The Zanzibar Blackout  
- a case study on consequences from an electricity power crisis

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Abstract
Availability of electricity in developing countries is by no doubt a tool for development. However, the development cannot be sustainable if necessary back-up facilities are not in place.

This is argued and demonstrated in this paper, using the last 10 years of development in Zanzibar as a case. In Zanzibar, the demand for electricity has grown fast and the amount of billed electricity increased with more than 50% from year 2003 to year 2007. The highest increase can be seen in the medium sized industries sector, where the tourism sector consisted of a large proportion.

With increased dependency of electricity, the fundament for a more vulnerable society is also created. This is illustrated by the economic and social depression that hit Zanzibar during the breakdowns of the power system that occurred for one month in 2008 and for almost three months in 2009-2010. As there where no public back-up generation facility in Zanzibar, this resulted in a total electrical blackout and the citizens had to rely on private electricity generation. In the paper some examples of the consequences are given.
Background and Introduction

Access to basic, clean energy services is assessed as essential for sustainable development and poverty eradication, and can provide major benefits in the areas of economy, health, literacy and equity. Accelerating the introduction of basic, clean energy services has during the last decades been seen as a key strategy for promoting sustainable development. The 1987 World Commission on Environment and Development (Bruntland), and its frequently quoted definition of sustainability as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, concerns the distribution of resources between and among generations. Applied directly on the energy sector it can be expressed as “sustainable energy development will require electricity services that are reliable, available and affordable for all, on a sustainable basis, world-wide” (Johansson & Goldemberg, 2002). Additional definitions have for instance been made by OECD (2006) where the concept is discussed in the three dimensions of economic, environmental and social sustainability, indicating that the social aspects of electrification is winning ground.

As policy makers have realised this vital role that electricity plays, interventions to address the energy needs of the bulk of the population have been taken. Using Africa as an example, different forms of power sector reforms are currently on-going or have been initiated in over 20 countries on the continent, mainly as a result of the electricity sectors poor performance. However, in spite of these vigorous measures, many of the weaknesses still remains, leaving the continents electricity clients exposed for and dependent on unreliable services.

Taking three month of electricity blackout in Zanzibar as a case, the aim of this paper is to illustrate how deficient maintenance combined with lack of back-up facilities can negatively influence the development of a society, from an economic but also a social perspective.

Following this introduction, the paper continues with a brief review on existing literature on effects of unreliable power supply. The third section describes the general development in Zanzibar, and the development of electricity uses from 2003 to 2010. It also gives a background to the circumstances that lead to the three month long power black-out. The fourth section analyse and discuss the effect of the blackout; its influence on values, and characteristics of actions taken by the electricity clients. The final section concludes and presents recommendations.

Existing literature on effects of unreliable power supply

The amount of scientific publications on electricity failure is substantial, in particular after the wakening-up call by the large-scale power outages that occurred in California, USA (Amin, 2003). Although substantial, the literature is mainly focused on technical aspects of system failure (see for instance Rosas-Casals & Solé, 2010 and Kjellström et al. 1992). Additional papers focus on regulatory issues (Bortoni and Pezzaglia, 2005), while others again mention lack of communication as one of the reasons for system failure (Roy et al., 2004). Social aspects of an unreliable power supply are brought up by for instance Zhong &.Sun, 2010, stating that; “electric power system is fundamental for social production and daily life”. The writers advocate an increased need of emergency management in the electricity sector.

In Africa, Steinbuks & Foster (2009), points out most of the power companies as “unreliable sources of supply, inefficient users of generating capacity, deficient in maintenance, erratic in the procurement of spare parts, and unable to staunch losses in transmission and distribution”.

