



Utilization of Electricity Consumer Co-operatives in Reduction of Banks' Energy Cost in Owerri, Nigeria

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Abstract: In many developing countries such as Nigeria, power supply is still very epileptic. This has resulted in the flight of top class industries. The only surviving firms are banks, hotels, gas stations and their likes. This paper therefore presents a scheme where cluster of banks located within the bank road in Owerri Metropolis at the Eastern part of Nigeria can generator-pool. It explains the concept involved, presents the justification of the scheme, and classifies various loads obtainable in these firms into levels based on priority, wherein the must run loads are assigned to level one; and the less critical loads follow consecutively. The requisite criteria for the firms' co-operation to ensure stability of the arrangement are also presented. Finally, a clearly worked out sequence of operation of the scheme is presented with an implementation flowchart. The full modelling and other technical components of the scheme are on-going.

Keywords: Electricity Consumer Co-operatives, Energy Cost Minimization, Load Prioritization, Optimal Resource Allocation, Sequence of Operation

1. Introduction

The growth in technology and economic development of any nation is highly dependent on her effectiveness in resource harnessing and utilization. Electricity occupies a top position in the energy hierarchy. Its uses are innumerable; in homes, industries, agriculture, and transport. This is because it is convenient form of energy; can be generated centrally in bulk and transmitted economically over a long distance and almost pollution free at the consumer level [1]. Generation, transmission and distribution are the three basic elements of power system and form an interconnected network for delivering electrical energy, from the generating station through the high voltage transmission lines to the demand centres. This interconnection of generation, transmission and distribution is known as grid system.

Electricity just like every other energy resources is subject to efficient management. In these days of deregulated electricity markets much attention has been paid to management and optimization of energy consumption in the

grid. This is because to practically meet all the energy demand from the end users, the grid system must be designed such that; it satisfies the peak power demand at all times [2]. This will result in high cost of energy generation and end-users paying higher for the energy. Presently, the Nigerian power sector is marked with low generating capacity compared to the installed capacity. Recently, the Transmission Company of Nigeria (TCN) reported the drop in power generation from 3,959 megawatts on January 4, 2017 to 2,662 megawatts on January 22, 2017 [3], while the present estimated consumption capacity is over 10,000 megawatts. This has denied many Nigerian citizens access to uninterrupted power supply resulting to the flight of top class industries. The power sector in Nigeria has been seen by many analysts as the major obstacle preventing the country's faster economic development. In 2015 World Bank ranked Nigeria 170 of 189 in the world, with a distance to frontier (DTF) or ease of doing business (EDB) score of 47.33%, against Singapore's 88.27% and Eritrea's 33.16% [4]. However in the 2016 version of the report, Nigeria climbed

done step to 169th position, but sheds about 3% point to clock 44.69% [5]. It was clearly highlighted in the report that Nigeria's major problem in doing businesses is poor access to electricity. Most of the time, when even connected to the electricity providers, Nigeria business biggest reported problem is the dwindling power supply. About 83% of top class firm managers interviewed considered electricity outage to be a serious problem – more than any other business constraints [4]. It was further reported that business firms of all sizes banks inclusive, in different states of Nigeria report average power outages of eight hours every day [4].

In most metropolitan cities, firms (e.g. banks) with closely related lines of business are located within same area to form a cluster. Due to the epileptic power supply in Nigeria and other developing countries, and these firms have resorted to using own generators to provide power for most time of their operation period. One noticeable fact is that the capacities of these generators are far more than the actual load demand. Due to some strict government regulations and harsh economic conditions, the firms are looking for ways to minimize operational cost. The authors believe these firms will positive respond to a scheme where their power generations can be arranged in such a way that each will supply its neighbours on specific days or hours from its generator while the other neighbour takes care of the other days or hours of operation.

2. Concept of Electricity Consumer Co-operatives

2.1. Electricity Consumer Cooperatives

Cooperative: “A cooperative is an independent association of people who voluntarily come together in order to face their common social and cultural needs and their economic aspirations by means of a jointly owned and democratically controlled company [6]. Electricity Consumer Cooperative is a collection of electricity consumers within a cluster or outside a cluster, who agree to participate in the cooperative scheme to reduce their energy cost and consumption.

