power and reactive power measurements in downloader transformer, LTC status, remote LTC and capacitor bank controllers and if any interruption. In addition, different communication standards IEC 61850, IEC 60870-5 and DNP 3.0 as intercommunication physical interface for the communication between

Distribution Company and downloader transformer concentrator and devices.

2.2. Secondary Phase Load Balancing

SPLB makes use of maximum load of secondary circuit to confirm and enrich the energy flow information. This case gives the opportunity to decrease the loss by load balancing among distribution companies' feeders.

SPLB detects the transformers that has unbalanced load and gives instant information to the distribution companies to regulate these unbalance manually. SPLB also considers surge connected to season and condition. This application also analyses the measurement taken from AMI meters in order to improve and validate the reports recommended to distribution companies on load unbalance.

SPLB makes clear and exact the decisions taken by Distribution Company in order to ensure correct load balance on secondary phases. This application provides the distribution company to generate a solution in a short time and exactly by integrating transformer loads and automatic meter measures with company analyses. Normally, meter data is given to the distribution company monthly or bimonthly, by means of this system, grid information, subscriber information and load unbalance information will be transmitted to the center instantly. Distribution companies will more easily make system analysis with this information. Incorporation of automatic meter data to the system gives the opportunity for the distribution company to offer more detailed suggestion for the solutions of the problems. The needed technology for this application about system optimization can be rank as Smart Meter menstruation data interface to read the meter data of the distribution company subscribers, voltage censors and current censors.

III. System Components

3.1. Smart Engines

Smart Transformer's main component is Smart Engine. Smart Engine is a modular product that is configured to meet each transformer's need and is scaled according to this. Smart Engine includes features as below:

- It involves all the communication systems towards transformer or from transformer to other ways. (two way communication) Broadband internet (BPL) solutions from electric lines are included to these and by means of BPL cost of communication including high capacity and dense data is decreased.
- It involves connectivity and censor solutions.
- It is integrated to RTU equipments for the control and monitoring of alarms, analog/digital censors and equipments.
- Whether it integrates to data collection module or makes management and monitoring with an interface.

3.2. Censors

Smart Transformer solution involves many different voltages, current and trouble censors both on aerial cable and underground distribution network. These censors are;

• YG, AG and current censors,

• Underground YG current and trouble censors,

• AG current and voltage censors,

• Aerial cable and trouble censors.

Smart Engine uses both Series Connection (RS485/RS232) and Ethernet interface in order to connect third generation censors used with the aim of controlling and monitoring the information such as transformer status temperature, ambient temperature, water existence, door connection [4, 5]. Smart Grid applications require monitoring grid and data management, simulations and all grids instantly. In order to the fact that this modern service can shape the system structure, it is necessary to make quick, reliable and safe descriptions [6, 7]. A smart grid on a modular and joinable architecture adds an flexibility to the system.

In Figure 1 sample shows a scheme of a distribution network.

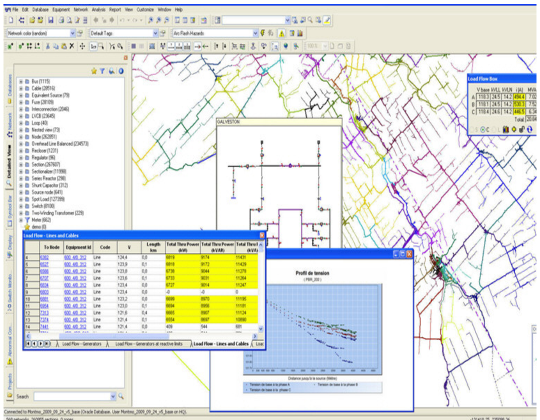


Fig. 1. Distribution network scheme

Smart systems in transformer R, S and T phases of voltage change is observed.

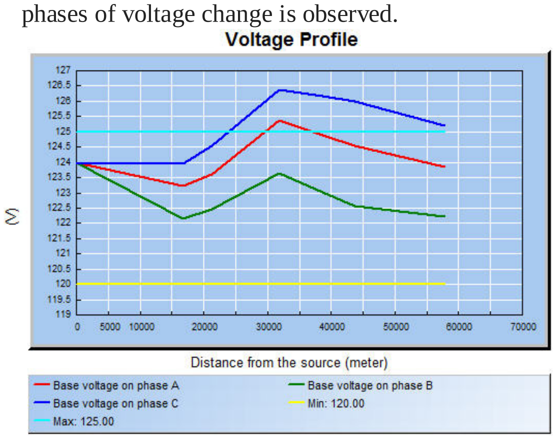
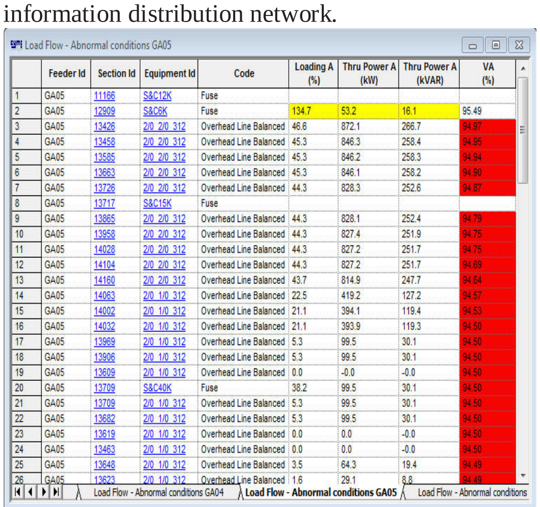


Fig. 2. Exchange of phase voltage transformer Smart system

Figure 3 shows instantaneous load information distribution network.