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In response to this unreliability of Africa's national electric power utilities, self-generated electricity has become an increasingly important source of power. Many end-users of electricity, from households to large enterprises, are now generating their own power by operating small to medium-sized plants (Karekezi and Kimani, 2002), mainly as back-up facilities to power supply provided by the national utility. These are mainly diesel generators. Apart from the negative environmental impact from diesel, additional studies illustrate how costly these market adjustments are. Self-generated electricity is generally more expensive than electricity from the public grid which limits its potential as a permanent substitute for unreliable public supply. Because it adds to the capital and operating costs of doing business, in-house generation affects the range of investment available to budding entrepreneurs, raises production costs, and lowers the competitiveness of local products (Steinbuks & Foster, 2009). The fact that unreliable power supply results in welfare losses is well demonstrated in the literature, and during recent years also some empirical research on the economic costs of power outages and own-generation in developing countries have been presented (see Steinbuks & Foster, 2009 and related references given).

In this paper, the consequences of an electricity outage are discussed, based on the events from the Zanzibar electricity blackout in 2009-2010.

Characteristics of Zanzibar

Zanzibar consists of two main islands; Unguja and Pemba, which are located off the eastern coast of Tanzania. The population is estimated to 1,200,000 inhabitants of whom 40% are living in Zanzibar town. The population growth rate is estimated to 3.1% annually, which exerts an increasing pressure on the island’s energy supply and forest resources (RGZ, 2010A).

The majority of the people of Zanzibar are depending on farming for their living, and almost half of the population was in 2004/2005 living below the basic needs poverty line, with women together with children being the most disadvantaged members of the society. The data from the 2009/2010 Household Budget Survey shows that this situation has only marginally improved.

However, the economy of Zanzibar is growing and the Zanzibar Gross Domestic Growth (GDP) was estimated to 6.7% in 2009 (RGZ, 2010A). Business Development in Zanzibar has passed through many stages. Starting from 1984, liberal opened market economies based on private ownership have been advocated as means to pursue economic growth. After the trade liberalisation and development of various cross-sector policies, Zanzibar has seen tremendous changes in terms of trades, business and tourism. Over all, the industry sector has enjoyed higher growth than the agriculture and service sectors. Still, the service sector accounts for the highest employment share at almost 40%, closely followed by the agricultural sector (37%), while industry, including the tourism sector, accounts for 15% of total employment (RGZ, 2010A).

The location of Zanzibar involves specific circumstances. The isolated position in the Indian Ocean; the increasing demand for energy through economic development and high population growth; and the large number of the population living below the basic needs poverty line; altogether creates specific requirements on the supply of energy. At present Zanzibar is totally dependent on import of electricity and fossil fuels from other regions, and on an unsustainable local production of woodfuel.
The energy balance of Zanzibar\(^1\) (RGZ, 2010 \(^2\)) was estimated to 4,200 GWh in 2007, of which woodfuel constituted the highest share (charcoal and firewood). More than 80% of the total energy uses on the islands are within the domestic sector, whereas the remaining 20% is used jointly by the industrial and commercial sectors.

The energy input of the main energy sources used is given below (Figure 1).

![Pie chart showing energy sources]

**Figure 1.** The Zanzibar Energy Balance, year 2007 *(Source: Zanzibar Energy Policy, 2010).*

The development of the electricity demand

Although electricity represents only a minor part of the total energy input on Zanzibar (4%), the demand of electricity has grown fast, and from 2003 to 2007 the amount of billed electricity increased by 50%. The main part (90%) of the demand arises from activities in Unguja and only 10% of the electricity is used in Pemba. The total number of registered clients amounts to approximately 80,000 and there are many potential clients that have applied for a connection. The demand is however presently higher than the supply on both islands, and the connection of new clients is therefore slow. The use of electricity in each sector is illustrated in Figure 2.