Cooperative businesses and societies have been formed and operated to meet the needs of its members. Cooperative leverages the buying power of members to purchase products or services. Members of cooperative businesses pay lower or stabilized prices for products and services because of the purchasing power of the cooperative [7].

2.2. Co-operative Generators

It has been discussed earlier that as a result of incessant epileptic supply from the utility companies here in Nigeria, the consumers which are the commercial banks in this case, generate their own electricity using diesel generators which are most of the times over-rated, to serve as their backup power supply. The electricity consumer co-operatives generators now comprises of these individual generators of each bank which are now scheduled to cooperatively serve the overall loads in days or in hours (generator-pooling).

Running these generators as a cooperative i.e. generator pooling will reduce the costs and energy waste resulting from running individual generators and form a more reliable alternative source to the utility supply.

2.3. Demand Management Mechanism

Demand management mechanism is one of the notable functions in grid system that enables end-users (the Consumers) to modify their demand and costs for energy through various methods such as financial incentives and education [8]. Demand management mechanism may be classified into two main categories Demand Response (DR) and Demand Side Management (DSM). Demand response methods are reactive (short term) solutions used for modification of the consumers' energy demand. Demand Side Management is a proactive approach aimed at making consumers' energy use efficient in the long term. In most literatures, demand response and demand-side-management are often used as synonymous [9]. Generally, the performance of demand side management programs largely depends on the amount of controllable loads [10].

Demand-Side Management (DSM) is often deployed to motivate the end-users to utilize less energy during the peak hours or to shift the time of their major energy usage to off-peak hours to render regulatory service to the grid. This helps to reduce system overload instead of load shedding or bringing online reserved generators, which are expensive.

Demand Side Management (DSM) also describes various measures that may be applied at the customer side for energy efficiency or conservation purposes [8]. Demand management mechanisms can also be designed to control the electric resource of individual users. However, this approach may have some undesirable effects [11]. In fact, consumers are characterized by a natural diversity in terms of appliance usage. This feature is fully exploited by the power system to optimize its efficiency in generating and distributing energy. In the case of systems for consumers' payment reduction, for example, all users would shift their loads to periods of the day where the electricity prices are low. Unfortunately, this would determine large peaks of demand during such low-cost periods and, possibly, service interruptions.

To contain these unwanted side-effects, management mechanisms can be designed to control the community of users, thus managing their resources based on a system-wide perspective. This paper introduces the concept of electricity consumer co-operatives as a form of community-based power pooling using demand side management mechanism to reduce the individual electricity cost of each bank through participation in electricity consumer cooperatives.

3. Justification

Experience has shown that there is energy waste which is always associated with individual firm generation and most of the time, this waste goes unnoticed. For instance; a typical bank in Nigeria whose load demand is 10kW will often buy 13kW to 15kW generator capacity or larger to serve as

alternative to the epileptic utility supply. When this generator is running there will be at least excess capacity of 3kW which could have been used to service the loads of other banks within. Let's consider a sample of about ten banks located within a cluster with individual generators capacity of 14kW with load demand of 10kW, therefore, the capacity waste will amount to $10 \times (14-10) = 40\text{kW}$, which is enough to comfortably serve another extra four banks. Moreover, the world is aggressively going into clean energy generation and the advocacy of clean energy is high because of its low carbon footprint. Hence, communities, individuals or firms who embark on electricity consumer cooperatives not only become self-sufficient, but they also reduce their carbon footprint [12, 13]. If these banks decide to come together and generator-pool, forming cooperatives of electricity consumer, the following benefits will be achieved:

- (1) The cost per bank of having stable electricity supply will be drastically reduced.
- (2) The number of redundant generators to bring online in the case of emergency will be increased, therefore making the cooperative more robust and reliable.
- (3) The environmental carbon footprint for the generators is reduced, same with their environmental noise pollution.
- (4) General improvement in local grid performance

