The impact of small and medium-sized businesses in Cameroon on the development of the energy system

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Abstract. The development of Cameroon's power grid is linked to the electricity supply and demand market. In recent years, small and medium-sized businesses, due to their rapid development, begin to significantly affect the balance of consumption. According to the results of the analysis, the paper presents the classification of the share of electricity consumption by small and medium-sized enterprises by industry. The forecast of self-generation of electric energy by enterprises from biogas is estimated.

1 Introduction

Energy is an essential commodity, access to which is recognized as a right in Cameroon. It has become indispensable in everyday life and is an essential component for business competitiveness. As a result, there can be no economic development or social progress without the availability of energy and electricity. To effectively provide economic operators with the energy they need to produce, convert and distribute their end products in order to accelerate the country's economic development, Cameroon has a significant number of underutilized renewable energy sources such as the Hydro-Energy sources. Economically, disruptions in the supply of electricity seriously limit the development of enterprises, generate additional costs, affect their competitiveness, lead to bankruptcies, and in General, slow down the growth of national economy. According to studies, Cameroon produces over 2 million tons of waste wood per year, which is noticed during deforestation and woodworking. 80% of this waste wood could be used in thermoelectric power plants to produce millions of WATT of energy, which could be used to provide power and electricity in rural areas to promote production and transformation of agricultural products, mining and other artisanal products. The waste wood can also be recycled by methanization or granulation before being used as an electrical energy source. Small businesses experience economic difficulties because of their fragile structures and low revenues. The problem of electricity shortage faced by small and medium-sized enterprises could be solved by decentralizing electricity supply and biogas use: exploring the balance sheet structure and management of Cameroon's electricity sector; structural description of small and medium-sized businesses in Cameroon on electricity consumption; development of a methodology for the development of distributed energy using biogas for agricultural enterprises.

2 Some legal reminders of the electricity sector in Cameroon

In Cameroon laws and bills, especially energy-related are influenced by the political system. The country is characterized by a strong presidential regime, and decisions regarding the energy and electricity sectors are made by the President of the state. It is also important to note that the methods of rationalization of the parliamentary system have led to a change in the role of Parliament in the constitutional recognition of energy as a legislative activity. Similarly, the creation of a national vision and strategy for the development of energy and electricity as well as a parliamentary oversight of electrical activities is really lacking and less effective because of our poor political and democratic system.

The government of Cameroon has made electrical energy one of its priorities by increasing the number of jobs in the electrical energy sector and also diversifying the processes of energy production, transmission and distribution.

In accordance with decree No. 2012/501 of 7 November 2012 from the Ministry of water and energy, a Ministerial Department has been created to play a major and important role in the exploitation of energy resources in Cameroon. Article 1 provides that the Ministry of water resources and energy has the task to develop, implement and evaluate activities in the fields of production, transportation and distribution of energy and water.

Act No. 2011/022 of 14 December 2011, regulating the electricity sector in Cameroon, establishes the conditions for access to energy and the legal regime for its use.

Energy production can be decentralized by creating power plants in remote and rural areas to meet the electricity demand of consumers located far from the urban areas. The energy production in Cameroon is

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Table 1. Actors of the electricity sector in Cameroon.

Institutions	Principal function
MINEE (Ministry of Water Resources and Energy).	Design the implementation of Government policies in the fields of energy and water resources. Apply these policies and monitor their implementation
ARSEL (Electricity Sector Regulatory Agency).	It ensures the regulation, control and follows the activities of the operators of electricity, and the protection of consumer interests
AER (Rural Electrification Agency).	It is a Public Administrative Establishment with legal personality and financial autonomy. It promotes and develops rural electrification throughout the national territory
EDC (Electricity Development Corporation).	It ensures on behalf of the State, the management of public heritage in the electricity sector; study, prepare or carry out any infrastructure project in the electricity sector entrusted to it by the State; participate in the promotion and development of public and private investments in the electricity sector.
SONATREL (National Electricity Transport Company)	It is in charge of the management of the transport network and electricity flows
ENE0-Cameroon	It is the dealer that replaces the former AES SONEL since June 2014 which operates in the segments of production and distribution of electrical energy
KPDC (Kribi Power development Corporation)	Electric power generation
DPDC (Dibamba Power Development Corporation)	Electric power generation
HYDROMEKIN	Hydropower development.
Проект MEMVE'ele	Project and development of hydropower.
NHPC (Nachtigal Hydro Power Company).	Project and development of hydropower.

mainly carried out by Eneo-Cameroon. Responsivities for electricity management belong to the ACTIS group, which benefited from the renewal of the private concession on 23 may 2014 by taking shares in AES-SONEL a subsidiary of AES Corporation, which at the time controlled 51% of the capital under the concession signed on 17 July 2001 between the government of Cameroon and AES corporation group.

