Cameroon: Small hydro power and framework conditions

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1. Introduction

Cameroon offers a wealth of hydropower opportunities and possesses the fourth largest hydro-potential in Africa. Although 722 MW of this has already been developed, 20 gigawatts of additional hydropower still remain untapped, with an economically feasible potential of 115 TWh. The small hydro potential is estimated to be more than 970 MW, but only one small hydro plant is under operation to date. The electricity sector remains dominated by large hydro generation plants and long-distance transmission networks over the country, mainly radial networks.

Within the auspices of Hydropower solutions for developing and emerging countries (HYPOSO), this paper assesses the status of small hydro and the framework conditions in Cameroon and its development since the commissioning of the very first hydropower plant in the country. Knowing the small hydro framework conditions of the country will contribute to addressing the electricity issues the country and the region are both facing. We have also presented the different stages of hydropower development in general in the country, with a special focus on small hydro, including the current trends and the future outlook.

2. Cameroon and Hydropower

In the African continent, the Republic of Cameroon is situated between 2° and 12° latitude north and the meridians 8° and 16° East, from the Atlantic Ocean to Lake Chad. The country has an area of 475,000 km2 and a population of 22.8M [1]. In terms of energy, access to modern electric services is still low in Cameroon, with a per capita consumption estimated in 2019 at 280 kWh. In grid-connected areas, poor reliability of the power system is causing voltage drops and frequent power cuts, which are exacerbated with the dry season as the supply system is hydro-dominant. Facing this, the various ministries involved in electricity energy programs are making important efforts towards electrification in order to yield positive results. The electrification rate in Cameroon is still low, up to 90% in cities against 20% in rural areas for a national average of 68% [2]. To increase the electrification rate, Cameroon has since 1998 drafted policies aimed at improving the private sector in the energy market. To date, the participation of private investors is still very low, while maintaining the balance between supply and demand of electricity remains a real challenge. Improving the state of the generation and the grid will be key to reduce losses, as well as interconnecting the existing isolated grids. Despite the low rate of electrification, the hydropower sector is the one that mobilises the most investments in Cameroon. The outcome of these investments should potentially be very important in the coming years because the country has a great hydro-potential and has just liberalized the electricity sector. To date, with the increase in energy needs that follows economic growth, the gap between electricity demand and generation continues to widen to around 3% per year. Therefore, thermal power plants are still used not only for meeting the daily peak-power demand, but also part of the intermediate demand as shown in Fig. 1.

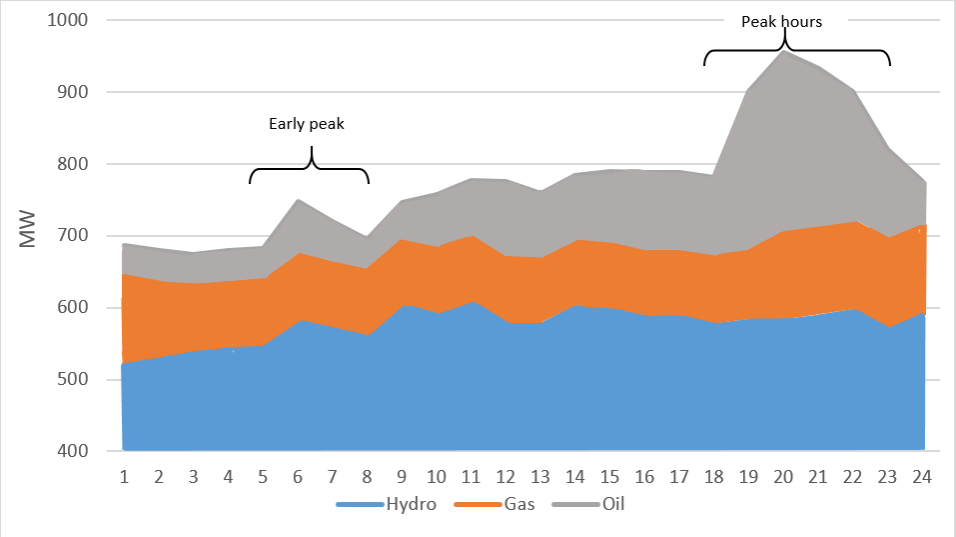

Fig. 1 : Average daily load profile by energy sources of the month of March 2018 on the Southern Interconnected Grid (Source: ENEO, 2018).

