

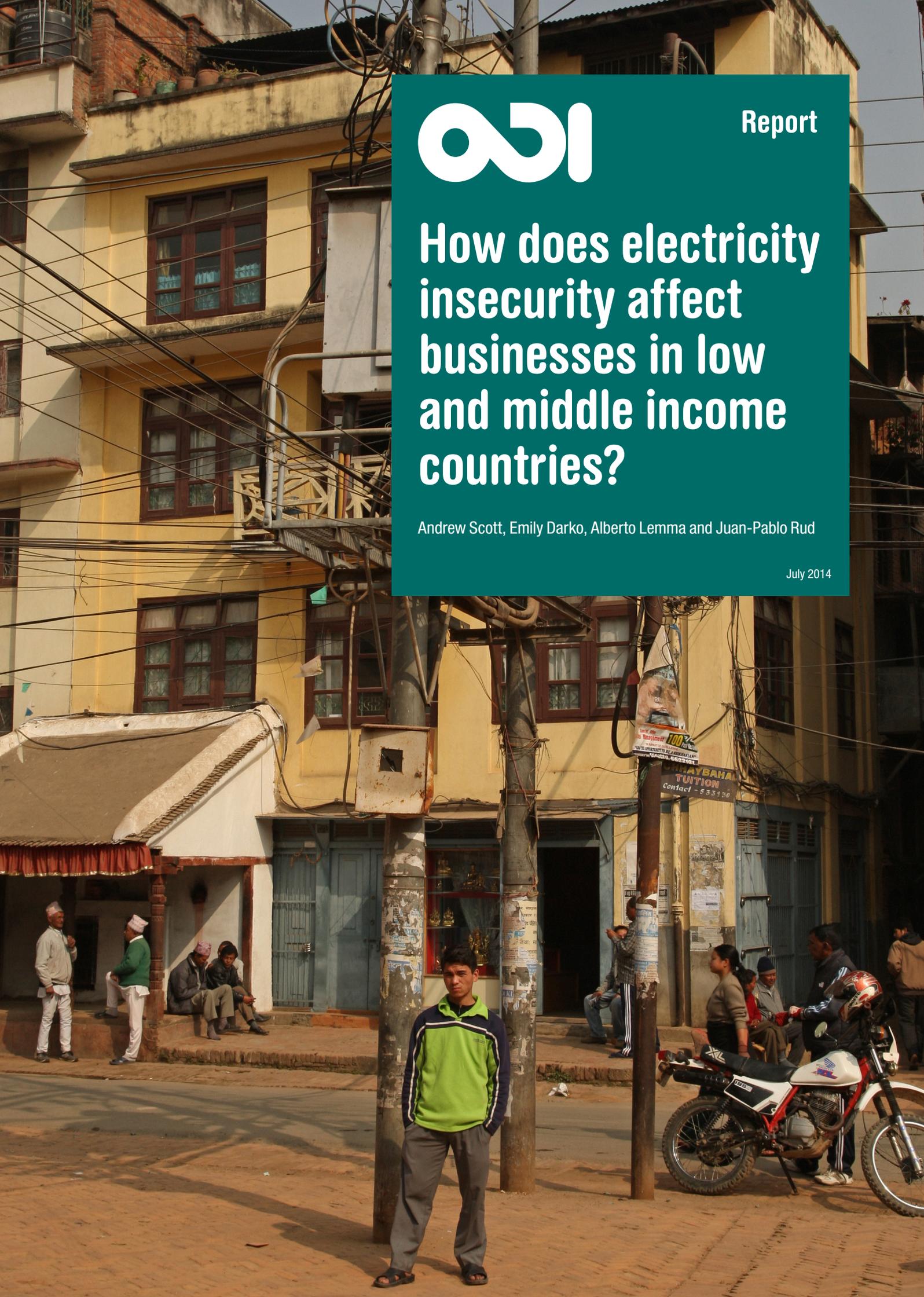


Report

How does electricity insecurity affect businesses in low and middle income countries?

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July 2014



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Cover photo: © Simone D. McCourtie / World Bank. Electricity lines in Kathmandu. Kathmandu, Nepal.



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Key messages

- Electricity insecurity impacts the productivity of manufacturing SMEs negatively, but these impacts are often statistically insignificant and they can at times be positive.
- Electricity insecurity does not affect the cost-competitiveness of manufacturing SMEs, partly because electricity costs are usually a very small proportion of total costs.
- Electricity insecurity influences investment in and by SMEs, notably the location of investment, but evidence that it constrains investment is mixed.
- Policy makers can help to mitigate the impact of electricity insecurity on SMEs by ensuring that outages are planned and by facilitating access to alternative supplies of electricity, including generators and renewable energy.

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Abbreviations

BEI	Bangladesh Entrepreneurs Institute	MAN	Manufacturing Association of Nigeria
BSCIC	Bangladesh Small and Cottage Industries Corporation	MIC	Middle Income Country
BWCCI	Bangladesh Women Chamber of Commerce and Industry	MSME	Micro, Small and Medium Enterprises
DoCSI	Department of Cottage and Small Industries, Ministry of Industry	NACEUN	National Association Community Electricity Users of Nepal
FNCCI	Federation of Nepalese Chamber of Commerce and Industries	NASME	Nigerian Association of Small and Medium Enterprises
FNCSI	Federation of Nepalese Cottage and Small Industries	OLS	Ordinary Least Squares (regression model)
FWEAN	Federation of Women Entrepreneurs Association Nepal	SME	Small and Medium Enterprises
GDP	Gross Domestic Product	SMEDAN	Small and Medium Enterprises Development Agency of Nigeria
HIC	High Income Country	TFP	Total Factor Productivity
ICCI	International Chamber of Commerce and Industry	UEDCL	Uganda Electricity Distribution Company Limited
IDCOL	Infrastructure Development Company Limited	USSIA	Uganda Small Scale Industries Association
IFC	International Financial Corporation (of the World Bank)	UWEAL	Uganda Women Entrepreneurs Association Limited
KACITA	Kampala City Traders Association	USSIA	Uganda Small Scale Industries Association
Kwh	Kilowatt Hour	UWEAL	Uganda Women Entrepreneurs Association Limited
LIC	Low Income Country		

Executive Summary

Access to a reliable electricity supply is widely considered to be vital to the operations of most small and medium-scale businesses and firms. Evidence of the impact of electricity insecurity upon business operations is limited, however. To better understand the impacts of electricity insecurity on small and medium-scale firms, the Department for International Development (DFID) commissioned the Overseas Development Institute to undertake a study that addresses the question “How does electricity insecurity affect the productivity and growth of small and medium-sized enterprises (SMEs) in low and middle income countries, and how can this impact be mitigated?” The study focused on four specific questions:

- How does electricity insecurity impact on the productivity of SMEs?
- How does electricity insecurity impact on SMEs’ cost-competitiveness?
- How does the perceived threat of electricity insecurity influence businesses’ investment decisions?
- What strategies and tactics have SMEs developed to cope with and mitigate the impacts of electricity insecurity?

Methodology

The study comprised a review of relevant literature, statistical analysis of data from the World Bank Enterprise Surveys from six selected countries (Bangladesh, Nepal, Nigeria, Pakistan, Tanzania and Uganda), and the collection and analysis of qualitative information from key informants in four countries (Bangladesh, Nepal, Nigeria, and Uganda). The analysis focused on manufacturing SMEs, which account for significant employment in developing countries and are associated with higher per capita GDP.

The literature review identified grey and published literature, which fell into two broad categories: empirical or statistical analysis, and anecdotal or qualitative approaches. More literature was identified on the effects on firms of access to electricity than on electricity insecurity.

The study carried out regression analysis to determine the effects of electricity insecurity on firms’ total factor productivity, cost-competitiveness, investment, and generator ownership, using data from the Enterprise Surveys for the six selected countries. Key informant interviews were undertaken in four of these countries. These semi-structured interviews were guided by findings from the literature review and statistical analysis. A total of 82 interviews were held, comprising 40 SME interviews and 42 stakeholder interviews.

Impact on productivity

The statistical analysis supports previous findings that electricity insecurity negatively affects the total factor productivity and labour productivity of manufacturing SMEs. In four of the six countries the association between outages and productivity is negative. However, this is not found in all circumstances, and in two countries SMEs affected by electricity insecurity have marginally higher productivity. The productivity effects are not always statistically significant, and findings can be influenced by how electricity insecurity is measured, suggesting that future analysis should use the duration of outages as the measure of electricity insecurity.

The study concludes that variability in the effect of electricity insecurity upon productivity can be explained by factors in both the context that SMEs are operating in and the internal capabilities of firms. Previous studies have highlighted the role played by the environment in which SMEs are operating (e.g. Cecelski, 2004; Cissokho and Seck, 2013). However, analysis of how firm capabilities affect the impact of electricity insecurity has not been found. This is potentially an area for further research.

Cost-competitiveness

The study shows that while electricity insecurity does affect SMEs’ overall costs, those experiencing outages do not have higher unit costs of production than other SMEs, and they do not experience a competitive disadvantage in this way. The absence of a significant effect on unit costs is partly explained by the small proportion of total costs accounted for by electricity (between 0.37% and 3.7% in the six selected countries). A further explanation is that power outages induce the adoption of good management practices which help to reduce negative effects (Cissokho and Seck, 2013).

The competitiveness of manufacturing firms also depends on product quality and the ability to meet orders on time. These factors can also be affected by electricity insecurity, but are not captured by the standard enterprise surveys.

Investment

Previous research and this study suggest that electricity insecurity can influence investment decisions, but it is not the only or the most significant factor considered by SMEs. Although it can affect the nature and location of investment, the evidence is inconclusive on the question whether electricity insecurity is a significant constraint on investment, as suggested by some of the literature (e.g. Meadows and Riley, 2003; Aterido et al., 2009). Electricity insecurity does appear to have a bearing on the location of investments in and by SMEs, and the effect on investment

appears to be more significant for some sectors than others, particularly those that are more dependent on electricity.

Mitigation

The study found that the main practice adopted by SMEs to mitigate the impact of electricity insecurity is the use of a standby generator, followed by changes in operations and reduced hours. Around 33% of SMEs in developing countries use a generator and in countries with very unreliable electricity the proportion is higher, reaching 86% in Nigeria. There is limited evidence of the sharing of generator amongst SMEs, but strong indication from stakeholders that facilitating further generator-sharing would be beneficial.

Although there is awareness of renewable energy there is limited evidence that it is used as an alternative to grid power at present, and a lack of information and advice on its use, as well as finance to access it. For motive power, renewable energy is not perceived to be a viable alternative. Changes in operations can reduce the number of stoppage hours during outages. Operational changes, such as regular night shifts replacing day-time working, are made possible and more effective where there is a reliable schedule of outages.

Policy conclusions

SMEs in developing countries play a significant role in employment and poverty reduction, especially in growing

urban areas, which can be enhanced by policies that facilitate access to reliable electricity.

Policy makers concerned with the effects that electricity insecurity has on the operation and output of manufacturing SMEs can promote action to reduce negative impacts in a number of ways. The most obvious area for action is to improve the reliability of the electricity supply, which needs to be measured and monitored. This may require short-term action to reduce technical faults, for example, through maintenance of the transmission and distribution infrastructure, or it may require longer-term interventions to expand generating capacity.

In the absence of a better quality supply, governments and electricity suppliers can help SMEs by providing reliable load shedding schedules, which would enable them to plan production around outages.

Sharing backup generators could help more SMEs to access and use backup power during outages. However, sharing generators requires good relationships and trust between firms and for some distance from other firms may be a constraint.

The use of renewable energy technologies by SMEs during outages could be facilitated by improving the availability of information about them and by measures to reduce their costs (e.g. through generator sharing, subsidies and credit schemes).

Introduction and background

Access to a reliable electricity supply is widely considered to be vital to the operations of most small and medium-scale businesses. Surveys suggest that, in middle and lower income countries, firms themselves consider access to electricity to be one of the biggest constraints to their business.

Inadequate electricity services can constrain business operations because a supply of electricity may simply be unavailable and, if it is available, securing a connection may be difficult and the supply unreliable, even before its cost is considered. High quality and accessible infrastructure encourages productivity, business growth and investment, but when it is poor and unreliable, businesses' productivity and growth suffer.

An unreliable electricity supply – electricity insecurity – can affect several aspects of business operations. The most significant impacts to productivity can be due to forced and unexpected halts in manufacturing processes, including running assembly lines, using machine tools, or producing textiles. Communications, delivery times, lighting and refrigeration are also affected by electricity insecurity, with consequences for the routine operation of businesses and their ability to ensure delivery times.

Many small and medium-scale enterprises invest in their own stand-by generators to ensure an electricity supply, but these are often expensive compared to electricity from the grid. Generators also require some technical expertise as well as reliable supplies of fuel and spare parts. Yet, in sub-Saharan Africa and elsewhere own-generation by firms is reported to have increased in recent years.¹

The evidence of the impacts of electricity insecurity is limited. Other than the World Bank's Doing Business and Enterprise Surveys there is little quantitative information available on the impact of electricity security upon business operations. In the absence of good empirical evidence it is difficult to know what impact electricity insecurity actually has on firm productivity and on cost-competitiveness. How does electricity insecurity affect business decision-making, particularly investment decisions? How do firms cope with unreliable electricity supplies?