The law of 2011 defines the conditions for the establishment and operation of electric power facilities, the conditions for the location of electric power operators, the procedure for conducting the Affairs of electric power operators, the applicable legal regime. Energy transportation is the next process and consists of transmitting electrical energy at very high voltages of about (≥ 400 kW) for delivery. However, the President of the Republic, by decree No. 2015/454 of 8 October 2015, created SONATREL, which is a state-owned company with the mission of transporting and redistributing energy in the national territory.

Distribution and supply of electrical energy is the last process on the scheme commercialized energy. We are talking of the creation and operation of medium-and low-voltage electricity (230 V or 400 V) network for the population. Under the 2001 concession contract, this task is mainly carried out by Eneo.

3 A brief overview of Cameroon's energy system

Power generation capacity is estimated at 1786.7 MW as of May 2018, of which 57% is hydropower and 43% is thermal (gas 21 %, light fuel 10%, heavy fuel 13 %).

According to the world Bank, less than 14% of rural households and 57% of urban households are connected to the unified power supply system, and 9% of industrial consumers are officially connected to the power system and, consequently, most of them have their own sources of electricity or are not officially connected. Only 20% of the population has access to electricity on a permanent base.

The reasons for this imbalance is due to: a general mismatch between supply and demand. The irregular supply is caused by periods of droughts where water level is low (given the large share of hydroelectric power in generating capacity), the aging production and distribution infrastructure, the lack of investment due to restraints from the financial sector. The consequences are sometimes dramatic.

Cameroon's electricity consumption in 2015 was estimated to be 274 KWh, which is only 9% of the global average.

Table 2. Structure of installed capacity of power plants in Cameroon.

power plants	Installed capacity, MW
hydroelectric power station	785
thermoelectric power	624.5
Solar power plant	75
Own production	302
total	1786.7

4 The structural description of the enterprises of small and medium size businesses in Cameroon's electricity consumption

After the independence of African countries, many enterprises were set up by the state to begin the movement towards development and industrialization. During that period, African countries were pursuing a strategy of leadership in enterprise creation, thereby encouraging protectionist policies in their economies. With the economic crisis that began in the 1980s, African States as a whole failed in their policy of economic protectionism. Most established large enterprises are successively liquidated due to bankruptcy or simply privatized in the interests of foreign investors. The reasons for this failure are numerous: poor governance, political instability caused by the emergence of a multi-party system, the inability to adapt to markets and economic policies pursued by monetary institutions, in particular the IMF and the world Bank, and the sudden opening of markets to imports, aided by globalization. In the face of all the world's financial and economic crises, small and medium-sized enterprises (SMEs) appear to be the backbone of economic activity. In Cameroon, in accordance with the provisions of act No. 2010/001 of 13 April 2010 on the promotion of

SMEs, all economic entities known as SMEs include all enterprises employing no more than 100 people and whose turnover does not exceed 1 billion francs. Cameroon's economic structure consists of and dominates enterprises in this category. According to the latest General census of enterprises of the national Institute of statistics, there are 93,969 enterprises in Cameroon, of which about 99% are SMEs.

The growth strategy is based on the development of infrastructure and modernization of the production apparatus. Indeed, the competitiveness and development of Cameroonian enterprises require infrastructure, quality and sufficient electrical energy supply. This need is now imperative and an urgent element for growing an effective business development strategy. The government of Cameroon has embarked on an ambitious program to address various infrastructure needs. However, many problems remain unresolved. Currently, companies face inadequate infrastructure that is not adapted to economic realities. This increases their operating costs, limits their production and investment, and hinders their development and competitiveness. the state of the national infrastructure. As a result, power outages are the most frequently cited constraint for companies that consider them a major obstacle to their business development.

According to the International labour office in its report published in 2013 entitled. "Assessment of the business environment in Cameroon"; classified electricity losses and power outages with an estimate of about 77% as a limitation affecting the activities of enterprises in Cameroon.

Agricultural enterprises are characterized by low levels of electricity consumption. This will stabilize the electricity supply of this sector of the economy of small and medium-sized businesses. As a result, a large number of distributed energy facilities can be created. Difficulties in the development of SMEs can be of various kinds, with regard to energy, in the African continent companies are mostly affected by the irregularity in electricity supplies. African companies lack electricity for an average, 13% of their working

Table 3. Distribution of enterprises and institutions by activity sector (2016 statistics).

