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PRECONDITIONS ANALYSIS OF SMART METERING SYSTEMS DEPLOYMENT IN LIBYA

The article provides detailed analysis of situation of balance and condition of energy in Libya to cover all needs, the need demand side management. The article identify the smart metering systems deployment and its benefit. The benefits of smart metering systems was analyzed and the cost-benefit analyze of smart metering systems deployment in European member states was provided. The creation of an intelligent electricity smart metering system in Libya is a promising and important task for the development and improvement of the energy system, which contributes to increased transparency of electricity metering, reliability of energy supply and ensuring the country's energy security.

Key words: *smart metering systems, Libya smart metering, Libya electricity, demand side management.*

Introduction. Current trends in the development of the electricity market are based on improving energy-saving technologies, creating virtual power plants, power storage systems and intelligent systems.

Literature review. The development of smart metering systems abroad is considered in the works of R. Bayandyr, I. Kolak, G. Fuli, K. Demirtas [1], Gangale, F., Vasiljevska, J., Covrig, C., Mengolini A. [2], Malik F.H., Lehtonen M. [3], Remizova T.S., Koshelev D.B. [4] and is largely a result of the functioning of regulatory bodies and existing regulations.

Purpose and objectives of the research. T he main aim is identify conditions of smart metering systems deployment in Libya based on cost-benefit analyze.

Materials and methods. The article uses data from the World Bank for 2000-2017 to analyze the Libyan electricity market. The report from the European Commission was used to provide cost-benefit analysis of smart metering systems deployment.

Results and discussion. An intelligent electricity smart metering systems (here and after referred to as the system) is understood as an accounting organization that provides a cost-effective, sustainable power supply system with low losses, a high level of quality and safety and effectively integrates the actions of all users connected to it – generating companies, consumers and other interested parties, in order to ensure.

Such a system allows to [4]:

– collection of measurement results from smart meters of electric energy and power with a given frequency and information about events (changing parameters, configuration of devices);

– storage of measurement results;

– providing measurement results with reference to time to all interested parties;

– analysis of measurement results, monitoring the integrity and completeness of the data provided;

– remote control of the mode of consumption of electric energy (full, partial restriction of consumption);

– protection of the collected data from uncontrolled interference.

Smart metering systems deployment will allow:

– increase the reliability of the power system;

– increase transparency of electricity metering;

– provide quick access to information on energy supply and energy conservation;

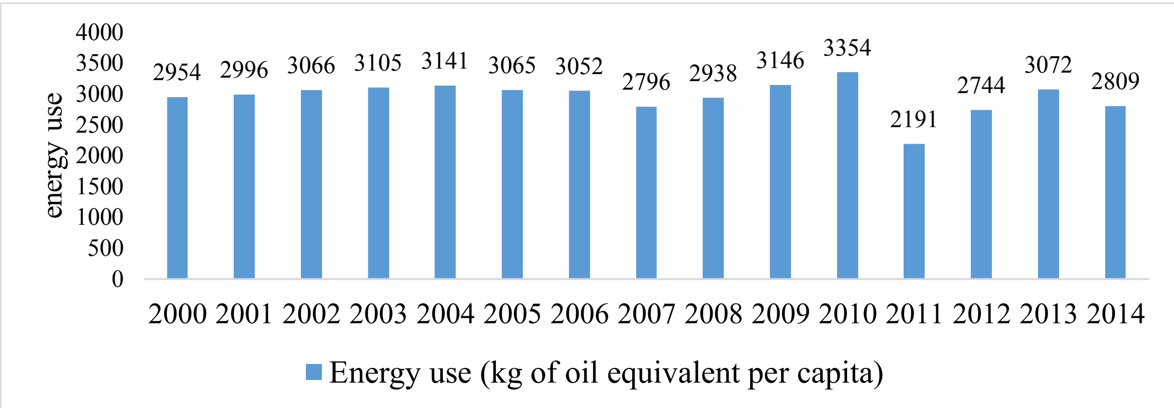
– improve the controllability of the energy system processes due to the possibility of operational consumption limitation.