Accordingly, and in order to better understand the impacts of electricity insecurity on small and medium-scale firms, the Department for International Development (DFID) has commissioned ODI (the Overseas Development Institute) to undertake a study that addresses the question "How does electricity insecurity affect the productivity and growth of small and medium-sized enterprises (SMEs) in low and middle income countries, and how can this impact be mitigated?"

The study

The research for this study aimed to assess and quantify the impact of electricity insecurity on firm productivity and competitiveness, and how it impacts on their investment decisions for start-up and expansion. The study also aimed to improve understanding of how small and medium-scale firms (SMEs) mitigate the effects of electricity insecurity upon their operations. The study therefore focused on four specific questions:

- How does electricity insecurity impact on SMEs' productivity?
- How does electricity insecurity impact on SMEs' cost-competitiveness?
- How does the perceived threat of electricity insecurity influence businesses' decision-making when considering whether to move into a new area or develop their business?
- What strategies and tactics have SMEs developed (on both the supply-side and demand-side) to cope with and mitigate the impacts of electricity insecurity?

An inception report (March 2014) presented preliminary findings from the first stage of the study and described the tasks proposed for the second stage. This report presents overall findings and conclusions from the study. The methodology of the study is described in the next section. This is followed by an overview of electricity and SMEs in developing countries, to provide some contextual background. The main body of the report summarises findings on the impact of electricity insecurity on SME productivity, cost-competitiveness, investment and mitigation approaches. In section 8, overall conclusions are presented. The full terms of reference for the study are reproduced in Annex 9.1, followed by the list of interviewees, and summaries of the statistical analysis and surveys.

Methodology

Overall approach

The study was undertaken in two main stages. The first was desk-based and comprised analysis of data from World Bank Enterprise Surveys and a literature review. The second stage collected and analysed qualitative information from key informant interviews conducted in selected countries. This section of the inception report describes each of these tasks.

The study focused detailed analysis on a number of selected low- and middle-income countries, six for the

¹ The analysis of Enterprise Survey data by Foster and Steinbuks (2008) showed that on average 35% of firms in sub-Saharan Africa had a generator. The dataset now shows 46.1% of firms in the region having a generator.

statistical analysis and four for qualitative information. Countries were selected using the following criteria:

- the population of SMEs (number of SMEs per 1000 people), number of manufacturing SMEs (number and proportion of total SMEs) and employment in SMEs (proportion of total employment in SMEs).
- the importance of electricity insecurity (number and frequency of outages, generator use, perceptions of electricity insecurity as a major constraint).
- relevance to DFID priorities.

Using these criteria, the study identified eight countries initially with a view to a final selection of six countries. The Enterprise Survey data for each of the eight countries was reviewed to assess its suitability for detailed statistical analysis. One country (Malawi) was found to have a data set that is unsuitable for analysis because of the small number of firms included and large gaps in the data for some variables. A second country (Zimbabwe) was excluded on the basis of the criteria. The six selected countries were: Bangladesh, Nepal, Nigeria, Pakistan, Tanzania and Uganda.

The terms of reference for the study specified a focus on manufacturing SMEs, in part because ‘The most significant impacts to productivity can be due to forced halts on manufacturing processes.’ The share of total manufacturing employment accounted for by SMEs has been associated with higher rates of per capita GDP growth, Beck et al. (2005) concluding that ‘a large SME sector in manufacturing is a characteristic of successful economies.’ This suggests that improved understanding the impact of electricity insecurity on the performance and growth of manufacturing SMEs is of interest to policy-makers.

Definitions

The study adopts the World Bank Enterprise Surveys’ definition of small-scale enterprises as those with 19 or fewer workers, and medium-scale enterprises as those with between 20 and 99 workers. This is consistent with some of the IFC MSME surveys, which use country-specific definitions.

Electricity insecurity is defined as the regular experience by firms of interrupted electricity supplies, and is measured in terms of the frequency of interruptions (or outages) and their duration.

Literature review

The literature review identified grey and published literature from previous reviews of literature on electricity and SMEs and through online searches (using Google, Eldis and Swetwise). Search terms used included:

- “electricity reliability developing countries”
- “electricity insecurity”

- “electricity reliability”
- “electricity insecurity and enterprise”
- “electricity reliability and enterprise”
- “electricity insecurity and business”
- “electricity insecurity and manufacturing”
- “electricity reliability and manufacturing”
- “smes productive use of electricity”

This review of published and grey literature focused on the specific research question on how electricity insecurity affects manufacturing SME cost-effectiveness and productivity. The literature review also covered literature on the factors influencing SME start-ups and investment decisions. This focus was expected to reveal any literature about how SMEs cope with electricity insecurity and their mitigation actions.

The literature identified falls into two broad categories. The first comprises empirical or statistical analysis, usually analysis of enterprise or household survey data, providing national-level and cross-country evidence. The second category adopts anecdotal and qualitative approaches, using more detailed analysis within a small area or comparison across areas, and through use of case studies. Some literature combines both approaches, using a combination of survey data and qualitative interviews for example.

This literature review sought to identify literature which looks explicitly at SMEs in the manufacturing sector. However, given that this literature is limited and that there is significant relevant literature which is not necessarily firm-size or sector specific, the review also considered literature that covers SMEs in general, household income generating activities and informal sector enterprises (some of which is disaggregated so information about manufacturing-type activities can be identified), and manufacturing sector enterprises of all sizes, where evidence and lessons seem to hold value for manufacturing sector SMEs.

There is considerably more literature on the effects on firms of access to electricity than on electricity reliability or insecurity. The literature on access to electricity provides insight into how having an electricity supply can affect SME performance and how access impacts different types of SME, in terms of size, sector and location. This may be relevant for understanding how the frequent temporary absence of an electricity supply, that characterises electricity insecurity, will affect SMEs.

The study focused on SMEs, i.e. firms with up to 100 employees. The literature reviewed suggests that disaggregation not only between sector and country, but also firm size, is important to understanding the impact of electricity quality on productivity and generator use. Annex 9.10 presents a summary of the coverage of the literature reviewed in terms of countries and information covered.

2 Details about the Enterprise Surveys have been taken from the website: <http://www.enterprisesurveys.org/>

Data

The World Bank has publicly available data from Enterprise Surveys in 135 countries.² These are firm-level surveys of a representative sample of firms, and cover a range of topics relating to business performance and the business environment, including access to reliable electricity. For the six selected countries, the study carried out regression analysis to determine the effects of electricity insecurity on firms' total factor productivity, cost-competitiveness, investment and generator ownership. The analysis of each country's data was limited to small- and medium-scale firms (as defined by the Enterprise Surveys) in the manufacturing sector. The analysis is described further in Section 4.

The detailed statistical analysis was complemented by a review of summary data from the World Bank Enterprise Studies and the International Finance Corporation's MSME Country Indicators data set. This is reported on below, in Section 3.

The main source of firm-level data for this study is the World Bank Enterprise Surveys, which cover a total of over 130,000 firms. These surveys cover a range of business environment topics, including access to finance, corruption, infrastructure, crime, competition, and firm performance. The data have been used in recent years by a number of studies examining the relationship between firm performance and the business climate (Dethier et al., 2011).

The surveys use two instruments: a Manufacturing Questionnaire and a Services Questionnaire, with scope for additional questions tailored to the national context. The standard Enterprise Survey topics include firm characteristics, gender participation, access to finance, annual sales, costs of inputs/labour, workforce composition, bribery, licensing, infrastructure, trade, crime, competition, capacity utilization, land and permits, taxation, informality, business-government relations, innovation and technology, and performance measures. Electricity falls under the infrastructure label, the specific questions covering applications for connections, outages, the use and ownership of generators, and expenditure on electricity.

Respondents to the surveys, which are conducted face-to-face by private contractors on behalf of the World Bank, are business owners and senior managers. Some of the data collected is subjective, based on perceptions and recall, and therefore open to bias (Dethier et al., 2011). This limits the potential for comparisons between countries and between surveys in one country in different years. Variations occur in the proportion of firms responding to each question, further limiting the scope for detailed statistical analysis.

The Enterprise Surveys use stratified random sampling, with strata for firm size, business sector, and geographic region within a country. Firm size levels are 5-19 (small), 20-99 (medium), and 100+ employees (large-scale firms). The surveys exclude micro-enterprises (fewer than 5 workers) and state-owned enterprises, but oversample large private firms. The size of the sample varies with country

size, ranging from 1200-1800 interviews in larger countries to 150 interviews in small countries. Overall, 47% of the firms surveyed are small-scale enterprises, 33% medium-scale and 20% large-scale.

This study focuses on manufacturing enterprises, which account for 56% of all the firms covered by the Enterprise Surveys. In the six countries selected for detailed statistical analysis the proportion of manufacturing enterprises in the samples ranges from 50% to 83%.

Interviews

Key informant interviews were undertaken in four of the countries selected for the statistical analysis. The number of countries was determined by the resources available for the study and the timescale provided for its completion. In each of the four countries, ODI worked with a local consultant to identify key informants and conduct interviews. A semi-structured interview technique was employed, with questions guided by findings from the literature review and statistical analysis.

To identify key informants, a mapping of stakeholders in the SME manufacturing sector of each country was prepared. Informants were identified purposively to ensure a range of perspectives (e.g. business associations, financial institutions and donors). The study set out to interview 20 informants in each country, including 10 SME operators and 10 stakeholders. A total of 82 interviews were actually conducted, listed in Annex 9.2, comprising 40 SME interviews (10 in each country) and 42 stakeholder interviews (11 in Bangladesh and Uganda, 10 in Nepal and Nigeria). Annex 9.5 provides a summary of the information from the interviews.

Limitations of the study

The principal data source for this study is the World Bank Enterprise Surveys for the six selected countries which cover in all 135 countries and a total of over 130,000 firms. These surveys allow comparisons between countries on the experience of electricity insecurity, which is not captured by standard international statistics. They are of a representative sample of private firms in each country, respondents being business owners and senior managers. Some of the data collected is based on their perceptions and recall and therefore open to a subjective bias (Dethier et al., 2011). This limits the potential for comparisons between countries and between surveys in one country in different years. Variations occur in the proportion of firms responding to each question and the proportion of firms in the manufacturing sector, limiting the scope for more granular statistical analysis.

The study builds on the Enterprise Survey data, adding supporting qualitative information for four countries. The qualitative information collected for the study relied on semi-structured interviews conducted in four countries on a small, purposive sample of SMEs and stakeholders. Although their open-ended nature provided qualitative

insights, these may reflect differing interpretations of key words and expressions by both interviewers and informants. Some of the interviews were conducted in local

languages and the answers translated which may have affected the details in each interview record but is not felt to have affected the overall conclusions.

Overview of electricity and SMEs

Characteristics SMEs in developing countries

There are around 90 million micro, small and medium scale enterprises (MSMEs) in developing countries and emerging markets, and the density of formal MSMEs in low and middle income countries is rising (Kushnir et al., 2010). Formal MSMEs generate 35% of employment in upper middle-income countries, 42% in lower middle-income and 34% in low-income countries (IFC MSME Country Indicators).

Data on the proportion of GDP for which MSMEs are responsible are limited for developing countries. According to Ayyagari et al. (2003), the proportion of GDP generated by SMEs is smaller in developing countries than it is for high income countries.

Quantifying SME activity in developing countries is a challenge. Aside from data availability, there are two main reasons for this – lack of consistency across data sets, particularly in the use of different definitions of small,

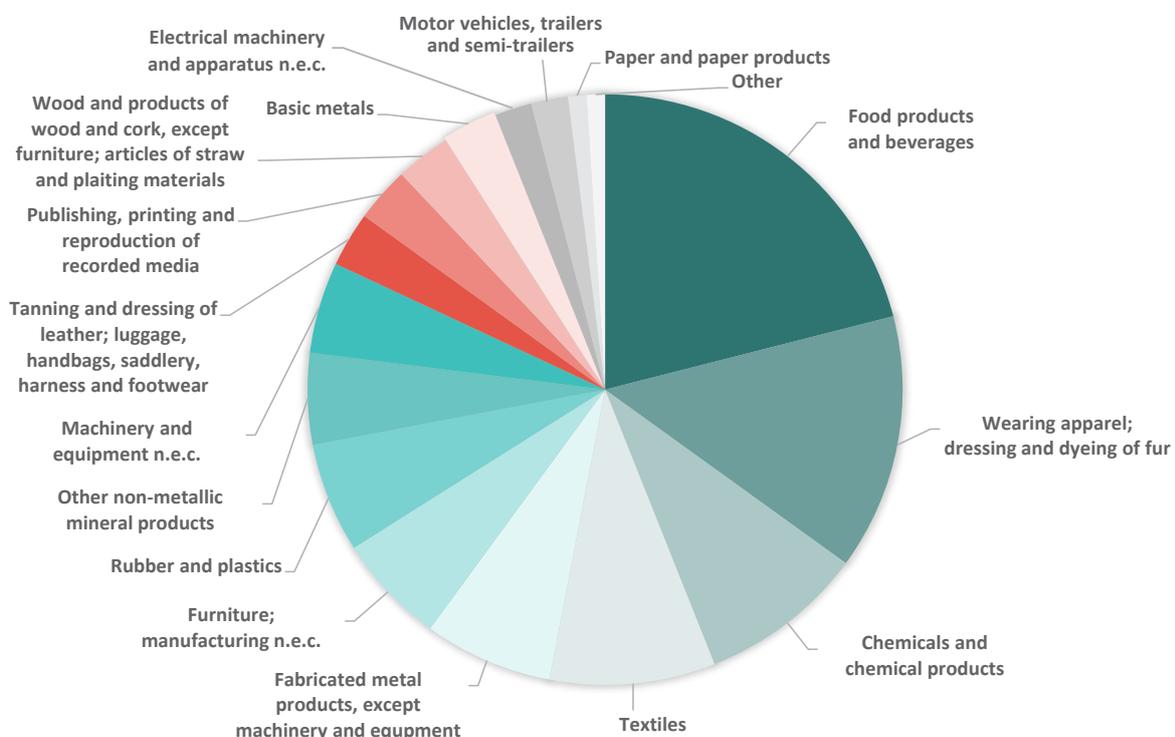
medium and large-scale in reference to firms; and secondly, a significant proportion of entrepreneurial activity in developing countries takes place outside the formal sector, and is not captured by enterprise surveys.

