# Potential Issues and Problems in Using DSM Programs to Address the Electric Power Demand Crisis in Ghana (West Africa)

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The structure of the electric utility industry in most developing countries differs markedly from that in the U.S. While those in most developing countries are state owned and controlled, most of the electric utilities in the U.S. are privately owned but publicly regulated. Therefore it is difficult to transfer technological developments from the U.S. to these countries successfully. While some technologies cannot be transferred at all, most of those that are transferable need to be modified to suit operating conditions in the country.

This paper analyzes these issues using a case study of one West African country, Ghana. The structure and problems of the electric utility industry in Ghana are described, as are mechanisms that have influenced the growth of utility DSM programs in the U.S. and how they can be modified and applied in Ghana. It further reviews, based on personal interviews with 22 policy makers in the electric power industry in Ghana, current government policies and institutional structures and mechanisms that act as barriers within the industry. The paper also suggests changes that need to be made to promote electric energy end-use efficiency. Finally, the paper provides suggestions as to how the experience of promoting DSM programs in the U.S. can be modified and implemented in Ghana to stimulate both the utility industry as well as consumers to use DSM programs to address the problem of increasing electric energy demand.

## Introduction

Electric utilities in the U.S. are increasingly relying on DSM programs or improvements in end-use efficiency as a means to address load growth requirements (Energy Information Administration 1991). Current expenditures on these programs are around $2 billion, representing an average of about one percent of all electric utilities total retail revenue. The incentives for these high investments have been provided through regulatory policy changes developed and implemented by state regulatory agencies. These changes were prompted by the need to reduce the cost of energy services (Geller and Walmet 1992).

The changes in electric utility regulatory policies were necessary because of the unique structure of the industry and the heavy reliance of its operations on public regulations. Most of the utilities in the U.S. are privately owned. They are however, publicly regulated by state and federal regulatory commissions (Phillips 1993). On the other hand, utilities in most developing countries, for example Ghana (West Africa), are state owned, few in number and not tightly regulated by the government departments under which they operate. In some cases, the utilities are so powerful that they virtually dictate to the agencies that are supposed to control them. In most situations, tariff setting is the only function strictly regulated by the government because of its political implications. These implications range from severe financial impact on low income people to making the government unpopular.

Due to a lack of research into better operational procedures and an absence of collaboration with other electric utilities outside the country, most utilities in developing countries lack access to modern operational technologies which would greatly improve their efficiency. The operational environment of electric utilities in most developing countries are very different from those in the U.S. Therefore, it is difficult to directly transfer mechanisms that have been used to stimulate utility adoption of DSM programs to these countries without any marked problems. However, because of the relationship between development and energy, electric utilities have an important role to play in the building of infrastructure and the struggle to raise the living standards in developing countries. The availability of efficient electric energy sources also serves

as an incentive to attract foreign investors to inject much needed foreign capital into the economies of developing countries.

This paper draws on personal interviews with policy-makers in the utility industry conducted by the author between December 1993 and January 1994 in Ghana. The policymakers were chosen from each of the departments in Ghana's two electric utilities and the Department of Power within the Ministry of Energy and Mines. Using a semi-structured interview format, the interviewing time ranged from 45 minutes to three hours with most of them lasting more than one and a half hours. All the interviews were tape recorded. For security reasons none of the interviewees names are used in the paper.

## Structure of the Electric Utility Industry in Ghana

Ghana is a country located on the west coast of Africa with a population of approximately 15 million people within an area of 92,100 square miles. The present form of government is a democratic one modelled after the British parliamentary system. There are two electric utility organizations, both state-owned: The generating company, Volta River Authority (VRA) and the distributing company, Electricity Corporation of Ghana (ECG). Currently the Volta hydroelectric dam is the only source of electric energy in the country. There are two dams on the Volta River and together they generate approximately 4,800 GWh/year even though they have an estimated capacity of 6,100 GWh/year. Their peak generating capacity is 1,012MW (Volta River Authority 1993). The hydroelectric dams are operated and managed by VRA. ECG, on the other hand is only concerned with the distribution of electric power to residential, commercial and most of the industrial consumers in Ghana. ECG makes its profits through the sale of electric power to these consumers. There are no natural gas distribution pipelines in the country.