Load Flow - Abnormal conditions GA05

	Feeder Id	Section Id	Equipment Id	Code	Loading A (%)	Thru Power A (kW)	Thru Power A (kVAR)	VA (%)
1	GA05	11166	S&C12K	Fuse				
2	GA05	12909	S&C6K	Fuse	134.7	53.2	16.1	95.49
3	GA05	13426	2/0 2/0 312	Overhead Line Balanced	46.6	872.1	266.7	94.97
4	GA05	13458	2/0 2/0 312	Overhead Line Balanced	45.3	846.3	258.4	94.95
5	GA05	13585	2/0 2/0 312	Overhead Line Balanced	45.3	846.2	258.3	94.94
6	GA05	13663	2/0 2/0 312	Overhead Line Balanced	45.3	846.1	258.2	94.90
7	GA05	13726	2/0 2/0 312	Overhead Line Balanced	44.3	828.3	252.6	94.87
8	GA05	13717	S&C15K	Fuse				
9	GA05	13865	2/0 2/0 312	Overhead Line Balanced	44.3	828.1	252.4	94.79
10	GA05	13958	2/0 2/0 312	Overhead Line Balanced	44.3	827.4	251.9	94.75
11	GA05	14028	2/0 2/0 312	Overhead Line Balanced	44.3	827.2	251.7	94.75
12	GA05	14104	2/0 2/0 312	Overhead Line Balanced	44.3	827.2	251.7	94.69
13	GA05	14160	2/0 2/0 312	Overhead Line Balanced	43.7	814.9	247.7	94.64
14	GA05	14063	2/0 1/0 312	Overhead Line Balanced	22.5	419.2	127.2	94.57
15	GA05	14002	2/0 1/0 312	Overhead Line Balanced	21.1	394.1	119.4	94.53
16	GA05	14032	2/0 1/0 312	Overhead Line Balanced	21.1	393.9	119.3	94.50
17	GA05	13969	2/0 1/0 312	Overhead Line Balanced	5.3	99.5	30.1	94.50
18	GA05	13906	2/0 1/0 312	Overhead Line Balanced	5.3	99.5	30.1	94.50
19	GA05	13609	2/0 1/0 312	Overhead Line Balanced	0.0	-0.0	-0.0	94.50
20	GA05	13709	S&C40K	Fuse	38.2	99.5	30.1	94.50
21	GA05	13709	2/0 1/0 312	Overhead Line Balanced	5.3	99.5	30.1	94.50
22	GA05	13682	2/0 1/0 312	Overhead Line Balanced	5.3	99.5	30.1	94.50
23	GA05	13619	2/0 1/0 312	Overhead Line Balanced	0.0	0.0	-0.0	94.50
24	GA05	13463	2/0 1/0 312	Overhead Line Balanced	0.0	0.0	-0.0	94.50
25	GA05	13648	2/0 1/0 312	Overhead Line Balanced	3.5	64.3	19.4	94.49
26	GA05	13623	2/0 1/0 312	Overhead Line Balanced	1.6	29.1	8.8	94.49

Load Flow - Abnormal conditions GA04 | Load Flow - Abnormal conditions GA05 | Load Flow - Abnormal conditions

Figure 3. Instantaneous load change info

IV. CONCLUSION

If we classify the contributions for the system optimization in Smart Grids by means of Smart Transformers as SPLB and CVR, we can explain the contributions of these two methods to the system optimization as below.

SPLB serves important opportunities to distribution companies so as to decrease losses and increase productivity of distribution operations. The benefits of SPLB are as below:

SPLB gains load data, that distribution companies traditionally gain manually, from the grid automatically and instantly and serves them as report to the distribution company to be analyzed. Instead of the fact that SPLB makes load analyses with monthly meter data at traditional applications, it serves the opportunity to report differently, usable, exactly and instantly.

After SPLB determine the problematic transformers, the distribution company can transfer the load to secondary feeder manually and can make reloading so as to balance the transformer load. If this application comes together with an AMI system communicating in two way, it reveals more detailed solutions for better balanced system.

CVR provides monitoring of secondary voltage distribution instantly and decreases the energy consumption by lowering the levels determined by EMRA. Additionally, distribution companies deal with system stress that is occurred with high leveled energy demands by using CVR.

CVR provides control flexibility. It serves different automatisation options according to the distribution companies' choice. If there will be any doubt about system's security or reliability, the aotomatisation can be deactivated and the system continues with two different running models. Question running models are as below:

Manuel Mode (application gives idea only about how to control an event and its parameters, but this application is completely under the user's control.

Full Automatic Mode (the user interfere from the computer to complete an activity.)

CVR makes data analyses easy. CVR application includes many analyses and informing such as data retention and reporting, reporting past rise and fall analyses and statistics on operations, whether present usage is suitable or not.

As a result, by means of efforts for system optimization, total operation and maintenance costs will be minimized. This case will prolong lines' and transformers' life, thus the investment amount for needed equipment will decrease. In other words, energy productivity will increase and thus greenhouse gas (CO_2) emissions will decrease. As the firm productivity will increase, the firm expenses will decrease. Interruption amount and time will be shortened and energy quality will be higher. With better management of production and storage systems, capacity usage will rise.

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