Manufacturing SMEs

Excluding micro-enterprises, manufacturing sector SMEs represent 17%, 21% and 29% of all SMEs in upper middle-, lower middle- and low-income countries, respectively (IFC MSME Country Indicators). Manufacturing enterprises, which are the focus of this study, therefore account for approximately a quarter to one third of formal SMEs in developing countries.

Amongst manufacturing SMEs, the largest sub-sectors are the production of food and beverages, and textiles and clothing (see Figure 1). Chemical products, wood products, fabricated metal products and furniture also account for significant proportions.

Figure 1: Breakdown of manufacturing sector MSMEs in emerging markets by sub-sector



Source: Enterprise Surveys (<http://www.enterprisesurveys.org>), The World Bank.

Table 1: Electricity Access and Insecurity in Sub-Saharan Africa and South Asia

	Sub-Saharan Africa	South Asia	High Income Countries
Cost to get electricity (as a percentage of income per capita)	4,736.9%	1,894.9%	79.1%*
Days to gain access	133	148	89*
People with access to electricity	36%	62%	99.7%*
Electricity losses as a percentage of output	10.8%	20.3%	6.2%
Electricity consumption (Kwh per capita)	534.9	605.2	8,905.4
Hours for an average outage	5.3	2.4	0.99
Percentage of firms identifying electricity as a major constraint	49.3%	53.2%	26.0%

* OECD only.

Sources: *Doing Business 2014*, World Bank; *World Development Indicators*, World Bank, 2010; *World Bank enterprise surveys*, accessed July 2014.

Electricity insecurity in developing countries

Electricity access and insecurity, as well as cost, are perceived to be significant problems in developing countries, considerably more so than in high income countries. The proportion of firms in the high-income countries (HICs) covered by the Enterprise Surveys that identify electricity as a major constraint is around half that found in sub-Saharan Africa and South Asia (Table 1). The cost and time to gain an electricity connection as well as the experience of outages is much lower in HICs.

Electricity insecurity and SME productivity

The impact of electricity on productivity and growth has been the subject of numerous previous studies. Researchers have examined the relationship between electricity and productivity at the economy-wide level as well as at the firm level, the focus of this study. Labour productivity³ and total factor productivity⁴ have generally been the measures used in these studies. Researchers have considered the effects of access to electricity on firms' productivity, compared firms with and without electricity, analysed the effects of electricity price changes, and assessed the impact on productivity of electricity insecurity. In this section, the literature about the productivity effect of electricity access is reviewed first, before considering findings from previous studies about the impact of electricity insecurity and the findings from new analysis undertaken for this study.

The effects of access to electricity

Electricity infrastructure and the consumption of electricity are generally understood to be positively correlated with productivity and economic growth (Rud, 2012a). Adenikinju (2005) goes so far as to say "It is fairly settled in the literature that infrastructure plays a critical and positive role in economic development." The available evidence is more nuanced, however, and provides a more complex picture, mainly because causation is hard to disentangle. Isaksson (2010) cites findings that output per capita and energy infrastructure are co-integrated and causation runs in two directions, but concludes from analysis of cross-country data that energy infrastructure is a significant factor in explaining differences in industrial development between countries. Kaseke et al. (2013) refer to a study of the relationship between energy consumption and GDP which found bi-directional causality and uni-directional causality in both directions, in different countries.

A number of developing country-specific studies support the general conclusion that electricity enhances productivity. For example, using 1970-2000 panel data for South Africa, and a range of 19 infrastructure measures, Fedderke and Bogetic (2006) found that electricity generation is positively related to labour productivity and total factor productivity growth in South Africa. Kirubi et al. (2009) analysed community-based micro-firms in rural

Kenya, and showed that use of electricity can increase productivity per worker by approximately 100-200% for carpenters and by 50-170% for tailors, depending on the item being produced. Grimm et al. (2011) found that tailors in Burkina Faso with access to electricity have revenues 51% higher than tailors without electricity, and attribute this to the use of electric sewing machines and longer working hours.

Although the evidence shows a correlation between electricity consumption and firm productivity, and firms with access to electricity tend to have higher productivity than firms without, establishing causality is complex. This is partly due to the range of exogenous factors, and partly to the nature of the impact of electricity itself.

The GIZ-led PRODUSE study (Mayer-Tasch et al., 2013), which undertook field surveys in Benin, Ghana and Uganda, confirmed substantial ex-ante differences between the firms that get connected to electricity and those that do not. The study also found that whilst service firms tend to get connected, take-up rates in the manufacturing sector in rural areas were low. In both sectors, electricity was mostly used for lighting and phone-charging, and the take-up of electric appliances was modest, except in some manufacturing firms where electrical appliances are essential for the production process (e.g. welding), (Mayer-Tasch et al., 2013). There is some evidence that enterprise growth occurs with a distinct time lag following electrification (Edquist and Henrekson, 2006; Legros et al., 2011).

For micro-enterprises the evidence of a productivity effect from electricity is less clear. Electrification has been found to have a small but significant impact on sales by microenterprises (World Bank, 2008), but a study of informal enterprises in West African cities found no systematic effect on profits (Grimm et al., 2011).

Electricity access does not automatically lead to intended results such as increased productivity, profits and income (Attigah and Mayer-Tasch, 2013). The existing conditions in areas undergoing electrification help determine the kind and scale of impacts that electricity can be expected to bring (Pueyo, 2013), and the full potential economic impact of electricity can be exploited only if essential preconditions are met, such as firms' endowment

3 The output in a given time period produced by a unit of labour, often measured as GDP per annum per worker or, at the firm level, the value of annual output per worker.

4 A measure of firm or economy-wide output relative to all inputs (capital and labour). In a standard production function, change in TFP is the change in output that is not explained by the change in inputs.

of adequate capital, access to markets and transport infrastructure (Attigah and Mayer-Tasch, 2013).

The effects of electricity insecurity

Most studies of the relationship between electricity and productivity have focused on the difference that electricity consumption makes. Research taking account of the quality of the electricity supply has received less attention, and often been based on small, country-specific studies. The quality of electricity supply, measured in terms of outages and voltage fluctuation, varies considerably between countries but is rarely measured or described (World Bank 2010), and is thus more difficult to factor in. However, Escribano et al. (2009) found that poor infrastructure quality has a significant negative impact on total factor productivity, and that poor quality electricity supply is the infrastructure element that has the strongest negative effect on enterprise productivity, especially in poor African countries (Escribano et al., 2009). In a study of the impact of rural electrification on household income in India, Chakravorty et al. (2012) found that the reliability of electricity supply is more important than being connected to the grid.

The impact of electricity insecurity on productivity at the level of the firm has been the subject of several studies using World Bank Enterprise Surveys and study-specific surveys, and employing a variety of methods. Studies look at cost of interruption, cost of back-up generators and effect on productivity (using a production function). Using World Bank Enterprise Survey data for over 1,000 firms in 10 Sub-Saharan African countries, Arnold et al. (2006) show that an unreliable electricity supply has a significant negative impact on a firm's total factor productivity. A study examining the impact of power disruptions on firm productivity in the manufacturing sector in Nigeria shows that power outage variables (measured using hours per day without power and percentage of output lost due to power disruptions) have a negative and significant effect on productivity (Moyo, 2012). The analysis for this study found that power outages have a negative and significant impact on productivity in small firms, but an insignificant effect in large firms, probably due to generator ownership patterns.

Cissokho and Seck (2013) obtained quite different findings in Senegal. Here, outages were found to have a positive and significant effect on the productivity of firms, and SMEs performed better than large-scale firms. The suggested explanation for this contradictory finding is that outages stimulated better management practices, which mitigated the negative effects of power supply interruptions, and that the more inefficient, lower productivity firms had gone out of business in the face of electricity insecurity (Cissokho and Seck, 2013).

Analysis from World Bank Enterprise Surveys

For this study, data from the Enterprise Surveys for six selected countries (Bangladesh, Nepal, Nigeria, Pakistan,

Tanzania and Uganda) were analysed to assess the effect of electricity insecurity on the productivity of manufacturing SMEs. The analysis followed the approach taken in other studies using a production function and OLS regression analysis to determine the effects of electricity insecurity on firms' total factor productivity, cost-competitiveness, and investment. The analysis had three elements: (a) an estimation of the impact of electricity insecurity, measured as (yes/no) experience of outages in the previous year, on firm total factor productivity (i.e. output, measured as sales, keeping inputs fixed) and on labour productivity (output per worker); (b) the same estimations, but using the duration and frequency of outages as the measure of electricity insecurity; and (c) an estimation of the effect of electricity insecurity on the labour productivity of firms with different characteristics. The results of are presented in Annex 9.4, Tables 2, 3 and 4.

The analysis reveals that many firms which experience outages have lower productivity than firms which do not. This is shown when productivity is measured in terms of total factor productivity and output per worker, and when the measure of electricity insecurity is binary (outages/no outages). However, all firms that experience outages do not have lower productivity than firms which do not, and some have higher output per worker. When electricity insecurity is measured in terms of the duration and frequency of outages, lower productivity appears to be associated with more frequent and longer outages. This effect is not uniform and some firms experiencing electricity insecurity have higher productivity.

There is no consistent variation in the effect of outages on labour productivity between SMEs of different ages, SMEs of different size (in terms of number of workers), SMEs in different sectors, SMEs with different ownership, and SMEs which have a high or low proportion of costs accounted for by electricity. The analysis employed different definitions of 'high electricity consumption' (i.e. SMEs above the median electricity share of total costs, a sector-based categorisation after Alby et al. (2011), and SMEs 50% above average electricity share of total costs), but in each case there is no difference in the productivity effect of electricity insecurity on SMEs with high or low electricity consumption. With regard to capital intensity, no difference was found in the productivity effect of electricity insecurity between high/low capital intensive SMEs (above/below 50% of average K/L), except in Bangladesh where more capital-intensive firms have a greater loss in productivity.

The differences revealed by the analysis are likely to be due to differences between the six countries in the way firms respond to electricity insecurity, which may be conditioned by both structural and behavioural factors. For example, firms experiencing outages may be high productivity firms in one country and low productivity firms in another. Analysis by sector might test this further, but the data do not include enough observations at this level to be able to draw meaningful results.

Conclusions

The statistical analysis undertaken for this study supports empirical findings that electricity insecurity tends to negatively affect the total factor productivity and labour productivity of manufacturing SMEs. However, this is not consistently found in all circumstances, the effects are not always statistically significant, and findings can be influenced by how electricity insecurity is measured. In some cases, SMEs experiencing electricity insecurity have higher productivity.

Within countries, differences between manufacturing sectors appear insignificant, though the data did not allow for detailed analysis by individual sub-sector. There is some evidence in the literature that in some places there are differences between sub-sectors.

The impact of electricity insecurity on SMEs' productivity is clearly variable, and depends on factors related to both the external context that a firm is operating in and to its internal capabilities. Variation in the findings between countries appears to be related to differences in geography, structure of the economy and SME sector, and the overall business environment. This is consistent with the findings of previous research (World Bank, 2010; Cissokho and Seck, 2013).

The statistical analysis, however, does not explain the difference between perceptions, amounting to a

conventional wisdom, that electricity insecurity is a major constraint on SMEs' operations and growth and the empirical evidence that its impact on productivity is limited. The Enterprise Surveys themselves show that firms see the quality of electricity as a major business challenge, though between the two categories of informants in this study, SMEs and stakeholders, it was stakeholders who perceived outages as a bigger problem. Hallward-Driemeier and Aterido (2009) suggest that firm characteristics affect the importance of perceived constraints. It is also possible that perceptions are influenced by the binary nature of electricity supply, either you have it or you do not have it, and by the frustration of managing with outages which may not be reflected in measurable costs.