VRA and ECG are independently controlled by their respective board of directors. Both utilities are supposed to be controlled by the Department of Power in the Ministry of Energy and Mines. However, the only regulatory function the ministry exercises is in the area of tariff control. VRA generates the electric power from the dam and sells it in bulk in the local currency to ECG, the mining industry and a few local energy intensive companies. VRA also sells power to three countries (Togo, Benin and Ivory Coast) and a foreign company operating in Ghana, Volta Aluminum Company (VALCO). These customers, unlike ECG, pay VRA in U.S. dollars. About 70 percent of the total kWh sales of VRA is to customers who pay in U.S. currency.

According to the agreement between VRA and ECG, ECG buys power from VRA at $0.01 per kWh even though the cost to VRA is $0.03. VRA on the other hand sells power to VALCO, Togo, Benin and Ivory Coast at $0.05 per kWh. VRA therefore sells at a loss to ECG but makes a profit on its sale to VALCO, Togo, Benin and Ivory coast.

## Problems of the Electric Utility Industry in Ghana

Currently, the electric utility industry is facing severe supply problems. The annual growth rate of electric energy demand has been approximately 15 percent over the past five years. Demand for electric power has far outstripped supply. This problem is manifested by the supply of poor quality electric energy due to severe transformer overloads. This has led to brownouts and blackouts in most areas. In certain cases, new customers have to wait for several weeks or months before they can have power connected to their facilities.

VRA is unable to meet the electric energy demands of both its local and foreign markets due to insufficient power generation. Therefore, VRA is unable to supply all the power needs of its foreign markets as promised in its various agreements. With ECG, the supply problem and its inability to meet peak load requirements of its customers were not only due to insufficient power from VRA but also to the poor quality and small size of transformers and sub-station equipment.

According to industry analysts, the current increase in electric energy requirements can be accounted for by four main factors. These are (1) the sudden release of a suppressed load, (2) rapid expansion of the major cities, (3) increased industrial consumption due to the government's structural adjustment program and (4) the government electrification program. These factors are further explained below.

ECG recently received a loan from the World Bank to improve its distribution system and general operations. The loan was used to replace most of their transformers with higher capacity ones and the building of more transmission sub-stations in rapidly developing areas. Most of the high capacity transformers were put in areas with severe overload problems. A couple of weeks after the installations took place, a sudden increase in electric power demand in those areas occurred. The transformers were overloaded again in less than a month leading to brownouts and blackouts. ECG analysts identified the cause as the sudden increase in the use of electrical appliances as a result of increased customer confidence in their operations. Most consumers had the appliances for some

time but were not using them because of the poor quality of electric power. The utility staff referred to this as the release of a "suppressed load."

Ghana has recently adopted a free market economy and this has resulted in an increase in the level of business activity in the country. In addition, there has been an increase in the level and type of goods available on the open market. This has led to a sudden increase in housing developments in the major cities. Since these houses are designed to take advantage of modern technology, most of them are dependent on electricity for their energy requirements. Therefore, there is a corresponding increase in electric energy demand which has contributed to an overall increase in electric energy demand.

With the aid of the World Bank and other multi-national agencies, Ghana is undertaking a structural adjustment program. This program emphasizes the development of industries to produce goods both for export and local markets. Existing industries are encouraged through credit facilities to expand their operations. The result is an increase in the productivity of these industries. This has led to an increase in industrial electric energy consumption.

Finally, the increased demand for electric energy can be attributed to the government's electrification program. Until 1990, only 40 percent of the total population of the country had access to electric energy from the grid even though government resources were used to develop the electric power infrastructure. To rectify this equity issue, the government has decided to connect 90 percent of the population to the national grid by 2010. Arrangements have already been made to obtain loans to develop the distribution infrastructure needed to meet this goal. The project is being carried out on a self-help basis and is moving at a rapid pace. As more and more people get connected to the grid, the total electric energy demand of the country also increases, contributing to the present state of electric energy demand.