Over the past decades, Libya has funded its electricity infrastructure. The investment was directly funded by the Libyan government through a development budget. However, GECOL, the General Electric Company, Libya's only national energy company, was a key institution for planning and organizing investments. The combination of oil in the country and a policy of universal electrification, energy supply with strict criteria for planning the expansion of the Libyan system led to the creation of a reliable power transmission network and ambitious projects for the construction of generating stations [9].

Libya's electricity market is still a complete monopoly. The price of electricity in Libya is very low. A fair and practical FiT should be in place. There is no energy regulator in Libya. Energy investment laws do not exist. The energy market in Libya is very fragmented, and it is not easy to come up with a risk assessment [9].

After the events of February 17, 2011, the state of GECOL changed, which began to affect the work of the main divisions of the company and the energy infrastructure of Libya. Insecurity and political instability led to a halt in most projects, consistent attacks on GECOL assets and personnel, a significant increase in thefts, especially conductors and electrical appliances, and a significant decrease in GECOL's ability to carry out maintenance work. As a result, some infrastructure assets, a drop in power grid capacity and a serious shortage of generating capacities were lost, which led to a prolonged blackout in many parts of the country, especially during peak periods in summer and winter [9].

In our research, we need to investigate the demand for energy in Libya.

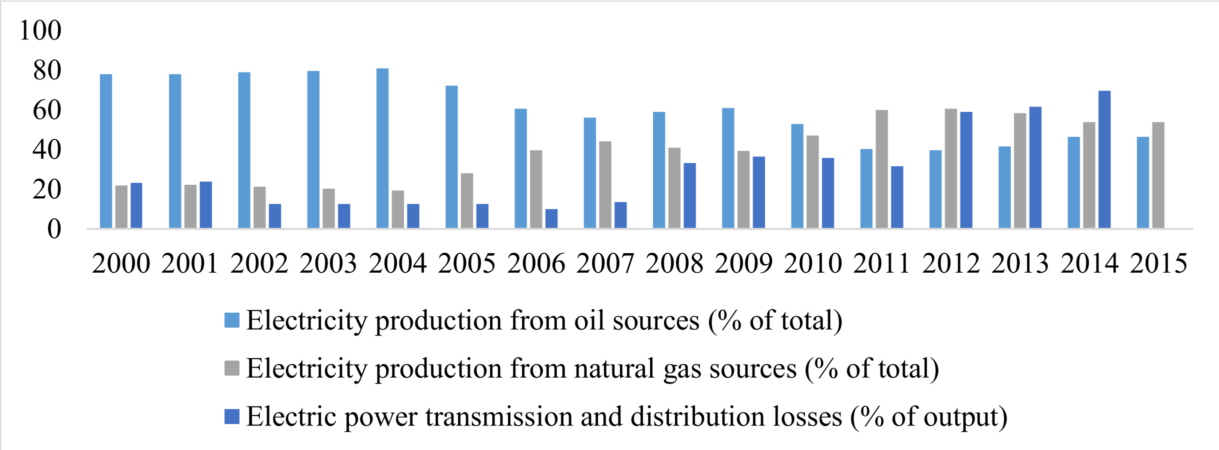


Source: World Bank.

Figure 1 – Energy use (kg of oil equivalent per capita) in Libya in 2000-2014 [7]

Energy use per capita rapidly decrease in Libya in 2011 and since 2012 increase slowly.

GECOL manages about 26 power plants, which contain 85 power units of various sizes, ages and technologies distributed throughout Libya. Most of the power plants are located on the Libyan coast of the Mediterranean Sea. GECOL's official installed capacity as of 2017 is 10.238 GW. Despite the fact that the power available for powering the mains is constantly changing in accordance with external and internal restrictions, as well as maintenance and other work, at the time of this study, the available power of GECOL was up to 5.35 GW, which amounted to 52% of the installed power.



Source: World Bank.