![Pie chart showing electricity uses]

**Figure 2.** Share of total electricity uses by each sector in 2007 *(Source: statistics from the Department of Energy and Minerals, Zanzibar, 2008).*

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\(^1\) Information has mainly been derived from different types of studies and reports provided by government institutions in Zanzibar, and by discussions with local stakeholders. (The material has been collected during an energy support program provided by Sweden to Tanzania in 2008-2010.)
The highest increase in electricity can be seen in the larger industries in Pemba, and within the medium sized industries sector in Unguja, and together with the commercial users these sectors consume just over 50% of the electricity in Zanzibar, which is important for the national economy. Also, the development potential for these sectors is regarded as high. One example can be given from the food crops sub-sector, were it has been revealed that there is potential to increase both smallholder and large-scale irrigation farming (Office of Chief Government Statistician, Zanzibar, 2005).

The manufacturing sector in Zanzibar is dominated by Small and Medium Enterprises (SMEs). Given the vast demand for manufactured goods, manufacturing has the potential for being a key driver of growth. The vast majority of Zanzibar’s manufactured exports are in textiles and garments. Other important manufactured exports are wood products, coconut oil, arts and handicrafts, spices as well as products from agro processing. In general, unreliable supply from key utilities such as electricity and water, and the high costs related to these have been pointed out as limits to further investments in the manufacturing sector (Office of Chief Government Statistician, Zanzibar, 2005).

Also the use of electricity in the domestic sector has increased during this period, however not to the same extent (30% increases from year 2003 to year 2007). The main uses of electricity within the domestic sector are: lighting; cooling for fridges and freezers; water pumping; and power to TV, radio, cell phones, fans, irons etc. The use of electricity differs significantly between urban and rural areas. The Household Budget Survey (HBS) (Office of Chief Government Statistician, Zanzibar, 2006) shows that only a small proportion (7%) of rural households use electricity for lighting, compared to about 57% of urban households. Only a very small proportion (1%) of the households in the country use electricity for cooking. Instead the overall results of the HBS revealed that firewood continued to be the major fuel for cooking in Zanzibar while for lighting it is paraffin (kerosene).

Electricity supply and non-supply

Electricity in Zanzibar is supplied by Zanzibar Electricity Corporation (ZECO). In 2008, electricity to Zanzibar (Unguja) was provided from Mainland Tanzania through an old single 132 kV submarine cable connection with a capacity of 45 MW. As the cable had been in operation since 1980 it was of old age and fully utilised, and decisions were taken to supply the island with an additional submarine cable of 100 MW. Also for the island of Pemba decisions were taken to install a submarine cable, although of smaller capacity (20 MW). The new supply in Pemba would replace power from diesel generators of very low standard (RGZ, 2010b).

However, the decisions were taken too late and on May 21 2008, the cable in Unguja came out of operation due to a serious breakdown. Unfortunately the utility had no access to back-up facility for electricity production, and the country was therefore hit by its first total power blackout which lasted until June 18. During that time the population had to rely only on private generation of electricity.

The second blackout in the island of Unguja came on 10 December 2009, and lasted until the 9th of March 2010 – a three month long complete power outage, still with no back-up facilities in place. Although no scientific studies have been made measuring the effect of the blackout, oral reports from citizens of Zanzibar have been used as illustrations for the crisis that severely affected all parts of the society.
Cooping with a three month long electricity blackout

As the electricity supply in Zanzibar for long had been subject to low reliability and poor quality of services, all sectors of the society - commercial as well as domestic - were used to these shortcomings, and many clients had access to private generators. However, the sudden increase in use of generators created a high demand of diesel, which lead to fuel shortages on the island - a fuel shortage that heavily disturbed also the transport sector of the country. Given the magnitude and the long time of the power outage, reserve stores of fuel, water, and other essential input commodities drained; industries failed to operate; the domestic sector suffered from lack of possibilities for pumping of water for tap water and flush toilets. Cooling and freezing equipment failed, and people returned to purchase fish, meat, dairies etc. on a daily basis. For those that did not have access to private electricity generation, the power outage restrained them to use electrical appliances in their homes such as lighting equipment, fans, TVs, radio, cell phone chargers, fridges etc. It is worth noticing however that cooking of food was hardly affected as only a very small proportion (1%) of the households in the country use electricity for cooking.