## Solutions as Perceived by Electric Power Industry Policy Makers

In my interviews with 22 policy makers within VRA, ECG and the Ministry of Energy and Mines, almost all felt that the current 15 percent annual growth rate of electric power demand is too high. They believe that this growth can only be addressed through an increase in generating capacity.

A description of their planning processes shows an emphasis on supply-side resources with virtually no mention of the need to modify electric energy demand load. One of the interviewees directly connected with the promotion of DSM programs, made a comment to the effect that he has not as yet heard of a successful DSM program. He believes it takes time to realize the results of DSM programs. He thinks that Ghana is in such a critical situation that it has no choice but to only consider supply-side sources to meet the increasing electric energy demand growth. He also believes that the price premium of energy efficient appliances, given the average pay levels, discourages consumers from investing in these appliances. In his opinion, the success of DSM programs in Ghana is very questionable.

VRA is currently pursuing a limited energy efficiency program as a fulfillment of a condition required by a World Bank loan agreement for the building of a new thermal plant. Even though a department has been created and charged with the responsibility of looking at the feasibility of implementing DSM programs in Ghana, not much has been done to date. The scope of their activities is limited to commercial and industrial lighting audits instead of developing and planning a comprehensive survey to identify the true potential for DSM programs in the country. In fact, they are not implementing efficiency programs as a means to address the electric energy demand problem, but rather they are doing something simply to satisfy World Bank officials.

Although Ghana is an importer of crude oil, a thermal plant which will utilize oil initially and later natural gas if available is being built by VRA. It is scheduled to be commissioned in 1996. This is intended to be a short term solution to the electric energy demand problems of the country. VRA has already completed a feasibility study of other hydroelectric generating sites on the Volta and other major rivers with the help of Acres International, a consulting firm. The scope of that study" was limited to identifying possible sites of hydroelectric generation and did not address ways to arrest the increasing electric power demand problem as a whole.

## Analysis of the Electric Power Demand Problem

Even though most of the personnel in responsible positions within the utility industry do not feel DSM programs can help address the demand problem in the country, a strong case can be made that they can make a significant difference. A look at the electric appliance market in the country reveals the abundance of inefficient appliances for sale. The most common lighting fixture on the market is the incandescent bulb. Fluorescent tubes or bulbs are known to be more energy efficient than incandescent bulbs as they use about 20 percent of the energy but provide the same level of lighting (Oldenburg 1990). Most of the

electrical appliances are also less efficient models that have been on the market for at least ten years. Even though recent, more efficient models are available in stores, their prices are over 4000 percent higher compared to the old models. Of the 40 random homes I visited, about 90 percent had mostly incandescent lighting fixtures with very few if any fluorescent fixtures. Since most of the newly developed areas depend on this same market to satisfy their electric appliance needs, there is the likelihood that the increase in electric energy demand due to the new developments is mostly a result of the use of energy inefficient appliances. If this is true, then the level of electric energy demand of the new developments could be less than the current level if modern energy efficient appliances are used.

According to electric utility industry officials, the suppressed load that was released after the improvement in the services of ECG was mainly due to the use of appliantes that have been stored by their owners for sometime. These appliances were not used because of the poor quality of the power supplied. The quality of electric power has been poor in most of these areas for the past five to ten years. It is likely that most of the appliances being used now are old energy inefficient models.

Based on these observations, there is the likelihood that a greater proportion of the 15 percent annual growth in electric energy demand may be due to the use of appliances which are energy inefficient. However, this can only be confirmed through a comprehensive survey to determine the extent of the potential for energy savings within the country.

## Barriers to DSM Implementation in Ghana

Although no survey has been done to quantify the potential that exist in Ghana for DSM programs, observations like those described above and VRA's ability to sell in a foreign market where there is growing demand make implementation of DSM programs logical. However, this is not happening.