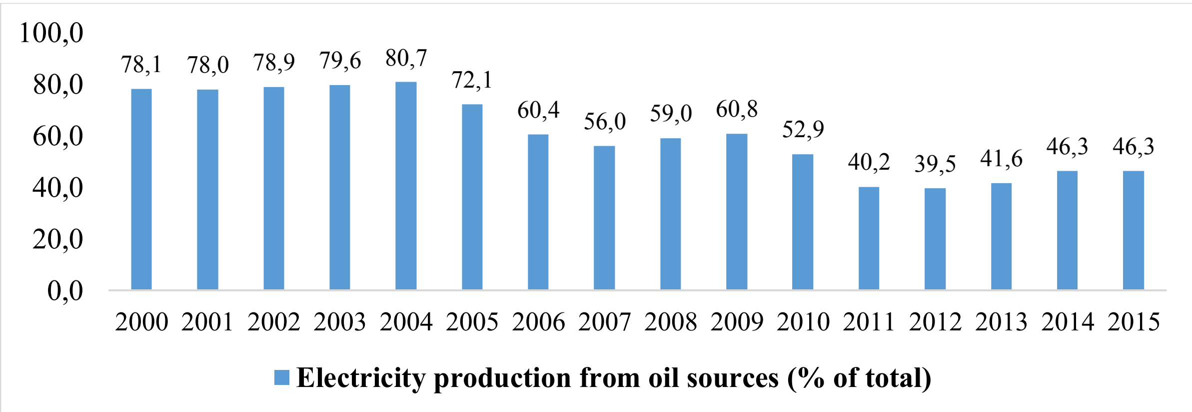
Figure 2 – Electricity production from different sources in Libya in 2000-2015[8]

Electricity production from oil sources in Libya decrees from 2005. Production of coal in 2017 was 3 773 421 ktoe, of crude oil was 4 477 212 ktoe. The import of crude oil was 2 453 086 ktoe, while export was – 2 381 804 ktoe. The import of oil products was 1 364 755 ktoe, while export was – -1 477 490 ktoe.

In 2010-2016, Libya availability ofweighted average generating unit fallto 66% from 78,3% and the capacity available fall to 53,7% from 64,6% of installed capacity. In the other hand, demand growth near 4% per year [9].

In 2010-2016 GECOL's generation power thermal efficiency increased by 7,3% due to the steam units, that was introduces. It is associated with the gas turbine units combined cycle at Misurata and North Berghazi. It help to increase generation operation of natural gas instead of liquid fuel. In 2016 energy production grew due to gas production from 40% in 2010 to 80% [9].

Despite all the difficulties of Libya's project environment since 2011, GECOL has commissioned 14 new generating units between 2012 and August 2017, total an addition of 2.295GW to the installed capacity.

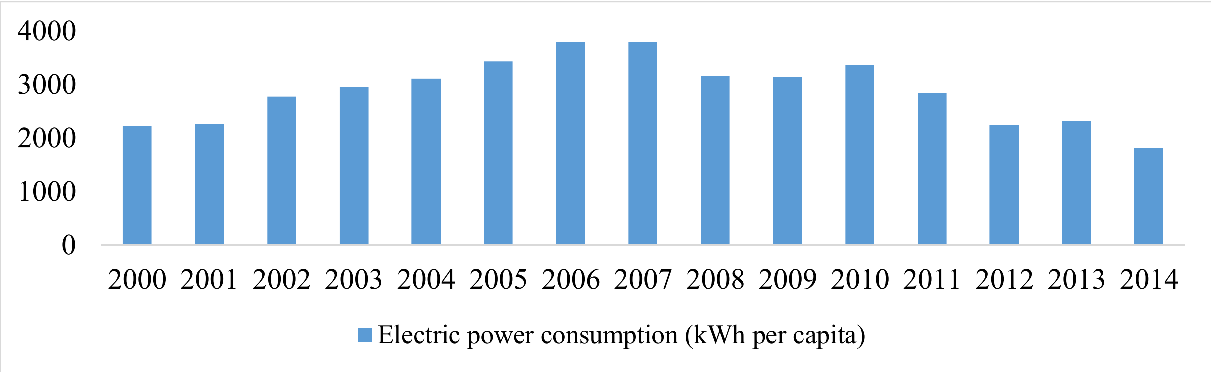


Source: World Bank.

Figure 3 – Electricity production from oil sources in Libya (% of total) [8]

The loss of installed capacity of more than 600 MW in Libya is due to several reasons. One of them is restrictions in the supply of fuel. Another problem is the loss or decommissioning of facilities due to maintenance problems. Lack of fuel and fuel reserves exacerbates the situation, because it limits the operation of capacities.