How electricity insecurity is measured has a material bearing on the assessment of its productivity effect. The analysis shows that using the duration of outages as the measure of electricity insecurity shows a greater impact than simply the experience of outages. This finding is consistent with previous studies (Cissokho and Seck, 2013; Moyo, 2012), and suggests that future analysis should use duration (the number of hours without power) for the measurement of electricity insecurity.

Electricity insecurity and SME cost-competitiveness

Interruptions to power supplies potentially affect SMEs' costs of production through the expense of repairing or replacing damaged equipment, the cost of spoiled goods and the additional cost of alternative sources of energy, such as generators (Cissokho et al., 2013). The effect of these costs on the competitiveness of SMEs depends in part on their impact on total costs. Reliance on generators for electricity during outages can be expected to increase the cost of electricity, and the effect on cost-competitiveness is related to the proportion of total costs accounted for by electricity.

The relationship between electricity supplies and SME competitiveness has not been explored well by previous studies, and there is an absence in the literature of research that looks explicitly at the influence of electricity insecurity on SME cost-competitiveness. Literature on the effects of outages on enterprise costs tends to consider either total costs or the costs of electricity. Eifert et al. (2008), for example, demonstrate that firm performance is sensitive to the cost of indirect inputs and that these costs, in which energy has the largest share, are a major factor in explaining the low productivity of enterprises in Africa.

According to the Manufacturing Association of Nigeria (MAN), the closure of 820 manufacturing companies in Nigeria between 2000 and 2008, and of a further 834 in 2009 alone, was linked to the high costs of infrastructure (Akuru et al., 2011). Although a causal relationship was not established, a survey published by MAN in 2005, which found that the costs of generating power account for about 36% of production costs, may help explain the impact on company closures (Moyo, 2012).

Study findings

In this study, data analysis in regard to costs focused on the effects of electricity insecurity on unit costs of production, as an indicator of competitiveness. World Bank Enterprise Survey datasets, which include data on total sales and costs, were analysed to determine whether firms with different characteristics have higher unit costs when exposed to outages. Total unit cost was defined as costs as a fraction of sales. As before, the country enterprise surveys included in this analysis were for Bangladesh, Nepal, Nigeria, Pakistan, Tanzania and Uganda.

In most cases there is no difference between the costs of SMEs with different characteristics (age, size, sector, ownership, proportion of costs accounted for by electricity, capital intensity) when experiencing electricity insecurity. Where differences do occur, the variance is not always in

the same direction. For example, medium-sized enterprises in Pakistan have higher unit costs than smaller firms, while in Uganda small-scale firms have higher unit costs than medium-sized businesses. The detailed results are presented in Annex 9.4, tables 5 and 6.

The statistical analysis found that SMEs experiencing outages do not necessarily have higher unit costs of production. This finding holds for the duration as well as the number of outages, it holds when using the log of total costs, and it holds when using the ratio of total costs to (fixed) capital as the indicator of competitiveness.

The analysis shows no consistent variation in the absence of an effect of outages on costs between SMEs of different ages, SMEs of different size (in terms of number of workers), SMEs in different sectors, SMEs with different ownership, SMEs which have a high or low proportion of costs accounted for by electricity (under alternative definitions), SMEs which have high or low capital-intensity, and SMEs which have a generator.

Half of the SMEs interviewed for this study reported that electricity insecurity has an impact on their prices, and half that it does not. Similarly, the number of SMEs who indicated an increase in prices due outages, which was felt to be affordable to their customers or possible because their customers have no alternative, was matched by the number who have not increased their prices for fear of losing their market or having to reduce the number of workers. Some enterprises are sensitive to the relationship between quality and price, one being prepared to compromise on quality to avoid a price increase, and another to increase prices to maintain quality and market.

Half of the SMEs interviewed reported that their prices are similar to those of their competitors and/or are affordable in their market, with roughly equal proportions indicating that their prices are higher or lower than their competition. Their markets are price-sensitive and competitive, and SME operators are conscious of the potential effects of an increase in price to accommodate higher electricity costs.

Conclusions

The analysis undertaken for this study shows that while electricity insecurity does affect SMEs' overall costs generally it does not affect the unit costs of production. Overall, SMEs experiencing electricity insecurity do not have higher unit costs of production than other SMEs and do not experience a competitive disadvantage in this way.

This holds for SMEs that use generators during power outages, despite their higher cost of electricity, and it is consistent with that reported by Cissokho et al. (2013) for SMEs in Senegal.

Part of the explanation for the absence of a significant effect on unit costs is the small proportion of electricity costs in total costs. The Enterprise Survey data for the six countries covered by the analysis show that reported electricity costs account for between 0.37% (Nigeria) and 3.7% (Pakistan) of total costs. In contrast, materials costs, which are variable and may not be incurred during outages, account for between 73.2% (Bangladesh) and 90.2% (Tanzania) of total costs. A further explanation is offered by Cissokho et al. (2013), who found in Senegal

that power outages stimulated SMEs to adopt best management practices, which would help reduce negative effects on unit costs.

The competitiveness of manufacturing firms depends on product quality and the ability to meet orders on time, as well as unit costs. These factors can also be affected by electricity insecurity. Quality can be reduced by spoilage of materials or poorly functioning equipment, as well as efforts to reduce overall costs that might be stimulated by higher electricity costs. Interruptions due to outages affect SMEs' production schedules and the delivery of goods to deadlines. However, these factors are not captured by the standard enterprise surveys.

Electricity insecurity and SME investment

The impact of electricity insecurity upon investment by SMEs, including the establishment of new enterprises, has not been addressed by much previous research. Electricity and its reliability are amongst several considerations when SMEs make investment decisions, so this section begins with a brief review of the main factors influencing SME start-up and growth, and the relative significance of electricity supply. It then looks at the impact of electricity insecurity on start-ups and investment by SMEs, considering differences in firm characteristics.

Factors influencing SME investment

The challenge of promoting the growth of MSMEs has generated an extensive literature on the factors inhibiting their development and expansion (Meadows and Riley, 2003; Aterido et al., 2009). Examining the impact of the business environment on firms of different sizes, Aterido et al. (2009), for example, using data from 56,000 enterprises in 90 countries, found that a lack of finance and poor infrastructure (including electricity) reduce the growth of medium and large firms more than small firms. Business regulations affect the growth of small firms, which may prefer to remain small to keep below the radar of regulators (Aterido et al., 2009; Fjose et al., 2011).

The factors influencing the development and growth of micro-enterprises appear to differ from those for small-scale enterprises. Aterido et al. (2009) show that while small firms (10-49 employees) can face more challenging conditions, micro-enterprises (less than 10 employees) can benefit, in relative and in some cases absolute terms, from an adverse business environment. They suggest that this can potentially explain why very small firms account for a larger share of employment in countries with an adverse business climate.

The critical factors for micro-enterprise growth and development, identified in the literature, fall into five broad categories. Access to finance is perhaps the most frequently cited constraint (Meadows and Riley, 2003; Kingombe et al., 2010) and is affected by both the capabilities of firms themselves and the financial environment they operate in. Other contextual factors are access to markets and sufficient demand, and the availability of institutional support (e.g. business development services and SME associations). Factors that are internal to firms are the skills and capacities of the workforce, including entrepreneurial ability (Meadows and Riley, 2003), and access to appropriate capital equipment and machinery

(Meadows and Riley, 2003; Peters et al., 2010). The latter may be of particular significance for enterprises wanting to use electricity to grow, and includes access to generators as well as electric machinery.

Electricity and SME development

Anecdotal evidence is often used to argue that electricity plays an important role in stimulating micro-enterprise. For example Meadows and Riley (2003) cite Rana-Deuba (2001), who argues that access to electricity produced by micro-hydropower in Nepal contributed to the establishment of enterprises, including agro-processing and sawmills, as well as agriculture and service sector activities. The empirical evidence in Legros et al. (2011) supports this, though most of the enterprises established after the installation of micro-hydro schemes were established several years afterwards. Legros et al. (2011) also found that other factors, such as market access, capital availability, and skills, are critical for potential entrepreneurs to take advantage of the availability of electricity.

The creation of new, often informal, home-based businesses induced by access to electricity has been analysed in a number of countries using data from household surveys (Attigah and Mayer-Tasch, 2013). Some of these studies find positive correlations between electrification and numbers of SMEs, but results must be interpreted with care as the prioritisation of economically dynamic areas for electrification can lead to a bias among surveyed electrified areas compared with areas not electrified. In South Africa, Prasad and Dieden (2007) found that MSME uptake is higher among households with electricity connections, while Dinkelman (2008) found that women in middle income quartiles were better able to take advantage of electrification for income generation. In the Philippines, a study in four provinces found 25% of households in the electrified areas are running a home business (mainly small retail shops) compared to 15% in non-electrified areas (ESMAP, 2002).

Firms established after electrification may be new types of business, offering goods and services that were previously imported from elsewhere or simply been unavailable (Mayer-Tasch et al., 2013). In the Philippines the variety of enterprises was greater in electrified areas (ESMAP, 2002). Peters et al. (2010) found that firms which rely on electricity, established following electrification, have better market access because they offer new products and

sell semi-finished products to other enterprises. They also have the potential outcompete firms that already existed.

Though electrification and the numbers of enterprises may be positively correlated, causality is unproven. Pre-existing economic conditions are clearly important to the impact of electricity access, and the prioritisation of economically dynamic areas for electrification can bias survey results (Attigah and Mayer-Tasch, 2013).

Electrification clearly does not always lead to enterprise growth. Peters et al. (2010), investigating the performance of micro manufacturing firms in grid and non-grid coverage villages in Benin, found that although beneficial impacts from firm creation following electrification occur, firms that existed beforehand perform no better than their matched counterparts in non-electrified regions. Neelsen and Peters (2013) found that the average total resale value of a firm's capital stock does not differ between access and non-access areas, although access to the grid does lead to a shift in the composition of capital stock towards more electricity using machinery and equipment.

Decisions by SMEs to connect to an electricity supply when it becomes available and their consumption of electricity are influenced by the costs involved. Neelsen and Peters (2013) use the example of a carpenter in Uganda to show that the marginal returns to connection are often deemed to be off-set by the high cost of connecting, which are out of proportion to the perceived short and medium terms benefits. In contrast, a foreign-owned small export enterprise planning to scale quickly to a medium-sized enterprise saw electricity as crucial and readily invested in a connection and backup systems (Neelsen and Peters, 2013). However, firms which are not reliant on electricity can decide to invest in grid access without proper assessment of the costs and benefits, and face an 'electrification trap' when they overestimate the profitability of a connection on the premise that electricity is a prerequisite to modernisation (Peters et al., 2010).

Abeberese (2012) uses data on Indian manufacturing firms to show that in response to an exogenous increase in electricity price, firms reduce their electricity consumption and switch to industries with less electricity-intensive production processes, meaning that electricity constraints may lead firms to operate in industries with fewer productivity-enhancing opportunities. Similarly, in Nigeria, on average obtaining an electricity connection takes more than 8 months and costs the equivalent of more than 10 times income per capita (World Bank, 2010). The relative costs of insecurity and back-up generation are explored below.

There is some evidence to suggest that manufacturing SMEs may perceive smaller gains from electricity than service sector firms. In Uganda, Neelsen and Peters (2013) found that manufacturing firms were less inclined to connect to the grid or use decentralised electricity than service firms, because of the high investment costs of electric machinery coupled with sharp competition in the market for manufactured goods.

Electricity insecurity and SME investment

Literature which explicitly looks at the effect of electricity insecurity upon SME start-up and growth is limited. In their paper about obstacles to SME growth in South Africa, Olawale and Garwe (2010) ranked poor electricity supply 25th out of 30 perceived obstacles to SME growth. The analysis of data from Enterprise Surveys by Aterido et al. (2009) found that infrastructure bottlenecks tend to constrain the growth of medium and large firms, but have a positive effect on micro-enterprises, which are likely to have less capital and energy intensive and are able to take advantage of opportunities created by the difficulties that larger firms face. Abeberese (2012) suggests that, in countries with high levels of electricity insecurity, firms may not have an incentive to move to productivity-enhancing industries and grow larger since doing so comes with the cost of having to rely on electricity.

Alby et al. (2011) consider the factors influencing firm size and development at the sector level, and find that in developing countries with a high frequency of power outages, electricity-intensive sectors have a low proportion of small firms since only large firms are able to invest in generators to mitigate the effects of outages. Also, for sectors that are very reliant on electricity (e.g. chemical and textile industries), a high prevalence of outages affects the return to investment so badly that small firms without enough initial assets to invest in a generator end up being squeezed out of the financial market and unable to borrow to expand production (Alby et al., 2011).

In Nigeria where 40% of electricity consumed is produced through own-generation, firms spend up to 20-30% of initial investment on measure to enhance the reliability of electricity supply (Lee and Anasm 1991; Alby et al., 2011). According to Ajayi (1995) in Adenikinju (2005), banks also insist that firms in Nigeria seeking project loans must make provisions for investments in captive generating equipment.