There are several barriers to DSM program implementation. These barriers make it extremely difficult to plan, design and effectively implement and monitor the programs. They include the structure of the industry, corporate culture of the utility industry, the tariff structure, lack of qualified personnel to plan and implement DSM programs, lack of appropriate information for both utility officials and consumers about energy efficiency programs and appliances, the lack of an incentive on the part of consumers to adopt energy efficiency programs, and the lack of any government policies that encourage or promote energy use efficiency.

The structure of the utility industry in Ghana makes it difficult to implement DSM programs without a prior agreement between the two utilities on some form of compensation. VRA stands to gain from the savings that will accrue from the programs since they can sell the power on the foreign market and make more money. ECG, on the other hand stands to lose since implementation of DSM programs without any tariff increases will result in a relative decrease in its revenue. However, the structure of the industry makes it difficult for VRA to implement any programs without the help of ECG. VRA does not have direct access to the local consumers. ECG on the other hand is in direct contact with the consumers and more suitably positioned to implement DSM programs. For ECG to implement DSM programs, there is a need for VRA to compensate them not only for managing the programs but also for the lost revenue that will result from implementing DSM programs.

Most of the policy makers in the electric utility industry in Ghana, especially VRA, have an educational background in engineering. Their professional development took place in an environment that has always promoted increasing electric energy consumption and generation as a means to show the efficiency and profitability of VRA. Therefore, a corporate culture has been established that believes in increasing generating capacity as the only effective means to address load growth problems. Their planning activities have therefore always concentrated on increasing generating capacity through construction of more generating stations. Implementing DSM programs will mean a change in the entire planning process and adoption of new planning strategies like Integrated Resource Planning (IRP). Implementation will also involve changes in certain structures of the industry to allow for the promotion and growth of DSM programs. The policy makers are comfortable and believe in the present corporate culture to such an extent that they are literally resistant to change. This resistance has in part been caused by the lack of the industry's analysts to provide convincing arguments to push policy makers in the direction of IRP and DSM programs.

The tariff structure in the country does not encourage consumers to adopt energy efficient measures. The residential tariff is low and has a block structure. The first 100 kWh has a fixed rate. Subsequent rates increase with increased consumption. However, about 25 percent of residential consumers use less than 100 kWh. For such consumers, there is no incentive to conserve since they will not receive the savings that accrue from their conservation practices. Conservation to this customer class is very expensive since they will have to absorb all the costs without any benefits.

There is also the lack of appropriately trained personnel to plan and implement DSM programs. Since DSM is new in Ghana, the utility industry does not have enough professionals who are knowledgeable and have experience in designing and implementing DSM programs. In order for DSM programs to be successful there needs to be good planning skills so that the program can be targeted to specific needs of the industry and the customers. The lack of appropriately qualified personnel makes it difficult for enough substantial evidence to be generated to convince policy makers of the benefits of DSM programs. This has resulted in the lack of interest in DSM programs on the part of policy makers in the industry.

Generally, both the utility industry personnel and the consumers lack access to appropriate information on energy efficiency programs and appliances. In most cases, the industry personnel lack access to information on DSM programs that can help them plan and implement programs. None of the foreign journals or newsletters that concentrate on DSM programs are available to personnel within the industry. Most of the people interviewed did not even know of any magazines or journals that provide information on DSM programs in other places in the world. Consumers also lacked access to information. My conversation with a couple of people including highly educated friends gave the impression that most people generally do not consider the energy consumption of an electrical appliance during the purchasing process. Energy efficiency is simply not one of the features that many consumers look for.

Due to the absence of utility programs to promote consumer participation in energy conservation and the block rate structure of tariffs, consumers lack incentives that encourage them to conserve electric energy or adopt energy efficiency practices. In situations where electric energy usage is less than 100 kWh a month (eg. for lighting purposes only), the tariff structure makes it economically unwise to invest in the modem energy efficient appliances that, in most cases, have very high upfront cost.