Libya's energy production depends on fuel. Instability and insecurity in Libya lead to a permanent shutdown of power plants that supply fuel. Another problem is the dependence of the country's power plants on the main working fuel – gas. Gas production and infrastructure in the country are constraints to meet fuel needs. Disconnecting units from the network is also a problem in Libya due to the need for larger units in the country. The direct and indirect costs of using the LFO are also high. Thus, all these problems in the aggregate significantly affect losses [9].



Source: World Bank

Figure 4 – Electric power consumption* in Libya in 2000-2014 (kWh per capita) [6]

** Electric power consumption measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants.*

Libya is one of the leading oil producing countries in the world. The leading industries are oil production, oil refining, petrochemical, metallurgical, transportation, cement, textile and food. The country accounts for 35% of all oil reserves in African countries. By this indicator, it ranks first on the continent and fifth among OPEC member countries (after Saudi Arabia, Kuwait, the United Arab Emirates and Iraq).The capacity generated by Libyan power plants is 86% of installed capacity and 94% of available capacity. Generating power is carried out by simple cycle and combined cycle units. GECOL has not supported the construction of a new steam power station since 1985. In fact, it was not until 2014 that the first unit of a new power station in the Gulf of the country was commissioned.

Libyan electricity is based on gas turbine generators. In accordance with the volumes of electricity consumption and production, the nationwide network of power plants (PS) with a total capacity of 5,000 MW is divided into 6 regional: Tripoli (32% of the total capacity of all PS), Benghazi (15%), the western region (20%; Zavia, Nelut, Zentan), central (18%; Hon, Sirte, Misrat), eastern (6%; Shahat, Tubrak, Salun), Southern (9%; Jalu, Saba, Kofra, Morsek) [1]. The entire nationwide network of power plants (ES) is divided into 6 regions in accordance with the volumes of electricity consumption and production.

Since the 1970s, GECOL has introduced monitoring centers to monitor generating plants and supply systems. The energy infrastructure control system includes the following institutions: National Control Center (NCC), two Regional Control Centers in Tripoli and Benghazi (TRCC and BRCC respectively), and Distribution Control Centers (DCC's) around the country.

Until 2011, NCC and TRCC worked at full capacity and functionality. BRCC was in the process of changing the system to integrate the software and hardware base with NCC and TRCC. A project was launched to create ten new DCCs, the purpose of which was to introduce mid-level voltage and distribution network management tools. Since that time, Distribution Control Centers focused on five of ten control centers that were highly advanced and could be commissioned. Distribution Control Centers in Tripoli were put into operation, but work ceased in 2014. Software and hardware systems are over 10 years old and require urgent updates. In control centers, network data is only 20%. In the communication network, decisions and concerted actions must be taken to eliminate problems in the communication network and substations. The problems today are causing deterioration in the availability of data about the entire system for management engineers. Without data, it is not entirely possible to control the power system and are limitations for personnel with control. Of particular importance is the adoption of decisions and measures for the repair of fiber optic cables. Damage to the cables that transmit data in the network and between stations aggravates the system. The network is operating in a stressed state. To ensure its safety and stability, it is advisable to ensure the operation of reserves. GECOL should create a new backup control center outside the Tripoli region.

No system control and monitoring system is fully operational. And engineers are forced to solve performance problems in both systems.

Therefore, it is important to develop a new management system. Benghazi is facing the same difficulties. Only one third of the stations are visible in the control system, most of the data is missing. BRCC operators depend on the operators at each substation, so you need to ensure the restoration of the management functions of network distribution devices.

The roll-out of smart meters is a crucial modernization program which will bring major benefits also to enhance things in Libya. Smart meters are going to be subsequent generation of gas and electricity meters. they're going to offer a variety of intelligent functions and supply consumers with more accurate information, bringing an end to estimated billing. Consumers will have near real-time information on their energy consumption to assist them control and manage their energy use, economize and reduce emissions. Smart meters will facilitate demand side response (DSR) through variety of load control features supported by the smart metering system. DSR may give consumers other new options to assist them manage their electricity usage, allowing them to schedule usage for particular times or to vary it on demand to save lots of money. Widespread use of load control could also allow better and more cost effective balancing of supply and demand, reducing the prices related to predicted or unexpected peaks and helping to supply security of supply also as helping with the mixing of renewables. this might potentially reduce expenditure on building generation capacity and reinforcing the transmission and distribution networks, contributing to keeping energy bills as low as possible for households and businesses. it'll be the consumer’s choice whether or not they plan to use load control services, or time of use tariffs. Access to any consumption data necessary to enable these services are going to be governed by the smart metering Data Access and Privacy Framework.