Self-generated electricity is generally more expensive than electricity from the public grid – it adds to capital and operating costs, affecting the range of investment opportunities available to prospective entrepreneurs, raising production costs, lowering competitiveness of local products and blocking the achievement of economies of scale (Steinbuks and Foster, 2010). Firms demonstrate high willingness to pay for reliable power through their investments in self-generation, which Steinbuks and Foster (2010) suggest is an opportunity for government and the private sector to charge higher prices for electricity in order to fund investments that will make power supply more reliable.

Study findings

Analysing data about expenditure on fixed assets from the Enterprise Surveys in Bangladesh, Nepal, Nigeria, Pakistan, Tanzania and Uganda, this study used regressions to determine whether SMEs exposed to more frequent or longer outages are more likely to invest, on average,

than firms experiencing less or no electricity insecurity. The analysis also attempted to show whether the amount invested by firms experiencing electricity insecurity is higher or lower than average. The results are presented in Annex 9.4, tables 7 and 8.

The results of the statistical analysis are mixed. They suggest that in some countries, SMEs with greater electricity insecurity are more likely to invest (i.e. spend more on fixed assets) than other firms. In other countries, SMEs with greater electricity insecurity are less likely to invest (i.e. spend less on fixed assets). The analysis also found that more capital-intensive SMEs are less likely to invest, though the result was not statistically significant in five of the six countries, the exception being Bangladesh.

A total of 17 of the 40 SMEs interviewed for this study, reported that they had invested in the previous year, a proportion that is comparable to enterprises covered by the Enterprise Surveys (17.8-54%). Investment mainly took the form of diversification into other types of business and improvements to the existing business. One firm invested in a generator. One firm dis-invested. Most of the firms interviewed (26) indicated that the reliability of electricity has influenced investment decisions, with 12 stating that it had a high impact. In Bangladesh, for example, firms said electricity had little impact on investment. In Uganda some firms indicated that it affected choice of machinery to invest in, altering investment detail rather than affecting overall decision to invest or not. In Nigeria, the cost of back-up power generation required for larger operations and to operate new equipment was seen as a significant barrier by several firms.

The effects of electricity insecurity on expansion were seen by SMEs interviewed to be felt through costs, including costs of back-up generators. Electricity insecurity also influences where SME expansion takes place, with a preference for urban areas where electricity supplies

are more reliable, and which sectors experience SME expansion. The effect on start-ups, however, was seen as less significant because the availability of a reliable electricity supply is taken into account in the decision to start a business. Electricity insecurity, however, influences where start-ups take place.

Conclusions

The evidence from previous research and this study suggests that electricity insecurity can influence investment decisions, but it is neither the only nor the most significant factor considered by SMEs in their operation and investment decisions. Electricity insecurity appears to have a greater bearing on the growth of medium- and large-scale firms than small-scale enterprises, and on the location of investments by SMEs. It also appears to be more significant for some sectors than others. This is consistent with the finding above (Section 4) that the productivity effect varies between countries, but it differs in finding a difference between sectors. Further research would be necessary to determine the differences in the effect of electricity insecurity in more detail.

The Enterprise Surveys have data on expenditure by firms on fixed assets, but do not reveal what these assets are. Although the interviews suggest that electricity insecurity influences the nature of investment (e.g. location and technology), the analysis is inconclusive in providing an answer to the question whether electricity insecurity is a significant constraint on SME growth, as suggested by some of the literature (Meadows and Riley, 2003; Aterido et al., 2009).

The statistical results are also inconclusive for an alternative hypothesis, that electricity insecurity is a driver of investment in stand-by generators and alternative manufacturing technologies, though in Nigeria endemic electricity insecurity does impact investment in stand-by generators.

Mitigating the effects of electricity insecurity

Firms in China were found by Fisher-Vanden et al. (2012) to reduce energy expenditure and increase material expenditure when there are electricity shortages, possibly achieved by outsourcing the production of intermediate goods. However, the literature suggests that the main way firms of all sizes and sectors deal with electricity insecurity is through use of backup systems, typically diesel generators. The SME and stakeholder interviews also show generators to be by far the most common back-up option, though limiting hours of operation is also a popular solution for motive power. This section first discusses the use of generators by SMEs to cope with electricity insecurity, before considering other actual and potential means.

Generator Use

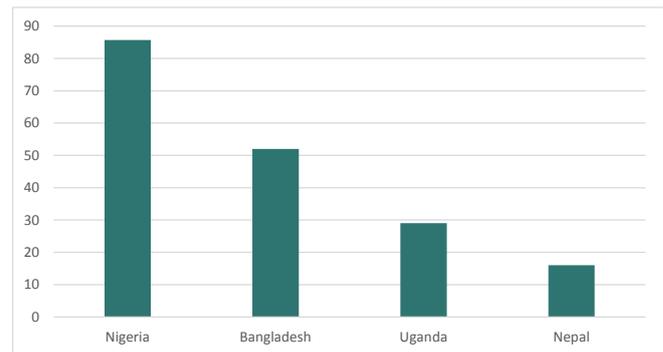
In countries where electricity reliability is very low, electricity-reliant businesses have to invest in diesel generators if they want to sustain regular business operations (Attigah and Mayer-Tasch, 2013). Foster and Steinbuks (2008) estimate that generators owned by firms represent about 6% of total installed generation capacity in sub-Saharan Africa, and up to 20% in some countries (e.g. Nigeria). Figure 2 shows the proportion of SMEs owning or using a generator in four countries with unreliable electricity. According to Malik and Baptist (2006), erratic power supply has become a fact of life for most manufacturers in Nigeria, who now increasingly rely on personal generators, voltage stabilizers, and motors to keep their machines running. Stakeholder and SME interviews in Nigeria confirmed this, with several stating that it is not feasible to start a business requiring motive power without having a backup generator. This puts manufacturing activity out of reach for small-scale low-income entrepreneurs.

Benefits of generator use

The benefits of generator ownership are substantial as firms with their own generators report a value of load lost per hour of less than \$50, compared with more than \$150 for those without (Steinbuks and Foster, 2010). Steinbuks and Foster (2010) found that self-generation is about three times as expensive as the price of purchasing electricity from the public grid. However, as generators only operate a fraction of the time, they do not greatly affect the overall average cost of power to the industry (Steinbuks and Foster, 2010).

According to the SME interviews, generators are used slightly more for lighting and communications than for

Figure 2: Proportion of SMEs owning or using a generator in selected countries



Source: World Bank Enterprise Surveys

motive power and heat. Stakeholder perceptions of current coping strategies place slightly less emphasis on generators than those of SMEs, though in Nigeria it was stated that generator use is seen as a given.

Firm type and generator use

Foster and Steinbuks (2008) argue that generator ownership is greatly affected by characteristics like size, sector, corporate structure and export orientation. This could not easily be substantiated from the interview evidence, as all but one of the SMEs reported generator use. According to Foster and Steinbuks (2008) the probability of owning a generator doubles in large firms relative to small ones. Rud (2012b) found that the adoption of generators by firms to cope with unreliable electricity can induce a reallocation of sales and profits towards more productive firms.

Data analysed for this study showed that SMEs and sole-ownership firms are more likely to adopt standby generators than other firms (i.e. large, and co-ownership firms) (see Annex 9.4, table 9 for detailed results). In 3 of 6 selected countries more capital-intensive firms are more likely to use a generator; in 3 of 6 countries firms experiencing higher frequency of outages are more likely to use a generator; and in 3 of 6 countries firms with high proportion of electricity costs are less likely to have a generator.

Around half of medium sized and large firms have their own generator, compared to just 10% of small and micro enterprise. The average capacity of the generators used by small firms is about one-third of those used by medium

sized enterprises, and a quarter that of large firms (Foster and Steinbuks, 2008). The costs and benefits of own-generation also differ according to firm size, being most efficient for medium-sized firms (Steinbuks and Foster, 2010). Adenikinju (2005) found that in Nigeria small-scale operators are more heavily affected by electricity insecurity because they are unable to finance the cost of the backup generation necessary to mitigate the impact of frequent and sustained outages. Interviews confirmed this finding.

Generator ownership is affected by firm characteristics like size, sector, corporate structure and export orientation (Foster and Steinbuks, 2008), a conclusion that is borne out by the stakeholder interviews for this study. The costs and benefits of generator ownership vary significantly between industries and whether it pays for a manufacturing enterprise to invest in a generator depends on the industrial sector in which the firm operates (Foster and Steinbuks, 2008; Neelsen and Peters, 2013). Size of enterprise is also a key factor affecting generator ownership, the probability of large firms owning a generator being double that of small firms, and the capacity of generators used by large firms four times larger than small firms (Foster and Steinbuks, 2008). Generators were found by Steinbuks and Foster (2008) to be more efficient economically for medium-sized firms than small firms, and the latter may well be unable to finance the cost of self-generation to mitigate the effects of electricity insecurity (Adenikinju, 2005).

No conclusive information was identified about generator ownership and informal SMEs. Informal SMEs interviewed for the study had access to generators. Another variable affecting own generation, however, is conflict - countries that recently experienced or are currently involved in armed conflict have a higher share of own-generation (Foster and Steinbuks, 2008).

In addition to generator use, the study surveys identified that batteries, inverters and even candles are used to replace grid electricity supply. However, none of these alternatives provide motive power during outages.

Sharing generators

Whilst many stakeholders interviewed suggested that sharing backup generators could be beneficial to business, few could provide any practical examples. Issues of trust and lack of proximity of SMEs were seen as key constraints. Where generator sharing occurs, a third party oversees sharing – for example, government-run industrial parks, or sharing is formalised, for example through a cooperative. No examples of manufacturing SME cooperatives were mentioned, beyond village-based agro-processing examples.

Other actual and aspirational coping approaches

Limiting production and changing production processes

Abeberese's study of Indian firms (2012) found that firms primarily use self-generation as a means of coping with outages, rather than in response to price increases, because of the high cost of own-generation. Firms cannot offset reduction in quantity of electricity with own-generation, so experience a reduction in their total electricity consumption (Abeberese, 2012). Evidence from interviews for this study indicates that reduction in electricity consumption can equate to stopping production. Limiting hours of operation was second to generator use in terms of coping strategies for motive power amongst the SMEs interviewed.

SME and stakeholder interviews also revealed that some SMEs, rather than limiting operations, change processes in order to cope. In Nepal, outages follow a reasonably regular pattern, so SME owners can plan evening shifts to correspond to power supply. An example was given of a business where the owner has provided accommodation close to the factory for staff, to enable them to work late evening and night shifts when power is available. The reliability of outages seems to be an important factor in enabling firms to plan in this way. Nepal has reliable load shedding schedules, for example, whereas outages in Nigeria are highly erratic and such planning does not easily work.

Another means of changing processes is to use manual labour and processes not reliant on electricity. The nature of the business dictates whether the use of manual labour is possible, and where it is possible in some sectors, manual processes are considerably slower and produce lower quality results (e.g. in the paper industry in Nepal).

Alternative fuel sources

The Enterprise Surveys do not include data about non-electricity energy expenditure, and the literature reviewed did not reveal instances of SMEs substituting alternative fuels for electricity, other than for generators. However, in their literature review on modern energy and micro-enterprises, Meadows and Riley (2003) cite the finding of Osunbitan et al. (2000) that agro-processing enterprises in Nigeria did not use electric engines because of unreliable power supplies, and preferred to rely on diesel engines. Informants for this study reported the use of other fuels for thermal energy, but not as a direct substitute for electricity.

Renewable energy

According to Santa Clara University (2013), small, modular power generation technologies that can be combined with load management and energy storage systems to improve the quality or reliability of the electricity supply are a critical driver for new business creation and the growth of SMEs. Evidence of this type of activity from informants for this study was very limited. Whilst several stakeholders mentioned renewables

as a good alternative energy source, few of the SMEs reported using them. Those that did were in Nepal and Bangladesh, and only used renewable energy for lighting, communications and information technology.

In their study in Mozambique and Tanzania, Ahlborg and Hammar (2011) found that there are significant barriers to adoption, adaptation and diffusion of renewable energy-based technologies. Fishbein (2003) suggests that in order to use new technologies, such as renewable energy sources, small and micro businesses in particular may need support with skills and knowledge, as well as technical support and capital. Stakeholder interviews confirmed that capital is perceived to be a significant constraint to renewable energy uptake, particularly in Nigeria. Several informants suggested that there needs to be concerted government support to increase renewable energy use. Micro-hydro systems and wind technology were not often mentioned by interviewees, and the consensus with solar was that it is likely to remain too expensive to be used as an electricity source for motive power in manufacturing.

Conclusions

The main mitigation practices are standby generator use, followed by changes in operations, and reduced hours.

There is limited evidence of the sharing of generator amongst SMEs, but strong indication from stakeholders in particular that facilitating further generator-sharing would be beneficial, either through promoting manufacturing SME cooperatives or through the creation of industrial parks with a backup supply.

Although there is awareness of renewable energy, there is limited evidence that it is used as an alternative to grid power at present. For motive power, renewable energy is not perceived to be a viable alternative. Improved availability of renewable energy options and information about them may help to promote their use, but cost is perceived to be the main prohibiting factor.