4. Load Classification

Electrical load refer to the total energy consumed by a system, circuit, component, device or equipment that is connected to the source of electric power. Generally, electrical load can be classified into various categories accord to various factors such as: nature – resistive, capacitive, inductive or combinational loads; according to load function – lighting, heating, etc. [1]. In this paper the loads of the banks are classified based on its functions and are assigned to different load levels based on priority. Loads on load level 1 are served first, followed by levels 2, 3, 4 and 5 successively based on availability of These are the electrical and electronic devices found in the banks: Lighting systems, computer systems, scanners, servers, network devices, ATM machines, security systems – security doors and CCTV, Air conditioners, industrial fans and pumping machine. Load level 1 includes; lighting systems, servers, network devices and computer systems, level 2: ATM machines, level 3: cameras and security systems, level 4: Air conditioners and industrial fans and load level 5: pumping machines and other non-frequently electrical equipment.

This is may be achieved using Cummins special power command load controller DMC8000. The DMC8000 is a system level controller designed to interface directly with Cummins power generation power-command paralleled generator set. Its load control feature will be quite applicable in this concept. DMC8000's Load control feature, also known as "Load Add /Shed", is the process of staging load on to the system after power to the loads has been interrupted. This staging of load ensures that power quality is maintained and generators do not become overloaded during

the application of load to the generators [14].

5. Criteria for Co-operative Power Pooling

The socioeconomic purpose of every cooperative society is to improve the quality of life of its members, in this paper electricity consumer cooperatives integrate its member into the economic and lesser cost cooperative generator-pool scheme, and advances their electric services towards best-practices standards [15]. In fulfilling the above goals some criteria have to be met by the collaborating banks in forming electricity consumer cooperatives:

- i. Generator considerations – the individual generator of the participant must be of a certain minimum rating capacity, it should also be from some known selected manufacturers and makes. The generator must have not been in operation for a particular number of years, say like 10 years.
- ii. Individual load conditions -the wiring system in each of the banks must follow the standard wiring regulations; it must be properly earthed and be of standard wire sizes. In this paper only institutions with similar load schedule were considered like the banks. The participant must maintain a certain minimum and maximum load demand to avoid overshoot in the system load profile.
- iii. For cooperative to be sustainable, certain policies must be obeyed. Cooperatives are sustainable enterprises that work for the sustainable development of their local communities through policies approved by their members [16]. Other social regulating conditions must be met by each participant.

6. Process Implementation

6.1. Sequence of Operation

This paper proposes step by step algorithm of forming electricity consumer cooperative through generator-pooling arrangement.

Step 1: finding the need for cooperation; - certain electricity consumers within a cluster and of similar load profile with individual backup generators are selected to form a cooperative and generator-pool. Each of the participating firm are called co-operator.

Step 2: Collect Load/Generator Data; - i. Individual bank generator data: capacity of the generator, voltage profile and number of years in operation, ii. Individual bank load data: the capacity of their electrical equipment e.g. lighting systems, computers, air conditioners, and other bank accessories that consume electricity, iii. The total cooperative load data; - which is the sum total of the individual loads.

Step 3: classification of loads; - loads each participating bank are prioritized based on the needs.

Step 4: set collaboration requirement; - from the above steps, the collaboration requirement is set using the available information from the data collected. If requirement is met, then cooperative can be formed.

Step 5: generators allocation; - some selected individual

generators are allocated to serve the cooperative for certain days or hours of the week.

6.2. Flowchart

The flowchart of generator-pooling by banks in electricity consumer cooperative in figure 1 below, is the diagrammatic

description of the step by step approach of realising the electricity consumer cooperative in reduction of the co-operators energy generation cost; from the selection of the participant to the serving of their loads. The flow chart is as contained in Figure 1 below.