The lack of any government policy on the energy consumption standards of local and imported electrical appliances also contributes to the prevalence of the use of energy inefficient appliances. One can bring into the country any type of electrical equipment whether it is energy efficient or not. Even though a board has been established now to set standards for electrical equipment that is used in the country, they have not as yet produced any recommendations that can be made into policy. This is partly due to the lack of the government's interest in that sector of the economy. There are no government policies that directly encourage or put pressure on the electric utility industry to invest in energy efficiency programs. This has resulted in the industry "doing business as usual" even though the potential exists to improve upon electric energy end-use efficiency.

## DSM Experience in the U.S. and How Ghana Can Benefit From It

Electric utilities in the U.S are increasingly relying on programs that influence electric energy consumption patterns as a means of addressing load growth problems. These programs have the advantage of reducing customer's electric energy demand (Prete et al. 1992). In 1989, DSM programs reduced potential peak demand by 20,100MW and saved a total of 16,300GWh of electric energy. In 1990, total electric energy saved due to DSM programs by 363 utilities was 18,700GWh with a reduction in potential peak demand of 23,300MW. The total energy saved by the DSM programs of 439 utilities in 1991 was 23,300GWh with a reduction in potential peak load of 26,700MW (Hirst 1993).

These benefits have been made possible through regulatory policy changes in the electric utility industry which have removed traditional disincentives that previously inhibited the promotion of DSM programs. These changes have resulted in utilities being compensated for lost revenue due to DSM implementation, the treatment of DSM investments just like supply-side investments, and the provision of adequate incentives that encourage utility investment in DSM programs (Moskovitz 1992). Not only were the changes designed to provide incentives, some were specifically designed to decouple utility profits from sales (Marnay and Comnes 1992). These changes were necessary because of the tight public regulatory nature of the industry. Thus, utility DSM programs in the U.S. have primarily been promoted through changes in regulatory policies and mechanisms.

Such regulatory policies or mechanisms can not be directly applied in Ghana to promote DSM programs due to the difference in the structure of the utility industry. However, some of the mechanisms can be modified and implemented to encourage VRA and ECG to implement DSM programs.

To address the problem of lost revenue that will be experienced by ECG if it implements DSM programs, VRA (since they stand to benefit by selling the saved power at a higher price in the foreign market) can compensate ECG using a mechanism similar to the way utilities are compensated for lost revenues in the U.S. Instead of increasing the tariff to take care of the revenue shortfall, VRA could share some of the profits that will be made when the saved power is sold at a higher price on the foreign market. In this case, both utilities come out

winners. On the other hand should demand within the country grow to absorb this savings, then there would not be the need for VRA to compensate ECG since the saved electric power could easily be sold to new consumers in the local market. There would not be any appreciable loss in revenues.

The capitalization of DSM investments used in the U.S. as a means of enticing utility investment in DSM programs will not be necessary in Ghana. This is because there is a natural incentive for VRA to reduce its local power supply (since it is sold at a loss) and increase its foreign power supply (since that is sold at a profit). Thus, any reduction in the level of local power consumption is to the advantage of VRA since it can make more money in the foreign market where the demand for more electric power already exists.

Regulatory mechanisms like the provision of share holder incentives have been used to influence utility policy makers in the U.S. They enable electric utilities to implement DSM programs without experiencing any losses in share value of their companies. This will not be necessary in Ghana. This is because the utilities are state owned and they are not in business to maximize their profits. They are only expected to operate at a profit so that they can finance their own growth to meet the electric power demands of the country. Therefore, the natural incentive provided by the structure of the markets accessible to VRA should be enough incentive to entice the utilities to invest in DSM programs.

## Suggestions on Ways to Address Barriers to DSM Implementation in Ghana

Even though there are several barriers that inhibit the implementation of DSM programs in Ghana, the potential still exists for the country to benefit from such programs. The country depends on the electric utility industry both to stimulate economic growth and to earn foreign exchange. Therefore, action taken to improve the efficiency of the industry will maximize the benefits it provides.