Sector of activity	Number of enterprises	percentage of total
Primary: (Agriculture, livestock, forestry, fishing)	347	0.4
Secondary: (food industry, other manufacturing enterprises, sales companies, Construction)	1088	12.9
Tertiary: (service sector)	13784	85.4
Not report	1347	1.4
Total	16 566	100
*The authors carried out an analysis of typical companies by sectors of activity, which allows them to be structured according to the level of electricity consumption.		

Table 4. Distribution of types of companies by level of power consumption.

Level	type of enterprise	proportion
High	Food industry, manufacturing industry	30%
Medium	Agriculture, animal husbandry	15%
low	the services sector, agriculture	10%

Fig. 1. Major constraints affecting business in Cameroon (Source: (international labour office), Cameroon business environment assessment, 2013).

hours. The world Bank estimated the average duration of power outages (load losses) at 90.9 days per year. This can be a significant challenge for businesses. In this part of the world, electricity is not only scarce but expensive.

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5 The development of distributed power generation using biogas for the agricultural enterprises

Biogas is a gas produced by hydrogen or methane fermentation of biomass. Methane decomposition of biomass occurs under the influence of three types of bacteria. In the food chain, subsequent bacteria feed on the products of the previous ones. The first type — hydrolytic bacteria, the second — acid — forming, the third-methane-forming. The production of biogas

involves not only the bacteria class of methanogens, and all three species. One of the varieties of biogas is hydrogen, where the end product of bacteria is not methane, but hydrogen.

Biogas is called "fresh" because its fermentation process is spontaneous (unlike natural gas) and occurs naturally in swamps. This process, also known as methanization, can also be caused artificially by digesters that treat sewage sludge from industrial or agricultural organic waste. From a chemical point of view, the composition of biogas consists mainly of methane (usually 50-70 %) and carbon dioxide (CO₂). It also indicates the presence of different amounts of water vapor and hydrogen sulfide. Biogas draws its energy from only one of these elements' methane. Compared to natural gas, which consists of methane, butane and propane, biogas is positioned as a Green alternative, a renewable version.

6 The process of biogas production

Methanization is a complex process. The principle is as follows: organic waste is stored in a cylindrical and sealed tank called a "digester" or "methanizer" in which it is exposed to microorganisms (bacteria) in the absence of oxygen. The biological reactions involved in methanization are complex, but in General there are three main stages;

- hydrolysis and acidogenesis: complex organic chains (proteins, lipids, polysaccharides) are converted

Fig. 2. Scheme of biogas production process.

into simpler compounds (fatty acids, peptides, amino acids);

- acetogenesis: acidogenesis products are converted into acetic acid;
- methanogenesis: acetic acid is converted to methane and carbon dioxide.

After methanization, the residual material (digestate) is retained.

There is also a physical process of methanation, which by gasification of dry biomass, usually wood, under the action of temperature leads to the formation of methane, synthesis gas and CO₂. This process, a primitive version of which formed the basis of gas generators used for automotive traction during world war II, is currently being developed to produce "green" methane.

7 Power supply systems for agricultural enterprises in Cameroon

The authors proposed 3 functional schemes for the decentralization of power supply system to agricultural enterprises of Cameroon, taking into account:

1) fully isolated system. A system in which a company independently supplies electrical energy; the principle is to produce methane through the process of converting waste into biogas from its operational

activities. Therefore, methane is used as a fuel for a group of electrogenic or small thermal power plants.

2) systems with flows of methane and electricity. The system is almost the same with the only difference that here the company has the opportunity to supply another company with methane or electricity.

3) a system of several agricultural enterprises interacting with external enterprises to collect their waste. In this case, the waste collection is carried out by a specialized company whose main activity will be the collection of organic waste, production of biogas, conversion to methane, which will either be sold as such or used as fuel in power plants to provide electricity (scheme 2).

These systems are solutions for firms operating in isolated geographical areas, as well as for those operating in areas with a high concentration of industry, for example: Douala Bassa; Yaoundé Nwan

In Cameroon, the use of biogas is not sufficiently popularized. Installations of the equipment are domestic and sometimes experimental. In some African countries, such as South Africa and Senegal, biogas is exploited on a large scale, in particular thanks to the construction of the Bronkhorstspuit biogas plant developed by Bio2Watt, it is the first industrial-scale biogas plant to be built in South Africa. The project was supported by the French development Agency (AFD) through SUNREF in partnership with IDC, its partner Bank. Electricity from

Fig. 3. Scheme of functioning of decentralized power supply system of agricultural enterprises of Cameroon.

cattle manure will provide renewable electricity for the BMW Rosslyn plant, eliminating hazardous emissions. Many projects have become feasible in the world thanks to the study of profitability of several experts, among which we can mention the group Solagro-wing-Erep for the study "examination of profitability of methane plants" in 2013. According to the results of their work, it

is possible to estimate the cost of energy production. Using this technique, the structure of "production costs" of energy was analyzed.