The daily load profile shown in the Fig. 1 is that of the southern interconnected grid (SIG), the main electricity transmission and distribution grid in Cameroon. The heavy use of fossil fuels as emergency solution is highlighted. The energy supply remains insufficient with a significant impact on economic development [3]. It is estimated that energy sector bottlenecks and power shortages cost Africa some 2-3% of GDP annually [4]. However, in Cameroon, the 30-year delay in energy plants development is resulting in the continuing mismatch between supply and demand illustrated in Fig. 2.

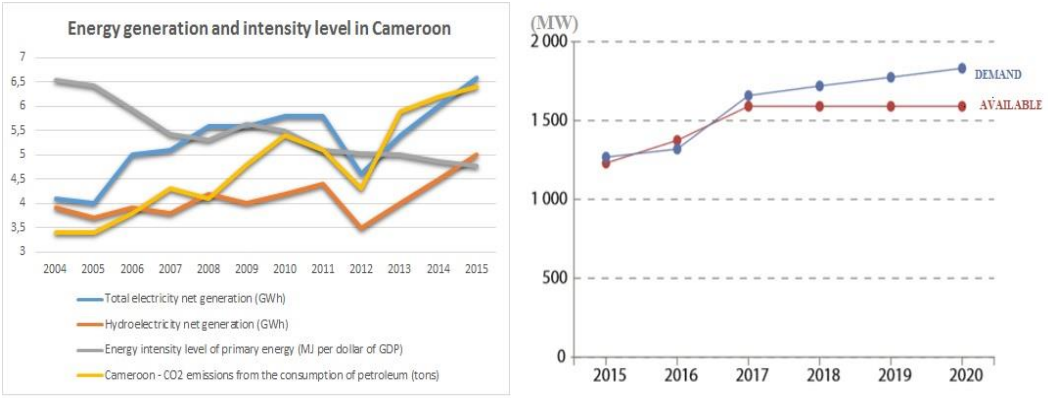

Fig. 2: Energy generation and intensity level in (derive from [5]) and gap between the demand forecast and offer in Cameroon [6].

As stated in the introduction, Cameroon has a huge hydropower potential, estimated at about 20 GW and considered the second largest in Central Africa behind the Democratic Republic of Congo. The hydro resource in Cameroon is supported by the tropical rainforest that covers almost the southern part of the country. This forest which covers the entire basin of the Congo River is the second largest tropical forest in the world after the Amazon. It is also home to a mosaic of ecosystems that regulate the local climate and the rich hydrographic network that underpins the hydroelectric potential of the entire sub-region. In Cameroon, the Sanaga river and Congo basins together account for nearly 80% of the hydropower potential. In particular, the Sanaga river, which is the longest river in Cameroon (918 km) has a pluriannual flow which can reach 2000 m^3/s. The other rivers have a pluriannual flow of less than 500 m^3/s, with water flowing to the Atlantic Ocean and Lake Chad.

The development of hydropower sector was sustained from early 1950's till 1988 for large plants. The country hence developed three large hydro plants, namely Edea (280 MW), Song Loulou (384 MW) and Lagdo (72 MW). It is recently in 2017 that one new large hydropower plant (Memve'Ele 205 MW) reached the commissioning stage, meaning that hydropower development in Cameroon experienced a long desert crossing of

30 years. The impact of this situation is very harmful to the country as depicted in Fig. 3. This leaded to the increase of the gap in power shortage in the country, but also for the expertise in the country in the sector.