Currently, the sale of electric power is the fourth highest foreign currency earner for the country. The market provides natural incentives for VRA to encourage a reduction in local electric energy consumption and to increase foreign sales. However, VRA can only take advantage of this incentive if it is able to reduce local electric power demand through ECG. This will be to the benefit of VRA but not ECG. Institutional structures can, therefore, be established between the two organizations so that VRA and ECG can both benefit from reduced local power sales and a corresponding increase in sales in the foreign market.

There is also the need for some restructuring of the electric utility industry as a whole so as to re-orient their objectives in such a way that does not limit cooperation only to the selling of power but also to the general welfare of the whole industry. These changes should involve the promotion of more cooperative activities through agreements between the utilities and the execution of joint projects to improve the operating efficiency of the whole industry. Departments should be jointly established within each of the utilities to handle end-use energy efficiency programs. These departments should be jointly charged with identifying the potential for end-use energy efficiency programs that exist in the country and design mechanisms and procedures that the utilities can use to tap into this potential. The functions of the departments should include promoting end-use efficiency at all levels of the economy, planning, designing, implementing as well as evaluating the success of DSM programs.

There is the need for a change in the corporate culture within the industry. There is a need to bring in more policy analysts and to promote changes in the entire planning process of the industry with special emphasis on the planning process of the generating company, VRA. Operational structures should be changed to promote the use of Integrated Resource Planning (IRP) mechanisms and eliminate the culture that promotes the reliance on only supply-side resources to meet increasing electric energy demands. This will ensure that electric energy services are provided at the least cost and that the planning process takes into consideration all available resources (both supply- and demand-side) that can be used.

There is the need for changes in the current tariff structure. The new structure should be such that it discourages unnecessary incremental inefficient power use and instead encourages conservation. The block rate, even if it is to be maintained, should be set at a lower level just above the level used by most consumers. The tariff structure should provide incentives for conservation and efficient use in such a way that consumers can benefit directly from reducing their power consumption.

Both utilities should make efforts to attract and hire professionals who are familiar with and have adequate working experience with utility DSM programs. These professionals should be well trained in planning, custom designing, implementation and the evaluation of DSM programs. They should be skillful enough to identify the specific needs of the industry and custom design appropriate measures that will effectively address those needs. Present employees could also be sent to places where DSM programs have advanced (U.S.) in order to

be trained. This would equip them with the necessary skills that will enable them to provide effective services to the industry.

Efforts should be made to acquire as much literature or information such as journals or publications on DSM programs for the use of both utility officials and consumers. This would keep utility officials well informed of both new developments and the general trend in activities of other electric utility industries. It would also enable them to share their experiences with people who are interested in the development of the industry.

Information programs should be created for consumers. This would help consumers better understand the concept of energy use efficiency and conservation as well as the benefits that they stand to gain from implementation of these measures. The utility industry should also establish some medium of communication to aid in the exchange of ideas and information between the industry and its customers. This would provide a forum for the sharing of ideas to benefit both parties. They should provide information on new programs, the performance of existing programs, changes in consumption patterns due to the programs, energy efficient electrical appliances and where they can be purchased, and customer testimonies on the benefits they have gained from participating in DSM programs.

To stimulate consumer interest and make them aware of the benefits of improving end-use efficiency, utilities should provide some form of incentive. Incentives can help consumers with the up-front cost of acquiring energy efficient appliances. The utilities can even establish a mechanism to provide financing to consumers for the purchase of energy efficient appliances and lease them out to the customers.

Finally, there should be government participation and promotion of energy efficiency through policy enactments. The government can establish policies that will encourage not only the utilities to invest in DSM programs but also consumers to actively adopt energy efficiency practices. Since Ghana imports most of the electrical appliances that are used in the country, the government can set standards and enact policies that will prevent the importation of energy inefficient appliances. The government can set the pace by requiring all its offices and buildings to participate in utility DSM programs or use energy efficient fixtures and appliances.

## Conclusion

Even though there are barriers to the implementation of DSM programs in Ghana, DSM programs can effectively contribute to the solution of the electric energy problems. The development of an appropriate institutional structure that promotes efficiency in electric energy use will serve as a good starting point. With effective planning and good implementation strategies, programs can be designed to overcome all the barriers.

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