A total of 13 "typical cases" were analyzed, ranging from "on-farm" methane units to "collective territorial units". Table 5 shows some of the results obtained for five of the 3 tests under current conditions.

Table 5. Classification Results the author obtained Some economic data on three typical methanization plants (Club biogas, 2013).

Description		Small business farmers		Small collective of agricultural enterprises		Agricultural and industrial enterprises	
Incoming organic matter (ton / year)	Compost, residues	6450	total: 8150	8500	total:1600	4000	total: 28000
	Agricultural fluids	1000		6000		8000	
	Waste of agri-food industry	700		1500		16000	
Part des déchets		9%		9%		57%	
Methanogenic potential (m3 CH4 / T)		37		45		45	
The maximum content of dry matter in the fermentation		13%		12%		11%	
Electric power kW		144		351		648	
Electricity production kWh / year		1035		2603		4687	
Investments in thousands of euros	Biogas production	870	1480	1960	3230	2830	4630
	Energy conversion	610		1270		1800	
Unit investment (thousands of euros / kW)		10,3		9,2		7,1	
Expenses less annual	Supply of materials	5	103	38	256	-105	334
	Biogas production	40		35		95	
	Energy conversion	44		93		191	

It should be noted that the results of this examination were supported by France, which is one of the leading investors in the field of biogas in Africa.

8 The legal basis for the practical implementation of the scheme of functioning of the decentralized power supply system

The use of energy without concessions is regulated by other mechanisms such as licensing, Declaration and individuals and legal entities. Licensing is an administrative act that is prominent in the field of energy use. Individuals and legal entities supervise the independent production of energy, the sale of electricity at voltage levels, the import and export of electricity from Article 29 of Cameroonian law in the field of energy. The license is issued by the Minister responsible for water and energy after consultation with the electricity sector regulator, which receives the applications (Article 30. Cameroonian law in the field of energy). The permit is another administrative act that allows access to an energy holding company of interest for electrical installations and the operation of power lines. The permit is issued in case of non-provision of the state service in the field of electric power industry because of absence or insufficiency in the corresponding region of means of production, transportation and distribution of electric energy. Permission is granted only in the following cases:

- own production facilities with a capacity of more than 1 MW;
- establishment and operation of a power distribution system in the with the aim of providing, directly or indirectly, less power, or equal to 100 kW;
- creation of private power lines using or crossing the route.

An investor in the electricity sector may also be subject to a reporting regime. This requirement applies to the owner of the plant, where the power of the generating plant itself exceeds 100 kW and less than 1 MW. It must make a preliminary statement before starting in operation with the regulatory authority.

The regime of freedom applies to the energy operations, when the work is entirely in private ownership. Article 40, provides two conditions of freedom: Electrical Transmission lines should not over cross public highways, and drivers should drive at least ten meters away from the transition lines of electrical energy, telephone or Telegraph line.

9 Conclusions

The electricity sector is an important part of Cameroon's environmental problems, leaving small and medium-sized enterprises stranded. Decentralization of the electrical system through self-production is a solution in the sense that it provides practical, economic and even financial solutions. Some businesses will be able to grow

and expand in other sectors while addressing the power supply problem.

At the state level, the production of electricity from biogas is not only a solution to energy problems, but also a contribution to solving environmental problems, not forgetting the participation of SMEs in the economic growth of the country.

It can be concluded that there is a need to raise awareness of potential investors about technologies and methods of using renewable energy sources based on biogas.

Training and informing economic operators on the efficient use of waste and investment opportunities can stimulate an active change in Cameroon's energy balance and eliminate electricity shortages for small and medium-sized businesses.