Changes in operations can reduce the number of stoppage hours during outages, but a reliable schedule of outages would make such changes more efficient to manage. The availability of viable non-electricity alternatives that do not unduly compromise speed and quality of production also enables effective changes in operations.

Conclusions

This study sought to address four main questions. How does electricity insecurity impact on SME's productivity? How does electricity insecurity impact on SME's cost-competitiveness? How does the perceived threat of electricity insecurity influence businesses' decision-making when considering whether to move into a new area or develop their business? What strategies and tactics have SMEs developed (on both supply-side and demand-side) to cope with and mitigate the impacts of electricity insecurity? This section presents the conclusions for each of these questions and some overall conclusions for policy makers.

Productivity

The study's findings support previous empirical analysis that unreliable electricity supplies tend to negatively affect the productivity of manufacturing SMEs. The effects, however, are not always statistically significant, which runs counter to perceptions that electricity insecurity is a major constraint on SME operations. A negative impact on SME productivity is not consistently found in all situations and in some instances electricity outages appear to have a weak positive association with productivity (see Annex 9.4, Tables 1 and 2).

Variability in the effect of electricity insecurity upon productivity might be explained by factors in both the context that SMEs are operating in and the internal capabilities of firms. Previous studies have highlighted the role played by the business environment, including the presence of complementary infrastructure, and the structure of the economy (Cissokho and Seck, 2013; Cecelski, 2004). Beyond the value of capital assets and the number of workers, analysis of how firm capabilities affect the impact of electricity insecurity has not been found. This is potentially an area for further research, although this would need to take account of the variability that has been found in the productivity effect.

The study also found that the results from statistical analysis can be affected by how electricity insecurity is measured. The duration of outages appears to have a greater effect on productivity than the number of days outages are experienced. This suggests that future analysis should use duration (the number of hours without power) for the measurement of electricity insecurity.

Cost-competitiveness

Overall, the study concludes that SMEs experiencing electricity insecurity do not have higher unit costs of production than other SMEs and do not experience a competitive disadvantage in this way. This holds for SMEs that use generators during power outages, despite their higher cost of electricity.

Part of the explanation for the absence of a significant effect on unit costs is the small proportion of electricity costs in firms' total costs and, according to Cissokho and Seck (2013), in the good management practices induced in enterprises facing electricity insecurity.

The competitiveness of manufacturing firms depends on product quality and the ability to meet orders on time, as well as unit costs. These factors can also be affected by electricity insecurity. Quality can be reduced by spoilage of materials or poorly functioning equipment, as well as efforts to reduce overall costs that might be stimulated by higher electricity costs. Interruptions due to outages affect SMEs' production schedules and the delivery of goods to deadlines. However, these factors are not captured by the standard enterprise surveys.

Investment

The evidence from previous research and this study suggests that electricity insecurity can influence investment decisions, but it is not the only or the most significant factor considered by SMEs. Electricity insecurity appears to have a greater bearing on the location of investments by SMEs, which is consistent with the finding that the productivity effect is variable. Although the productivity effect of outages does not vary between sectors, the effect on investment does appear to be more significant for some sectors than others, in particular those that are more dependent on electricity.

The Enterprise Surveys have data on expenditure by firms on fixed assets, but do not reveal what these assets are. Although the interviews suggest that electricity insecurity influences the nature of investment, the analysis is inconclusive in providing an answer to the question whether electricity insecurity is a significant constraint on SME growth, as suggested by some of the literature. The results are also inconclusive for an alternative hypothesis, that electricity insecurity is a driver of investment in stand-by generators and alternative manufacturing technologies.

Mitigation

The study found that the main practice adopted by SMEs to mitigate the impact of electricity insecurity is the use of a standby generator. There is limited evidence of generator sharing, which might offer an opportunity to reduce generator costs to individual firms, and there is a strong indication from stakeholders in particular that facilitating generator sharing would be beneficial. This might be organised through cooperatives or through the creation of industrial parks with a backup supply.

Although there is some awareness of renewable energy options for alternative electricity supplies, which were

mentioned frequently during interviews for the study, there is limited evidence that it is a viable alternative, particularly for motive use. The availability of renewable alternatives and of information about them may help increase their adoption, but cost is perceived to be the main prohibiting factor.

Changes in operations can reduce the number of stoppage hours during outages. However, in order to alter practices efficiently, there either needs to be a reliable outage schedule or an SME needs to have viable non-electricity alternatives that do not unduly compromise speed and quality of production.

Conclusions for policy makers

SMEs in developing countries play a significant role in employment and poverty reduction, especially in growing urban areas. Their contribution to economic development can be enhanced by policies that facilitate access to reliable electricity. Indeed, the reliability of the electricity supply can be more important than having a connection in affecting SMEs' production. Policy makers concerned with the effects that electricity insecurity has on the operation and output of manufacturing SMEs can promote action to reduce negative impacts in a number of ways.

The most obvious area for action is to improve the reliability of the electricity supply, which itself needs to be better measured and monitored. This may require short-term action to reduce technical faults, for example, through maintenance of the transmission and distribution infrastructure, or it may require longer-term interventions to expand generating capacity. In countries where electricity is highly unreliable, the expansion of self-generation, generally a more expensive source of electricity than the public grid, indicates a willingness to

pay for reliable power which may provide an opportunity for the government and the power companies to finance investments that make the power supply more reliable.

In the absence of a better quality supply, governments and electricity suppliers can help SMEs by providing reliable load shedding schedules. Where reliability is caused by lack of generation capacity, and gaps between demand and supply can be predicted, load-shedding should be scheduled and advertised in advance to allow SME operators to plan their production around outages. It may be necessary to focus on reducing technical faults in existing transmission and distribution infrastructure as a short-term priority over the long-term necessity to increase generation capacity in order to provide load shedding schedules.

For many firms an alternative supply of electricity can mitigate the effects of outages. Standby generators are currently the preferred option for most firms, but decentralised renewable technologies are increasingly available. Increased availability of information about renewable energy technologies could facilitate their adoption by SMEs. However, their investment cost can make these alternatives unaffordable for some firms, particularly smaller ones. To improve access to an alternative electricity source by reducing the investment costs, measures such as credit schemes, tax or duty concessions, and shared ownership arrangements, should be considered.

Sharing backup generators or renewable energy capacity to achieve economies of scale could help more SMEs to access and use backup power during outages. However, sharing a power supply generators requires good relationships and trust between firms, and for some the distance from other firms will be a constraint. This can be addressed by mechanisms to facilitate or promote generator sharing.

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Appendix

Terms of Reference

Key Policy Issue/Research Question

How does electricity insecurity affect the productivity and growth of small and medium-sized enterprises (SMEs) in low and middle income countries, and how can this impact be mitigated?

Reliable electricity access is vital to business and firms. High quality and accessible infrastructure encourages productivity, growth and investments, but when it is poor, unreliable, or inaccessible, businesses' productivity and growth suffer.

This research question will analyse how, and to what extent, insecure or unreliable access to electricity can impact on SMEs' productivity and growth, and research how the perceived threat of energy insecurity can act as a barrier to the establishment, or growth, of SMEs. The question will then research into the supply-side and demand-side strategies and tactics SMEs have developed to mitigate the impacts of energy insecurity.

The question will focus on SMEs in the manufacturing sector (including, but not limited to, agro-processing, textile and garment production, and fabrication). The research will focus on small to medium sized companies as large firms are often able to bypass energy constraints as they have the resources available to set up and maintain their own generation capacity.

Key questions to be addressed

1) How does energy insecurity impact on SME's cost-competitiveness and productivity?

Once companies are operating within a country, how does energy disruption impact on cost competitiveness and productivity?

2) How does the perceived threat of energy insecurity influence businesses' decision-making when considering whether to move into a new area or develop their business?

For example, what quantifiable impacts does energy insecurity have on businesses that may be deciding whether to expand or invest within a country? This could include businesses from HICs considering establishing bases or offices within MICs or LICs, or businesses expanding regionally.

How does energy insecurity impact upon the decision of poor would-be entrepreneurs to set-up businesses?

3) What strategies and tactics have SMEs developed to cope with, and mitigate, the impacts of energy insecurity (both supply-side and demand-side)?

How satisfactory do firms feel own generation is as a solution? How high are the entry barriers to generator ownership? How can they be addressed?

Is there any evidence of privately-developed microgrids or cooperative solutions between businesses?

What demand-side measures have businesses developed to mitigate the impacts of energy security? For example, flexible manufacturing processes or adapting programmes of work to minimise disruption.

Are there examples of successful lobbying between manufacturing or business associations to improve reliability of supply?

Expected timeframe for delivery

6 months

How will the research contribute to...

- a) *new knowledge and insights to inform policy, and*
- b) *build on existing studies and research knowledge.*

Reliable electricity access is vital to business and firms. High quality and accessible infrastructure encourages productivity, growth and investments, but when it is poor, unreliable, or inaccessible, businesses' productivity and growth suffer. The World Bank Enterprise Surveys show that firms in middle and lower income countries consider electricity access one of the biggest constraints to their business, with constraints stemming from inadequacies in aspects of electricity service (access to electricity, availability of electricity, and reliability of supply), as well as cost.

Electricity insecurity has impacts on numerous aspects of business operations. The most significant impacts to productivity can be due to forced halts on manufacturing processes, including running assembly lines, use of machine tools, or textile production. Other impacts which can affect small businesses include limited communications (e.g. a lack of access to charging points for mobile phones), missed delivery times, inadequate lighting and risks to refrigeration.

Many small and medium businesses invest in their own diesel generators, however these are often expensive compared to access to centralised electrical power, and require technical expertise and a reliable supply of fuel and spare parts to maintain. In Sub-Saharan Africa, own generation by firms—which has been on the rise in recent years—accounts for about 6% of installed generation capacity in Sub-Saharan Africa (equivalent to at least 4,000 MW of installed capacity). This share doubles, to around

12% in the low-income and post-conflict countries, and increases to over 20% of capacity in the DRC and Nigeria. The operational cost of own generation can be around three times as high as the price of purchasing (generally subsidised) electricity from the public grid, and the initial capital expenditure required to purchase a diesel generator can also have an impact on small businesses³.

While there is some limited existing evidence (particularly in Sub-Saharan Africa) on the impacts of energy insecurity, other than the World Bank's Doing Business and Enterprise Surveys, there is little quantitative information on the impact of energy security on businesses. Unreliable electricity access is a deterrent to businesses looking to expand or enter new markets, and ultimately impacts on a country's economic growth and development.

The first research question will build on existing studies and data, such as the World Bank's Enterprise Surveys, to understand how energy insecurity impacts SME's cost-competitiveness and productivity.

The second two research questions will undertake interviews and analyse specific case studies to identify both how the perceived threat of energy insecurity affects the decision-making of businesses or entrepreneurs; and to identify specific strategies that SMEs have developed to cope with the impacts of energy insecurity.

The research will analyse the success of these interventions, and identify whether these may be replicable and scalable for other SMEs and within other environments or contexts.

What is the overall purpose of the research and what is it intended to accomplish?

This research aims to understand and quantify the impact of energy insecurity on business development, and how it impacts on the decisions on where businesses choose to invest. There is already an existing body of work around the first research question (How does energy insecurity impact on business's cost-competitiveness and productivity?), and the further two questions have been identified as drivers for research.

The outcomes from this research will inform DFID's future energy programming and identify whether there are actions that could or should be pursued to mitigate the impact of energy insecurity on businesses. This research will also act as an initial study to identify further areas of research within DFID's Growth Research Team.

What type of research initiative is proposed? How will it be carried out and what methods might be used to generate the findings and outputs (desk reviews, surveys, fieldwork, etc.)?

The research initiative will comprise:

1) A synthesis of existing research and analysis of data to provide an overview of the existing body of evidence, and a response to the first question (How does energy insecurity impact on business's cost-competitiveness and

productivity?). This review will include a stakeholder mapping exercise to identify business associations, enterprise funds, and unions who can be consulted within the second phase of the study.

This should be completed through an initial desk study and through analysis of existing resources and data, such as the World Bank Enterprise Surveys.

These outputs will feed into an inception report, which will be reviewed by DFID.

2) Evidence-gathering to address the second two questions (How does the perceived threat of energy insecurity influence the decision of businesses and entrepreneurs; and what strategies have SMEs developed to mitigate the impacts of energy insecurity) though:

- A set of targeted telephone interviews with business associations, enterprise funds, entrepreneurs, and other identified stakeholders, and the possible use of a wider quantitative survey.
- A review and analysis of the evidence to produce the required research outputs.

Research outputs

Research outputs are:

- 1) A inception report synthesising the existing research, a stakeholder mapping, and an analysis addressing the first research question (end of month 2)
- 2) A final report of the research outcomes (submitted in draft first for any DFID comments, within 2 weeks, prior to finalising)
- 3) At least one peer reviewed article in a well-respected energy journal
- 4) A final presentation (ppt)
- 5) A short summary outlining the strategies that may be of use to SMEs (≈3 pages), which can be disseminated to stakeholders.