From 2002 to 2017, smart metering systems were created in 28 European countries, including Switzerland and Norway; for 2017, there are 950 projects with an average investment of one project from 3.3 to 9 million euros, depending on the type of project and a total volume of 5.5 billion euros. There are serious differences between the EU countries in the number of projects and the general level and rate of investment. Only 15% of the projects were funded exclusively by private investment, which is especially large in the UK and Luxembourg, as well as in Belgium and Denmark. The share of private investment in other projects ranges from 40 to 60%, the rest is national funding (within one country) and European Union funding, which have a significant impact on the project.

16 Member States (Austria, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Luxemburg, Malta, Netherlands, Poland, Romania, Spain, Sweden and the UK[5]) will proceed with large-scale roll-out of smart meters by 2020 or earlier, or have already done so. In seven Member States (Belgium, the Czech Republic, Germany, Latvia, Lithuania, Portugal, and Slovakia), the CBAs for large-scale roll-out by 2020 were negative or inconclusive, but in Germany, Latvia and Slovakia smart metering was found to be economically justified for particular groups of customers. In 15 out of the 16 Member States that have decided to proceed with a large-scale roll-out, the distribution system operators (DSOs) are responsible for implementation and own the meters, so the operation is to be financed through network tariffs.

While divergence in key roll-out parameters calls for caution (Table 1 and Table 2), available data indicate that a smart metering system could cost on average €200 to €250 per customer. Cost per metering point ranges from under €100 (€77 in Malta, €94 in Italy) to €766 in the Czech Republic.

Table 1. Summary statistics — key smart metering roll-out parameters for electricity (based on Member States' long-term economic assessments) [5]

Indicator	Range of values	Average based on data from positively assessed cases
Discount rate	3.1 to 10%	5.7% + 1.8% (70%[10])
Lifetime	8 to 20 years	15 + 4 years (56%)
Energy saving	0 to 5%	3% + 1.3% (67%)
Peak load shifting	0.8 to 9.9%	-
Cost per metering point	€77 to €766	€223 + €143 (80%)
Benefit per metering point	€18 to €654	€309 + €170 (75%)
Consumer benefits (as % of total benefits)	0.6% to 81%	-

Source: European Commission

Table 2. Summary statistics — key smart metering roll-out parameters for gas (based on Member States' long-term economic assessments) [5]

Indicator	Range of values	Average based on data from positively assessed cases
Discount rate	3.1 to 10%	-
Lifetime	10 to 20 years	15 - 20 years (75 %)
Energy saving	0 to 7%	1.7% + 1% (55%)
Cost per metering point	€100 to €268	€200 + €55 (65%)
Benefit per metering point	€140 to €1000	€160 + €30 (80%)

Source: European Commission

Smart metering systems are expected to deliver an overall benefit per customer of €160 for gas and €309 for electricity along with assumed energy savings of 3%. The latter range from 0% in the Czech Republic to 5% in Greece and Malta. Of the countries that have completed roll-outs, Finland and Sweden have indicated energy savings of the order of 1-3%, but no data were available for Italy.

Conclusion. Thus, the instability and low security level in Libya negatively affect the implementation of projects on network management systems in the country's energy sector. After 2011 in Libya, there are practically no changes in the operation of control and monitoring systems, the old and new systems do not fulfill all functions. The control system does not prevent fuel control and control of the operation of all units, substations. Government agencies should implement smart metering systems that provide benefits in energy consumption. The experience of European countries shows positive results after the introduction of smart metering systems: benefit per metering point is 80%, energy saving is 55%.

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СЕКЦІЯ 2.
ЕНЕРГЕТИЧНИЙ МЕНЕДЖМЕНТ ТА ІНЖИНІРИНГ