References

1. Cameroon has developed a national energy action plan for poverty reduction (PANERP) to improve the quality of services provided by priority sectors in the fight against poverty (education, health, rural development, etc.). see PNUD (2014:162).
2. The sources of energy production are: biomass 53%, electricity 4.3%, petroleum products 42.7%, a total of 8,521 thousand tons (1 ton of oil equivalent) =11,628 kWh). RACE (2011: 26).
3. The transmission network consists of high voltage (HT), medium voltage (MT) and low voltage (BT) lines, i.e. 43,236 km according to, see MINEE report (2012).
4. Article 2, paragraph 1, of the Decree States that SONATREL " has for its purpose the transmission of electrical energy and the management of the transmission network on behalf of the state ". The Board of Directors by decision n° 005/2017 / CAO / SONATREL of 28.02.2017, held on 28 February, appointed members, and the state of Cameroon launches the process of transferring Eneo assets to SONATREL
5. Optimization of power supply of the circumpolar territories on the basis of renewable energy sources Elistratov, V., Konischev, M., Fedorov, M. 2017 2017 International Conference on Industrial Engineering, Applications and Manufacturing, ICIEAM 2017 – Proceedings.
6. Habachev L. D. (Хабачев Л.Д.) Techno-economic planning of development of electric power systems. Ed. Peter the Great St. Petersburg Polytechnic University, 2014.
7. Results and scientific and technical problems of the use of plant biomass and organic waste in energy [scientific article] VM Borovkov, LV Zysin, BB Sergeev proceedings of the Russian Academy of Sciences: Energy, 13-23.
8. Maskova Yu. R., Novikova O. V. Analysis of the use of renewable energy sources in the infrastructure of the metropolis. In the collection: Week of science Peter the Great St. Petersburg Polytechnic University materials of the scientific

- conference with international participation. 2017 Pp. 209-212.
 9. Energy and Exergy Analysis of Clinker Cooler in the Cement Industry Taweel, T.J.B., Sokolova, E., Sergeev, V., Solovev, D.B. 2018 IOP Conference Series: Materials Science and Engineering.
 10. Assessment of the environmental efficiency of the life cycles of energy facilities based on renewable energy sources Sidorenko, G.I., Mikhhev, P.Yu. 2017 Ecology and Industry of Russia.
 11. Problems of assessment of efficiency of investment projects in energy, Grebchenko I. S., grushkin, A. N., Novikova O. V. In the collection: Week of science science Peter the Great St. Petersburg Polytechnic University Materials of the scientific conference with international participation. Institute of industrial management, Economics and trade. 2018. Pp. 572-574.
 12. The Application of Adapted Materials and Technologies to Create Energy Systems Based on Renewable Energy Sources under Harsh Climatic Conditions Elistratov, V.V., Panfilov, A.A., Konyshev, M.A., Denisov, R.S. 2018 Applied Solar Energy/
 13. Biomass pyrolysis and gasification comprehensive modeling for effective power generation at combined cycle power plant A Fedyukhin, I Sultanguzin, A Gyul'Maliev, V Sergeev Eurasian Chemico-Technological Journal 19 (3), 245-253
 14. A comprehensive approach to planning the development of the energy complex of the metropolis (on the example of St. Petersburg) / T. M. Bugaeva, L. D. Habachev / / Scientific and technical Bulletin of the science Peter the Great St. Petersburg Polytechnic University. Ser.: Economics. - 2013. - ISSN 1994-2354
 15. Nyemb, Bekoume Suzanne. Realization of the potential of renewable energy sources in the development of energy strategy of Cameroon [Electronic resource]: master's thesis: 38.04.02 / V. S. Nyemb; Peter the Great St. Petersburg Polytechnic University, Institute of industrial management, Economics and trade; sci. hands. O. V. Novikova. URL: <http://elib.spbstu.ru/dl/2/v16-753.pdf/>
 16. Small and medium-sized enterprises in Cameroon : opportunities and challenges, Prudence Missoka, December 2013 URL:https://www.foretiafoundation.org/wp-content/uploads/2013/12/PME-au-Cameroun_Missoka_New1.pdf
 17. Biogas[Wikipedia]URL:<https://ru.Wikipédia.org/wiki/%D0%91%D0%B8%D0%BE%D0%B3%D0%B0%D0%B7>
 18. Assessment of the business environment in Cameroon 2013 / Mario Berrios; International labour Office. - Geneva: ILO, 2013 ISBN 9789222279586; 978922279593 (web in PDF format); 978922279609 (CD-ROM) business development / economic conditions / social conditions / political aspect / environment / Cameroon 03.04.5.
- URL:https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/ifp_seed/documents/publication/wcms_230287.pdf.
19. Turning waste into energy: South Africa's first biogas plant URL: <https://www.sunref.org/projet/south-africas-first-industrial-biogas-plant-leads-way-for-waste-to-energy-developments/>.
 20. Cost-Effectiveness Study of methanization plants-2013: the biogas club ATEE URL: <http://atee.fr/biogaz/etude-rentabilit%C3%A9-des-installations-de-m%C3%A9thanisation-2013>