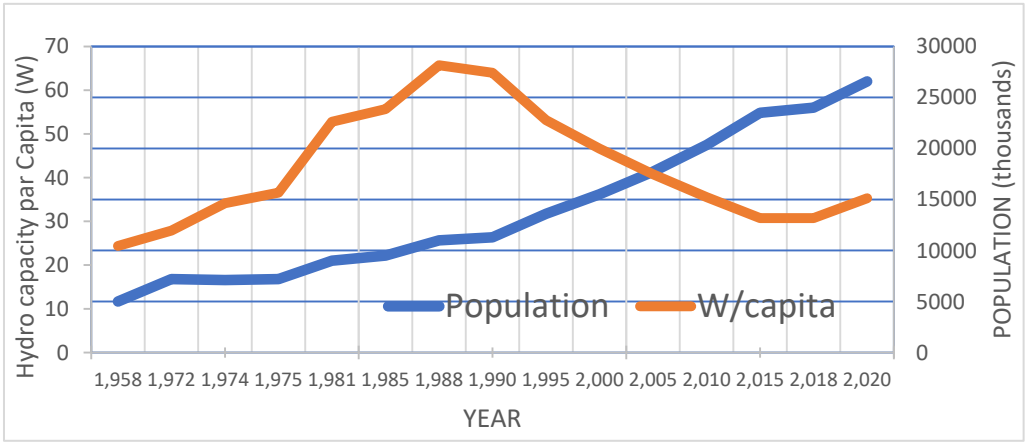

Fig. 3 : Evolution of installed Hydro capacity per capita in Cameroon.

The above figure shows that we had 24 W per capita in the early 1960's, and a peak was 65 W per capita in 1988, but it is now 35 in 2020, meaning the same level as 1975. This means that the development of hydropower sector is weak. Just to better understand the gap, the installed capacity per capita for Germany is 753 W. A few years ago, things started moving again and HYPOSO project comes at the right moment.

In terms of small hydropower (defined in Cameroon as hydropower plants with installed capacity lower than 10 MW) the potential in Cameroon has been subject of successive assessments and is currently estimated at 970 MW by UNIDO & ICSHP [7]. The geospatial distribution of this potential makes small hydro a good alternative for electrification of many off-grid regions or to overcome the obstacle of weak national grid. However, the first small-scale hydropower projects were subsequently abandoned. It is only a few years ago that a new dynamic in this direction was seriously initiated with initiatives such as the Hydropower Solution (HYPOSO) project, which seems to come at the right time with the Cameroonian government's determination to develop the country's hydropower potential. It is one aim of HYPOSO to assess and map for the best sites for small hydro in all target countries, so for Cameroon this would mean preparing the field for future development. The establishment of a high-quality databank as foreseen in HYPOSO is urgently needed in Cameroon. Furthermore, HYPOSO will also assess the framework conditions, and will, together with the financial experts, analyse the possibilities for better private investment stability.

3. Small Hydropower development

3.1. Before 1988

The exploitation of large hydropower plants of more than 15 MW started in early 1950s in former French Cameroon. But earlier in 1929, the Western Cameroon under British administration had taken the lead with the commissioning of the 750 kW small hydropower plant in Malale [8]. This dynamic has continued with the commissioning of other micro/small-hydro projects across the country, such as Foumban (128 kW), Dschang (260 kW), Bekili (1 MW), Yoke (3.3 MW [9] commissioned in 1961). Thereafter, all these power stations were abandoned in the 1980's because of the development of the two large hydro plants at Edea and Song Loulou and the extension of the southern interconnected grid, which reached number of localities where these plants were running. As result, the utility no longer found any interest in operating the existing micro/small-power plants, which have fallen into ruin. On some of the sites of these abandoned power plants, some civil engineering constructions and electromechanical equipment are still visible to date as depicted in figures 4 to 7.

Fig. 4 Site of Bekili abandoned small hydro plant.

Fig. 5 Site of Yoke abandoned small hydro plant.

Fig. 6 Site of Malale abandoned small hydro plant.

Fig. 7 Dam and intake of Dschang abandoned. microhydro plant

3.2. After 1988: Ongoing development of small hydro plants

Since 1988, the development of hydropower in Cameroon has remained stagnant, the government resorting to thermal power stations to alleviate the glaring energy deficit that occurred in early 2000s. The year 2017 opens up a new era in the Cameroon hydropower sector, with the partial commissioning (80 MW from the planned 205 MW) of the Memve'Ele power plant, and later the start of construction work on Nachtigal (420 MW). In addition, small-scale hydro initiatives have begun to take shape, precisely with the following either commissioned or under construction plants.