The effect of the blackout were more severe in urban areas were electricity has been integrated into the daily activities to a higher extent than in rural areas. At sudden, more time had to be reallocated from income-generating activities to more life-sustaining activities. The 26%2 of the households in the urban areas that normally used flush toilets had to rely on other solutions, as also the 92% with access to piped water. Lack of water also meant increased risk of diseases such as cholera, and although no official statistics is available, unofficial sources reported an increase of such diseases. Other indirect complications of the blackout were environmental effects from the large number of small generators that were running on diesel, generating not only electricity but also hazardous exhaust fumes, noise, and accidents due to faulty refilling of fuel etc.

Finally, the total blackout left Zanzibar in darkness, which lead to an increased risk of thefts and other security related crimes. For instance the staff of the electricity utility spent long hours trying to prevent stealing of wires from the distribution system, as these composed of copper attractive on the world market. The financial sustainability of the utility was heavily undermined from such thefts, as was the economy as a whole due to the consequences of the blackout. Also the relation to the clients of the utility was heavily affected. A client satisfaction survey made by the utility after the blackout revealed that the general client-satisfaction had decreased from more than 50% of satisfied clients in 2004, to only 26% in June 2010 (ZECO, 2010), and staff of the utility report on a sense of failure that can be expected to have an impact on the performance of the corporation, also on a long term basis.

\(^2\) Office of Chief Government Statistician, Zanzibar, 2006
Socio-economic implications from power outages

For an economic development to evolve, income-generating activities are necessary, and electricity is often an important factor; through activities performed in households; in micro enterprises (NREL 2000); in industries of different types and sizes; and in agriculture (Gullberg et al. 2004). In the manufacturing sector of Zanzibar for instance, unreliable supply from key utilities such as electricity and water, and the high costs related to these have been pointed out as limits to further investments (Office of Chief Government Statistician, Zanzibar, 2005).

Based on these evidences, it is clear that the market in Zanzibar was negatively affected by the electricity blackout. However, as no studies have been made measuring the economic effect of this blackout, consequences of power outages in other countries has been studied. In Nigeria for instance, Adenkinju (2005) concluded that power outages imposed significant costs on business, and small-scale operators were found to be most heavily affected by infrastructure failures. This is supported by other studies showing that the costs of own-generation in general are about three times as high as the price of purchasing (subsidised) electricity from the public grid (Steinbuks & Foster, 2009).

Access to own generation increases the opportunities for firms to maintain its business during periods of outages. However, what could be surprising is what Steinbuks & Foster (2009), illustrates in their analysis of underlying causes and costs of own generation of electric power in Africa. The study shows that the percentage of firms owning their own generators would remain high (at around 20%) even if subsidised power supplies from a utility was perfectly reliable, suggesting that other factors such as emergency driven back-up requirements play a critical role in the decision to own a generator. Also, the possibilities to control your own electricity generation can increase the power quality and reduce damage to equipment. These factors may very well imply that the benefits of own generator ownership outweigh the costs. Steinbuks & Foster argues that through own generation, the majority of large formal sector enterprises are able to effectively insulate themselves from the impact of unreliable power supplies, and the overall impact on the weighted average cost of power supply to these firms can be hold relatively small given that outages are only intermittent.

For the informal sector however, the study made by Steinbuks & Foster reveal that the major victims of unreliable power supply are within these clients, where the limited survey evidence suggests that generator ownership is an order of magnitude less prevalent than in the formal sector, consisting of larger businesses. Productive uses of electricity in the informal sector have been studied by Ilskog (2008) among others. The study of seven electrified areas in eastern and southern Africa illustrated how electricity where used to enable income-generating activities in households. In Tanzania for instance, some 42% of the households reported having a business in year 2000 (Tanzania NBC, 2002). In Zanzibar, approximately 30% of the households reported having a business (Office of Chief Government Statistician, Zanzibar, 2006). Many of these businesses are physically located in the vicinity of the household making the separation of electricity uses between domestic and commercial sectors difficult. Although no evidence can be given, it is likely to believe that these are among those electricity clients most heavily affected by unreliable power supply.