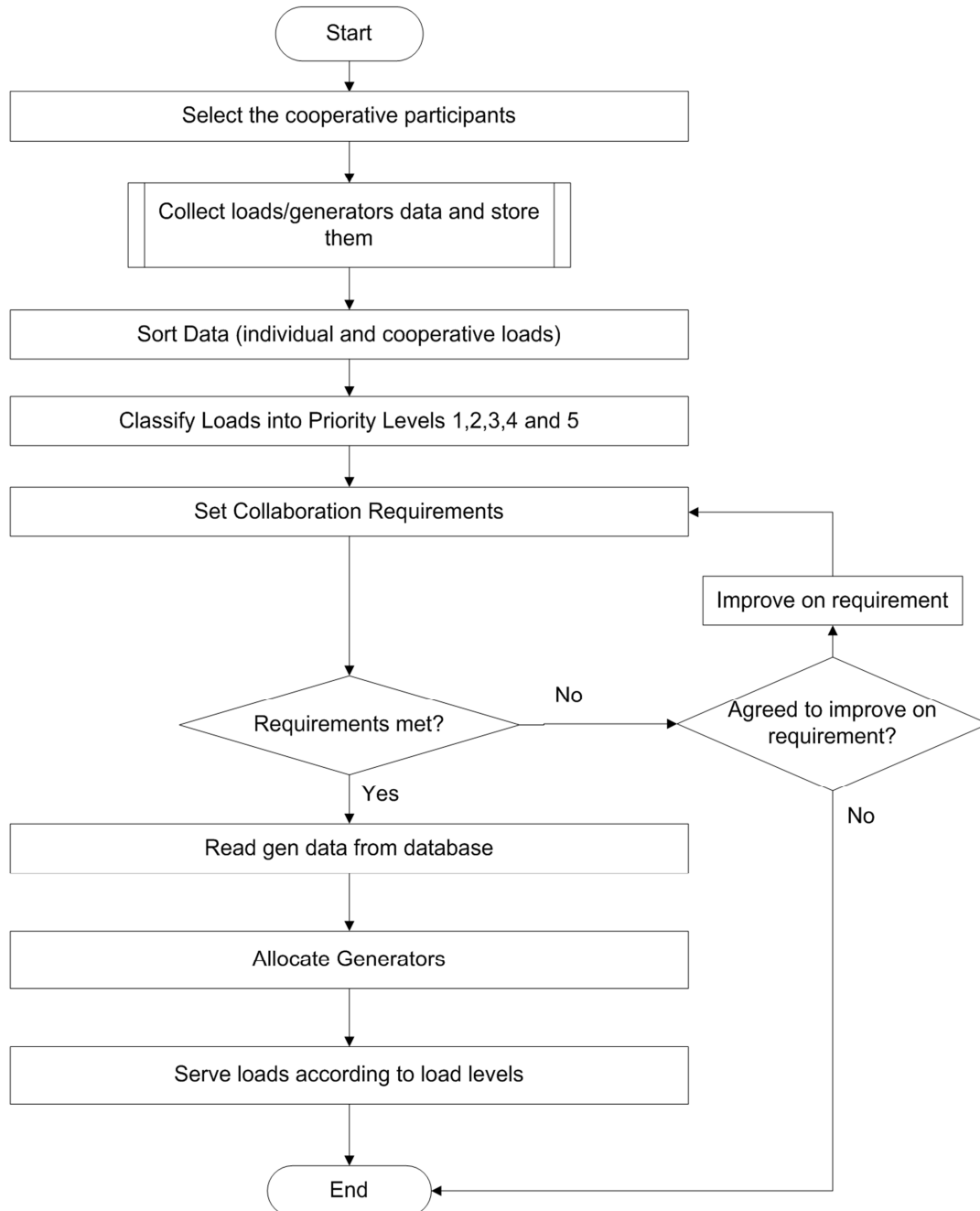


Figure 1. Flowchart of generator-pooling by banks in electricity consumer cooperative.

7. Conclusion

This paper has successfully presented a feasible electricity consumer cooperative concept to reduce energy generation cost of clustered banks and other firms of similar operations in Owerri municipal, particularly at bank road where more

than ten banks are closely located. It detailed the concept and applicability of electricity consumer cooperative, justifications, consumer load classification with five different priority levels, sequence of operation and flowchart. This work is still on-going and in the nearest future the full simulations and engineering analysis will be published.

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