3.2.1. Mekin small hydro plant

The Mekin hydropower project is located on the Dja River in southern Cameroon. It was intended to be connected to Cameroon’s Eastern Interconnected Grid in 2017, but due to some technical issues, its complete commissioning just occurred. The power station is installed at the toe of the dam, with a catchment of 10,800 km2 and a normal impounded water level of 613 m. The total installed capacity is 15 MW, with three 5 MW units, and the power generation capacity is expected to be 70 GWh.

Fig. 8 Mekin small hydro plant just completed.

3.2.2. Ngassona 210 falls project

The Ngassona 210 falls (ERD RUMPI project) project site is located on the Uve River, a tributary of the Meme River in southwest Cameroon, around 30 km from the town of Kumba. The construction is still ongoing and it is co-funded by the 2007 Energy Facility from the partnership between European Union and the government of Cameroon [10]. It is part of the Electricity for Rural Development in the Rumpi area (ERD RUMPI) project and is aimed at electrifying approximately one hundred localities. It should also be grid connected. The installed capacity is 2.9 MW, with a height of 44 m and a designed flow of between 7.4 m^3/s and 9 m^3/s.

Fig. 9 : *Ngassona Falls (RUMPI) small hydro plant under construction.*

3.2.3. Mbakaou carrier (1.4 MW)

IED INVEST, as project developer and Independent Power Producer (IPP), is constructing the small hydroelectric power plant in Mbakaou Carrière (1.4 MW, 11.2 GWh/year) in Cameroon, in partnership with the IED Group in France, the Ministry of Energy of Cameroon (MINEE), the Rural Electrification Agency, ARSEL (regulation), ENEO (utility), with financial support from the European Union, the French Fund for the World

Environment and the pre-financing of the bank BGFI. The work also includes 40 km of medium and low voltage network. The Mbakaou hydro power plant commissioning is scheduled for early 2021 [11].

3.2.4. Batie small hydro plant

The rural electrification Agency just launched a call for tender for the construction of a 1.6 MW small hydro plant in Batie (a village in the West region of Cameroon), co-funded by EU and the Government of Cameroon.

4. Policy, legal, institutional and financial frameworks

Since 1998, the power sector in Cameroon has been experiencing major institutional changes, such as the privatisation of the national vertical integrated infrastructure, the liberalisation of the supply side and the set-up of a state-owned transmission system operator (TSO). In 2011, a new electricity law was passed to improve sector legislation in the following issues: the management of surplus energy from independent producers (i.e. rules for feeding electricity into the grid), the creation of a transmission system operator (TSO), the creation of an agency for renewable energy (still to come), the renewable energy purchase obligation, and the management of water storage for electricity production (including a planned water royalty). Additional legislation for full implementation of these issues is yet to be introduced. However, this law should guarantee third party access to the transmission grid. The grid code is also available. The obligation to purchase electricity from renewable energy sources (in the case of hydropower, plants with an installed capacity up to 5 MW) is guaranteed.

From the situation described above, it appears that Cameroon offers an interesting case study. Institutional changes were aimed at having more private sector investments and developing electricity generation. Technically, the demand is not satisfied even though Cameroon has a huge hydropower potential, huge biomass reserves and regions with high solar radiation. Following the vision of emergence in 2035, perceptible efforts are being made by the government in the direction of considerably improving the efficiency of the power system, especially production capacity. A few years ago the goal was to expand installed capacity to 2 GW by 2020 with an investment of US$ 6 billion, but this target has not been met. However, the additional installed generation capacity is projected between 4.8 GW and 8.3 GW by 2035, with the ultimate goal to achieve 100% electricity access in urban areas at least. Moreover, as part of its clean development mechanism (established in 1997 in the Kyoto Protocol and entered into force in 2005), Cameroon is committed to increase the share of renewable in the energy mix to 25%, with hydro having a key role to hold in this vision.

The development of hydro in Cameroon also affected by the institutional reforms over the last decades. Indeed the economic crisis that followed the fall of the Berlin Wall forced sub-Saharan countries to introduce structural reforms in the governance of development infrastructure. The power sector in Cameroon followed this dynamic privatisation and deregulation that were parts of a broader set of reforms in the 1990s. The objective was to boost the performance of these economic entities, which in the end was not the case: Old problems were not resolved (e.g., having new investments, increasing efficiency and access rates), while a raft of new problems emerged, such as complex institutional governance frameworks with overlapping roles of the actors.