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3 The main data source for the study is the World Bank's Enterprise Survey Database, which captures business perceptions of the obstacles to enterprise growth, the relative importance of various constraints to increasing employment and productivity, and the effects of a country's investment climate on the international competitiveness its firms. The database comprises 8 483 firms in 25 North and Sub-Saharan African countries sampled from the universe of registered businesses between 2002 and 2006. Detailed information on the World Bank's Enterprise Survey Database can be found at http://www.enterprisesurveys.org.
Conclusions

With increased dependency on electricity, the fundament for a more vulnerable society is created. This is illustrated in this paper using the 2009-2010 power blackout in Zanzibar as a case. The three month long blackout that hit Zanzibar could resemble an economic and social depression, with serious implication on areas such as economy, health, and environment.

The aim of the paper has been to deepen our understanding of consequences from power outages on different levels in the society. Not only are the industrial and commercial sectors important, so is also the domestic sector and the large informal and formal business activities related to the sector.

For the case of Zanzibar it is important to highlight what could have been done to prevent the blackout, and in particular, to minimize the negative effects of the break-down of the transmission cable that was the underlying cause. It is equally important to realise that all power systems are sooner or later prone to failure, whether in Africa or somewhere else worldwide (Rosas-Casals & Solé, 2010). Electric power networks are getting larger and more complex, and in order to effectively prevent risks for blackouts and to implement rapid response to power outages, several measures have to be prioritised. Such measures shall include; development of emergency plans and plans for down-regulation of power; sectioning of distribution in predetermined areas as to avoid overloading of the system; procurement and installation of necessary electricity back-up generation facilities; systematic maintenance; and advanced planning of the electrical power system. As large energy sector investments in developing countries worldwide are still partly covered by resources from donor funding, an important input to strategies produced by the donor society is to include not only the installation of technical equipment, but also to raise demand on development of maintenance plans and their implementation. It stands to reason that these should be of highest priority, and in retro-perspective it can be realised that these measures could have saved the Zanzibarians from the long dark and economically ineffective period.

The paper also highlights the differences between shorter power outages, and total blackouts of the electricity system. Evidence from other studies shows that many businesses would remain with their own generator, even with reliable subsidised power supplied from a utility. This suggests that factors such as emergency driven back-up requirements play a critical role in the decision to own a generator.

However, from the discussion in the paper it is obvious that there is an almost un-quantifiable difference between the effects of an intermittent power outage and a total blackout of the magnitude reported from Zanzibar. A total power blackout as the one experienced in Zanzibar is one of the most severe accidents in electric power system failure, and should be paid great attention at all times, especially in urban areas, where electric power network is a key infrastructure. On the positive side is that experiences shows that blackouts can help prepare electricity restoration plans. The Government of India can be taken as an example. Here, the Electricity Act has been the tool for restructuring and reforms in all states, where the act provides for mandatory open access. The act includes proposals on frequency control, voltage control, and control of line loadings are the main issues for control and limiting risks of blackouts (Roy et al., 2004). If handled properly, this could also be the case for Zanzibar.
Finally, in Zanzibar as in every other place of the electrified world, lighting up areas has been a longed-for change, and electricity for TV, radio, and charging of cell phones is highly appreciated for facilitation of access to news, communication, and business development. Improved security resulting from installation of street lights, better health services, and water services and are other important results from electrification that benefits the majority of the population in an electrified area. However, such development also increases the dependency on modern services, and it is the responsibility of the government and its designated utilities to proper manage this confidence – to prove to be trustworthy and to manage the activities on a sustainable basis. New confident and credibility has to be build among the Zanzibar society at large, and even if electricity production back-up facilities are now in place, the crisis have been a huge set-back for Zanzibar that will take a long time to recover from.
References