Skills and personnel

It would be envisaged that this research would be undertaken by one or two experienced researchers or research officers with a background in energy and the private sector, with input and direction from senior research staff. The team could comprise, for example:

- 1) Research lead with demonstrated track record in providing high quality research outputs, to provide leadership, and quality assurance.
- 2) One research officer with demonstrated experience in producing papers on energy and the private sector, with experience in SMEs, cost-competitiveness, and productivity.

Potential Users/User Engagement - inside DFID, across HMG and in partner countries

In DFID:

- The Infrastructure, Climate and Environment, and Private Sector cadres
- The Policy Division (Low Carbon Development team)
- The outcomes of this research will also contribute towards the energy research programmes under development within DFID's Growth Research Team and Climate and Environment Research team.

Across HMG:

- Department for Business, Innovation and Skills
- Whilst the focus of this research will be relevant for SMEs and businesses operating in countries with an insecure electricity supply, possible mitigation strategies for firms may have energy-saving or cost-savings solutions which would be of interest to UK businesses.

Communication strategy – engaging users and communicating findings

The findings of the research will be communicated through the DFID R4D website, and will be submitted for peer reviewed journal publications. Links will also be made to other key institutions, such as the World Bank and the World Bank's "Doing Business" team, the Sustainable Energy for All initiative, and UNDP to communicate the findings of the project. The findings of the research will also be shared through a seminar to which interested DFID and external participants will be invited.

Interviewees

Country	Stakeholders	SMEs
Bangladesh	BEI	1 st Choice Real Estate
	GIZ	Amazing Printing
	Katalyst	Arts and Crafts
	IFC	Bangladesh Shilpa Furniture
	IDCOL	Colourline Limited
	BSCIC	Good Star Automobiles
	Bangladesh Bank	S.S. Printers
	Energypac Ltd and DCCI	Comilla Ideal Timber Traders
	ICCI	Topal's Dress
	IDLC Finance Ltd.	Premium Sweets
Nepal	BWCCI	
	Asian Development Bank	Ganesh Ceramics
	Alternative Energy Promotion Centre	Unregistered
	FNCCI	Sen Soap Industry
	FNCSI	Om Handicraft
	FWEAN	Himalayan Biotrade
	National Planning Commission	SEAN Seed
	NACEUN	Mahila Utthan Pashmina Uddhyog (Women Upliftment Pashmina Industries)
	DoCSI	Greenland Organic Farm
	Ministry of Industry	Shree Textiles
Nigeria	Nepal Electricity Authority	Gorkha Ayurved Company Pvt Ltd
	Albertina Nigeria Ltd	Uru Industries
	SMEDAN	La Flavour Bakery
	MAN	Lord's Will Venture
	Anambra Ministry of Commerce and Industry	Bold Ventures
	Awka Chamber of Commerce & Industries	Cutix
	Onitsha Chamber of Commerce	Manya International
	Bank of Industry	Mikky Distillers
	Standards Organization of Nigeria	Omata Holdings
	Enugu Electricity Distribution Company	Onyerika Metal Construction
NASME	Stargate Industries	

Interviewees (continued)

Country	Stakeholders	SMEs
Uganda	Electricity Regulatory Authority	Block Technical Services
	Global Trust Bank	Busagazi Millers Association
	KACITA	Hot Loaf Bakery
	Ministry of Energy and Mineral Development	Kutegeregana
	Private Sector Foundation of Uganda	Magie Engineering
	UEDCL	Reliable Engineering and Décor Ltd
	Uganda Investment Authority	Sam Diesel Services
	USSIA	Textile Development Agency
	UWEAL	Uganda Joinery and Steel Fabricators
	Enterprise Uganda Foundation	New Express Engineering Workshop
	National Insurance Corporation	

Table 2: Productivity effect of outages

	Bangladesh		Nepal		Pakistan		Nigeria		Tanzania		Uganda	
	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker
<i>All firms</i>												
Power outages last year? (=1 if yes)	-0.177 (0.07)**	-0.214 (0.08)*	-0.031 (0.08)	-0.869 (0.18)***	-0.194 (0.16)	0.462 (0.34)	0.037 (0.23)	.074 (0.09)	-0.101 (0.10)	0.509 (0.20)***	-0.482 (0.21)**	-0.294 (0.20)
Observations	993	1142	175	239	307	307	1547	1549	269	270	663	884
R2	0.83	0.13	0.97	0.37	0.96	0.16	0.96	0.13	0.93	0.31	0.60	0.07
<i>SMEs only</i>												
Power outages last year? (=1 if yes)	-0.144 (0.09)*	-0.090 (0.11)	0.043 (.08)	-0.282 (0.16)*	-0.217 (0.17)	0.615 (0.31)**	0.048 (0.03)*	0.163 (0.08)**	-0.143 (0.10)	0.433 (0.19)**	-0.424 (0.21)**	-0.130 (0.21)
Observations	702	799	123	180	282	282	1483	1485	236	237	545	724
R2	0.76	0.11	0.93	0.18	0.94	0.14	0.95	0.10	0.90	0.31	0.67	0.09

Table 3: Productivity effect of frequency and duration of power outages

	Bangladesh		Nepal		Pakistan		Nigeria		Tanzania		Uganda	
	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker	TFP	Output per worker
<i>Frequency</i>												
Frequency of power cuts (per month)	0.001 (.001)	0.001 (.001)	-.002 (.002)	-.014 (.005)***	-.005 (.005)	-.007 (.009)	.001 (.0003)***	.005 (.001)***	.005 (.007)	.009 (.010)	-.004 (.006)	-.024 (.015)
Observations	519	600	97	135	497	653	1386	1388	183	184	265	265
R2	0.73	0.15	0.92	0.22	0.58	0.09	0.95	0.12	0.91	0.37	0.95	0.12
<i>Duration</i>												
Average duration of power cuts (hours)	0.009 (.004)**	.015 (.008)*	-.012 (.031)	-.117 (.041)***	-.0003 (.007)	-.003 (.009)	-0.002 (.001)*	.006 (.003)**	-.012 (.012)	-.052 (.021)**	-.002 (.005)	-.029 (.011)***
Observations	519	600	54	72	498	653	1387	1389	184	185	265	265
R2	0.74	0.15	0.95	0.06	0.58	0.08	0.95	0.10	0.91	0.39	0.95	0.13

Table 4: Productivity effect by firm characteristics

The table reports whether there is a differential effect of power outages on the productivity of the sub-groups that are being compared.

	Bangladesh	Nepal	Pakistan	Nigeria	Tanzania	Uganda
Young v. rest	No difference	No difference	No difference	No difference	No difference	No difference
Very young v. rest	Very young negative	No difference	No difference	Very young negative	No difference	No difference
Small v. Medium	No difference	No difference	Medium negative	No difference	Small Negative	Medium negative
Sole ownership v. rest	No difference	No difference	No difference	No difference	No difference	No difference
Sector 1 v. 2 v. 3*	Sector 3 negative	No difference	No difference	No difference	No difference	Sector 2 Negative
High v. Low Electricity costs A	Low negative	No difference	No difference	No difference	No difference	Low negative
High v. Low Electricity costs B	No difference	No difference	No difference	High negative	High positive	No difference
High v. Low Capital Intensity	High negative	No difference	No difference	No difference	No difference	No difference

* Sector 1: food, garments, textiles and leather products; Sector 2: chemical and non-metallic mineral products; Sector 3: machinery and equipment, other metal products.

Statistical analysis

In most cases there is no difference between the costs of SMEs in the groups being compared. The only discernible differences are as follows:

- In Bangladesh and Nigeria, very young firms (i.e. the 25% youngest firms) have lower productivity than other firms.
- In Pakistan and Uganda, medium sized firms have lower productivity, while in Tanzania small firms do.
- In Bangladesh, firms in Sector 3 and in Uganda firms in Sector 2 have lower productivity.
- In Uganda, firms with low electricity costs and in Nigeria firms with high electricity costs have lower productivity. In Tanzania, firms with high electricity costs have higher productivity.
- In Bangladesh, firms with high electricity costs have lower productivity.

In most cases there is no difference between the costs of SMEs in the groups being compared. The only discernible differences are as follows:

- In Nepal and Uganda, older firms have higher costs than other firms.
- In Pakistan medium sized enterprises have higher costs than smaller firms, while in Uganda it is the opposite.
- In Bangladesh and Uganda, firms in sector 2 [?] have higher costs.
- In Nepal and Uganda, SMEs with relatively low electricity costs have higher unit costs of production; in Nigeria it is

firms with high electricity costs that have higher unit costs. In Tanzania, firms with high electricity costs have lower unit costs.

- In Nepal and Nigeria, firms with generators have higher unit costs.

With the exception of firms in Bangladesh, there is no difference between SMEs of high- and low-capital-intensity in decisions to invest. In Bangladesh, firms with high capital intensity are less likely to invest.

Summary of stakeholder and SME key informant survey

Interview Approach

Semi-structured interviews were conducted in four countries – Bangladesh, Nepal, Nigeria and Uganda. A total of 82 interviews conducted, 40 SME interviews (10 in each country) and 42 stakeholder interviews (11 in Bangladesh and Uganda, 10 in Nepal and Nigeria). Interviews with SMEs were with owners or managers, depending on availability. The other interviews were with stakeholders in each country, across a range of different types of organisation (details below and full list in Annex 9.2). SME interviews captured basic information about the size and nature of the SME, their experience of outages and use of power, then asked them how they mitigate outages for the various different ways in which their business uses electricity. Finally, they

Table 5: Costs

	Bangladesh		Nepal		Pakistan		Nigeria		Tanzania		Uganda	
	Total Unit Cost	Cost/Capital	Total Unit Cost	Cost/Capital	Total Unit Cost	Cost/Capital	Total Unit Cost	Cost/Capital	Total Unit Cost	Cost/Capital	Total Unit Cost	Cost/Capital
All firms												
Power outages last year? (=1 if yes)	0.052 (0.048)	-0.019 (0.130)	0.026 (0.052)	-0.105 (0.297)	0.067 (0.16)	-1.629 (1.01)	-0.012 (0.019)	0.132 (0.094)	0.054 (0.087)	0.545 (0.448)	0.122 (0.065)**	-0.820 (0.576)
Observations	781		180		607		1485		232		273	
R2	0.04		0.04		0.04		0.02		0.06		0.05	
Frequency of power cuts (per month)	0.0004 (0.0006)	0.003 (0.001)*	0.006 (0.002)***	-0.004 (0.007)	-0.002 (0.002)	-0.009 (0.006)	-0.0004 (0.000)	-0.002 (0.002)	0.001 (0.005)	-0.043 (0.02)**	-0.002 (0.003)	0.006 (0.015)
Observations	584		135		551		1388		184		265	
R2	0.04		0.10		0.04		0.03		0.09		0.04	

Table 6: Costs

The table reports whether there is a differential effect of power outages on any of the sub-groups that are being compared. A positive result for a group implies that costs are higher for SMEs that share the specified characteristic.

	Bangladesh	Nepal	Pakistan	Nigeria	Tanzania	Uganda
Young v. rest	No difference	Old positive	No difference	No difference	No difference	Old positive
Very young v. rest	No difference	Old positive	No difference	No difference	No difference	Old positive
Small v. Medium	No difference	No difference	Medium positive	No difference	No difference	Small positive
Sole ownership v. rest	No difference	Rest positive	No difference	No difference	No difference	No difference
Sector 1 v. 2 v. 3*	Sector 2 positive	No difference	No difference	No difference	No difference	Sectors 1 and 2 positive
High v. Low Electricity costs A	No difference	Low positive	No difference	High positive	No difference	Low positive
High v. Low Electricity costs B	No difference	No difference	No difference	No difference	High negative	No difference
Firms with Generator	No difference	Generator positive	No difference	Generator positive	No difference	No difference
High v. Low Capital Intensity	No difference	No difference	No difference	No difference	No difference	No difference

* Sector 1: food, garments, textiles and leather products; Sector 2: chemical and non-metallic mineral products; Sector 3: machinery and equipment, other metal products.

Table 7: Investment

	Bangladesh		Nepal		Pakistan		Nigeria		Tanzania		Uganda	
	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment
Power outages last year? (=1 if yes)	0.082 (0.04)**	-0.929 (0.42)**	0.136 (0.08)*	-0.730 (.603)	0.044 (0.37)	1.29 (0.49)***	0.038 (0.052)	0.267 (0.72)	-0.066 (0.08)	-1.264 (1.33)	0.315 (0.07)***	5.084 (1.07)***
Observations	814	210	180	55	766	576	1485	1485	237	237	282	281
R2	0.07	0.20	0.17	0.52	0.05	0.05	0.04	0.06	0.07	0.09	0.09	0.11
Frequency of power cuts (per month)	0.0002 (.001)	-0.003 (.004)	-0.006 (.003)**	-0.022 (.020)	-0.0004 (.001)	-0.0007 (.008)	.0000 (.0007)	.004 (.010)	.007 (.005)	.109 (.081)	0.016 (.006)**	0.253 (.106)**
Observations	610	173	135	46	691	527	1388	1388	184	184	265	264
R2	0.09	0.33	0.22	0.60	0.05	0.05	0.04	0.05	0.06	0.05	0.07	0.09
Average duration of power cuts (hours)	-0.003 (.002)*	-0.186 (.132)	-0.030 (.030)	0.047 (.031)	.003 (.004)	.061 (.065)	0.014 (.002)***	.193 (.03)***	.002 (.009)	-.011 (.146)	-.003 (.005)	-.065 (.083)
Observations	610	173	72	19	691	528	1389	1389	185	185	265	264
R2	0.07	0.33	0.28	0.68	0.05	0.05	0.07	0.09	0.05	0.08	0.06	0.07

Table 8: Does the decision to invest or the amount invested differ for firms according to the capital intensity?