The technical potential of small hydropower is hence underassessed and underdeveloped in Cameroon. This underdevelopment is due to several factors, the most important one being linked to finance and poor local expertise. Financing can mostly be found for micro hydro from NGOs and for large scale projects from international major donors and Official Development Assistance. Overall, there is a lack of financial schemes for small hydropower which actually is an opportunity for new business models. But the main challenge remains the financing for feasibilities studies to bring projects to bankability. This gap should be covered to boost the sector by making available bankable projects to investment funds. In addition, unlike large hydro, the small hydro potential is still to be seriously assessed as stated above.

5. Sustainable small hydro in Cameroon

In Cameroon, electrification needs to be accelerated in order to ensure the economic development. Considering sustainability requirements, power generation should be based on renewable energy sources as much as possible in order to mitigate climate change effects. Outside the major cities, access to electricity is not at all guaranteed, due to the heavy dependence of these localities on unreliable grid extensions (some with wooden poles) or sometimes thermal power plants. Small-scale hydropower has however the potential to be the basis for sustainable development for many of Cameroon's rural populations. In this view, HYPOSO proposal is to push for sustainable small hydro development in Cameroon based on a holistic and integral approach. An integrated development means that the natural and socio-economic environment is taken into account. The plants should contribute to protect the natural environment and mitigate the risks of climate change. The local appropriation of

a project is key in order to insure sustainability through local ownership. Local key stakeholders are hence associated to the action. Existing technologies should be adapted to the geographical and climatic conditions, but also to the capabilities and knowledge of local operators. Local contribution for the conception, construction, operation and maintenance have to be considered and adequate capacity building trainings put in place, especially for the design and the O&M. In this framework and among other actions, feasibility studies will be done for three sites selected together with local stakeholders, including site visit and local training.

Finally, small hydropower development should be built on a national electricity master plan. Cameroon is for example currently establishing such a master plan. This is urgently needed as numerous Memorandums of Understanding (MoU) are signed by the Government and private companies for the construction of new hydropower plants with poor coordination between the main actors of the electricity sector. So far, very few projects with a MoU have advanced to a stage of securing a PPA. All projects are behind schedule. Companies involved in small hydro projects development include: GREEN WATT**,** BAMUSSO CITY COUNCIL, Fabien ASSIGANA & Associates International Consulting, FOKOUÉ CITY COUNCIL, BERKELEY ENERGY, ADEID**,** SOLARHYDROWATT, BILL, HYDROMEKIN, ALPHA TECHNOLOGY, KEDJOM POWER PROJECT, MINEE/AER/UNIDO, AER/Plan VER, AER/ERD RUMPI, AER/Projet FED. Many of these companies have signed a MoU with the government. The Electricity Sector Regulatory Agency (*ARSEL*) has granted 16 titles since the liberalization of the sector. Among them, we have 4 titles for hydropower, namely: ENEO (utility 721 MW), IED Invest (IPP 1.4 MW), MBUROCADASS (less than 100 kW), NACHTIGAL (420 MW). 10 Titles are for thermal plants, 1 tiltle for solar plant and 1 title for transport. Titles for Mekin (15 MW) and Memve'Ele (205 MW) are yet to come.

6. Conclusion

In this paper, an assessment of the electricity sector and small hydropower development in Cameroon has been made and opportunities identified for a sustainable development of small hydro in the country. This includes assessing the small hydro potential, closing the financing gap for feasibility studies that lead to bankable projects; encourage local ownership, municipalities and industrial and private developers to ensure sustainability; put in place capacity building; develop hybrid grids with hydro complementary to other renewable energy sources. Finally, Cameroon still need a serious assessment of its small hydro potential, together with feasibility studies and a relevant master plan. HYPOSO is working on some of many key aspects including the assessment of the small hydro potential. By promoting the development of small hydro in Cameroon, HYPOSO is giving a big push to the fight against poverty and is sustaining the climate change target. In addition, the development of small hydro can create local jobs while ensuring electricity access, securing electricity supply and improving grid efficiency when connected to the transmission grid.

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