	Bangladesh		Nepal		Pakistan		Nigeria		Tanzania		Uganda	
	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment	Purchase any fixed assets? (=1 if yes)	Log Investment
High v Low Capital Intensity	High negative	No difference	No difference	No difference								

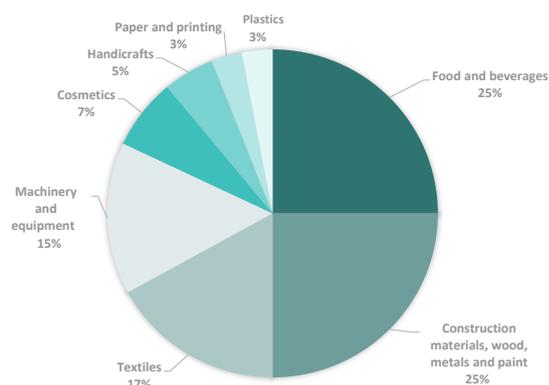
were asked about the cost competitiveness of their business, and about how electricity insecurity has affected investment. Stakeholders were asked less quantitative questions about the importance of electricity unreliability to SMEs, the mitigation strategies adopted, and the impact on investment.

Interviewee profile

SMEs

10% of the SMEs had 5 staff or fewer, 65% of the SMEs had 6-50 employees, 20% had 51-100 employees and 5% had more than 100. The average size of the sample is just under 38 employees. Figure 3 shows the breakdown of SMEs by sector. All SMEs interviewed were in the manufacturing

Figure 3: SMEs by sector



sector, and the sample covers major sub-sectors. 85% were in urban areas, 5% in rural areas and 10% in peri-urban areas.

Stakeholders

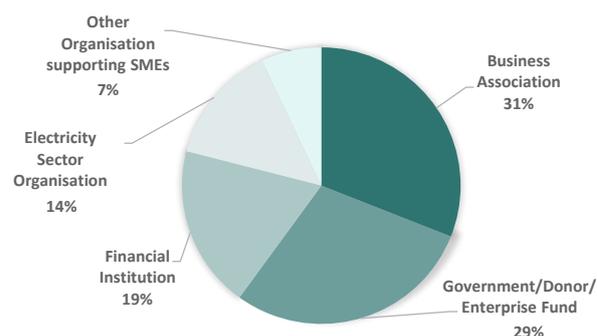
Figure 4 shows the split by organisation type of the stakeholders interviewed.

Productivity and Cost competitiveness

Perceptions of the impact of electricity insecurity

Based on SME perceptions, outages are least frequent in Bangladesh and most frequent in Nigeria. The most 'reliable' electricity was in Nepal, and rated similarly unreliable in Nigeria and Uganda.

Figure 4: Stakeholder organisation type



The perceived importance of the cost of electricity for SMEs varied from very important to those who said it was not very important, although there was fairly evenly split across the SME sample across the range of perceptions. In general, the cost of electricity is least important to Bangladeshi SMEs, and most important to Nigerian SMEs.

Stakeholders in Uganda and Nigeria perceived electricity costs to be more important than stakeholders Nepal and Bangladesh. Overall stakeholders perceived electricity costs as more important to SMEs than SMEs themselves did. There is variety even within countries in terms of stakeholder perceptions:

Table 9: What type of firms adopt power generators?

	Bangladesh	Nepal	Pakistan	Nigeria	Tanzania	Uganda
Outage	Less likely	Less likely	Less likely	No difference	No difference	More likely
Frequency of cuts	No difference	More frequency less likely	No difference	More frequency more likely	No difference	More frequency less likely
Age	Older more likely	No difference	No difference	No difference	No difference	No difference
Sector	No difference	No difference	Sector 3 less likely	Sector 2 less likely	No difference	Sector 3 more likely
SME v others	SME less likely	SME less likely	SME less likely	SME less likely	SME less likely	SME less likely
Sole ownership	Sole owners less likely	Sole owners less likely	Sole owners less likely	No difference	Sole owners less likely	Sole owners less likely
High Electricity costs	High less likely	High less likely	High less likely	No difference	No difference	No difference
High Capital Intensity	No difference	No difference	No difference	High more likely	High more likely	High more likely

'Grid is expensive – you pay for connection whether it gets used and whether you get power or not.' (Nigerian stakeholder)

'Access is very, very cheap, if everything was working properly.' (Nigerian stakeholder)

Stakeholders highlighted that backup generation costs are high, both the cost of diesel and generators themselves, even when the generators are second hand and the diesel subsidised. Indirect costs also make electricity expensive: a Ugandan stakeholder mentioned production costs, reduced man hours and repair costs, for example.

'Directly, [electricity costs are] not so high, but indirectly and considering the overall impact on the business for an SME, the real cost may be very high indeed.' (Bangladesh stakeholder)

Electricity reliability is not perceived by most stakeholders to be the most important constraint on SMEs, although several observed that it is a prerequisite for doing business, alongside capital and skills and market access:

'Need capital, need to plan, need to employ people and to invest in local, need to power materials and machinery – not until you get all of these things does the business function effectively – need electricity, without electricity all your effort in other areas is in vain.' (Nigeria stakeholder)

'Everything goes hand in hand, so for example without electricity it is hard to use technology, no electricity means lower levels of productivity from using more basic tools. Manual labour is slower, need electricity for better productivity.' (Nepal stakeholder)

Some stakeholders did consider that electricity security is a fundamental constraint:

'SMEs can manage to handle other obstacles like, finance, market, technical support etc., but it becomes very difficult to handle the electricity insecurity.' (Bangladesh stakeholder)

'The management problem is always there, without electricity though it doesn't matter how smart you are.' (Nepal stakeholder)

Whereas some indicated that access to reliable power is a surmountable problem:

'When SMEs need power, they will have to get back up or would be out of business. Access to finance – can't control it, unlike backup power, so has more impact.' (Bangladesh stakeholder)

Table 10: Uses of electricity by SMEs

Percentage of SMEs mentioning each use	
a) Heat	17
b) Communications and IT	23
c) Lighting	38
d) Motive power	39

'Without money, can't operate but without electricity can find ways to cope.' (Bangladesh stakeholder)

Reliability of load shedding schedules also seems to have an impact on business planning/coping strategies. In Nepal, stakeholders said that load shedding schedules are reasonably reliable and allow businesses to plan and adjust shift times accordingly. This was definitely not the case for Nigeria, where even 'planned' outages do not necessarily coincide with advertised schedules, where such schedules are even provided.

Uses of electricity

The vast majority of SMEs interviewed used a combination of grid and self-generated electricity (82.5%). One used only generator power, and 4 used renewable energy in addition to grid or generator power. Table 10 below shows the proportion of all SMEs interviewed that mentioned each type of use for electricity.

The most cited use of electricity is for motive power, followed by lighting. Heat is the least common use of electricity by the SMEs interviewed and, when it is used, is typically only used as part of the production process. SMEs rated motive power as the most important use for electricity, and communications and information technology as the least important.

Impact of unreliability on prices

Within and across countries, SMEs were evenly split between those that thought that outages impact on prices and those that do not. For those who did perceive price increases, several said they would respond by increasing prices, and that they could do so either because their product remained affordable and/or because there was no alternative for customers, so they would continue to pay. Several SMEs, however, said they would not increase prices in the face of rising costs for fear of losing their market base or having to reduce staff, with one saying that instead of cutting costs they compromised on product quality because the local market preferred that to price increases.

'Our prices are competitive among similar companies that are doing quality services but higher than small companies who don't care about quality. This is a big challenge. We

are losing clients to those low quality companies.’ (Uganda SME)

As Table 11 shows, SMEs are quite evenly split between those who perceive that their prices are low or high compared to similar businesses, with a majority stating that their prices are similar.

One SME indicated that they work long hours in order to remain competitive:

‘Our prices are competitive among our competitors because of our flexibility to work when conditions are favourable. During our time of existence, we have seen many people start similar businesses and collapse even before half a year. We are lucky that we are still in existence. But our survival is at high cost. Our families miss us.’ (Uganda SME)

Another explains the importance of moderating generator use to keep costs affordable:

‘When we are pricing, we have to consider the open market prices and this is why we limit the hours of work while on a generator. If you run many hours on generators, you produce products at a high cost beyond the open market prices.’ (Uganda SME)

Investment

18 of the 40 SMEs interviewed said that they had invested in their business in the previous year; 22 had not. Of those that did invest, most improved or expanded the existing business, some diversified into other businesses, and a small number invested in additional electricity generation capacity or added staff. Two of the SMEs interviewed did the reverse, and reduced the size of their businesses.

‘We keep on changing designs of fabrications to meet the different needs of our clients and to attract new customers. There are many Indians and Chinese who have setup workshops manufacturing similar things with new technologies. We have to innovate in order to cope with those competitions. Of course, many Ugandans who have

left us for those improved goods but they don’t have a lot of money. So, they stay buying from us even when our quality is lesser because our prices are cheaper.’ (Uganda SME)

‘Last year I invested in a new machine what would help produce improved variety of soap. I made investment in a hope that the load shedding situation would improve, and there would be less power cut. However, load shedding hasn’t gone down. I had planned to buy more machines, but now I am not investing more as there is no adequate electricity.’ (Nepal SME)

‘Yes, we increased our investment in constructing a new factory and also renovated the old one. So far we haven’t expanded the production but sometimes we expand when we get more orders in which case we mostly depend on generator.’ (Nepal SME)

26 of the SMEs said that electricity reliability has an impact on their investment decisions, and 14 said it did not. Of those that said there was an impact, only 12 found this to be a high impact with the remainder perceiving the impact to be moderate or limited on their business.

‘Reliability of electricity supply has influenced our decisions to invest e.g. it **influences the type of machinery we have to procure**. Before new workstations/ branches are opened the issue of electricity is considered as **paramount**.’ (Uganda SME)

‘Uninterrupted electricity would have surely helped us to invest more in other inputs to increase production. Now I’m seeing a **tendency of people becoming middlemen rather than involving in the production process**. Such middlemen would have easily involved in production had there been enough electricity, and no additional cost for diesel generator and other such sources.’ (Nepal SME)

‘Investment decision has not much to do with electricity availability because our biggest problem in investing more is that we are not able to compete with cheap Chinese products.’ (Nepal SME)

Table 11: Prices compared to similar businesses (SMEs)

Prices compared to similar businesses	
Low prices	27.50%
Affordable/similar to other businesses	50.00%
High prices	22.50%

Impact of unreliable electricity on expansion

In terms of how stakeholders perceive unreliable electricity to impact on the expansion of SMEs, the most common response is that it reduces capacity to expand, forces the business to invest instead in backup generation and/or makes the business uncompetitive. Unreliable electricity was also perceived to lead SMEs to use sub-optimal processes and technology for production, which impact on the quality of outputs.

‘Second best technology happens a lot, but firms will invest when they are in industries that need to keep up with technology and can’t avoid it e.g. in printing – it’s big, you to compete need to be up to date with technology, if not, you’re pushed out because of poor quality outputs, rather than staff/manual processes vs technology costs.’ (Nigeria stakeholder)

Several stakeholders suggested that expansion is more difficult in rural areas, because the electricity supply is more unreliable than in urban areas.

For the expansion of SMEs, assurance from different authorities on electricity availability is very important. According to informants, SMEs’ expansion in rural areas is not happening in Bangladesh because of electricity insecurity. This is causing a major problem of over-crowding the capital city. Efforts to keep people in Dhaka happy are stronger among the policy makers. *In recent years, the power situation in Dhaka has improved dramatically, but not proportionately in rural areas.* Bangladesh stakeholder

Nepali and Bangladeshi stakeholders in particular said that there is a preference for labour-intensive industry over new technology which is electricity dependent, although one stakeholder indicating that this is changing.

‘Spending more in purchasing power curtails investment. Still have a lot believing in labour-intensive production (cheap and low collateral) but companies/entrepreneurs are accessing finance for technology – this is happening through ICT sector, INGO skills development programmes. Currently a period of transformation towards technology is happening in agriculture, IT industry, leather – SME funding is available, and is shifting technology.’ (Bangladesh stakeholder)

Informants in Nigeria also mentioned that smaller firms are more labour intensive.

Stakeholders mentioned that it was harder for both smaller enterprises (small and micro) and manufacturing sector SMEs in general, to expand. One stakeholder

mentioned the impact of product quality requirements for exporting SMEs as influencing their ability to work without electricity and thus to be profitable and expand.

‘Firms that are largely affected are the packaging ones, fabrication firms, agro-processing and others. Unlike other businesses that can survive on one phase line of power supply, SMEs in manufacturing require a three phase line of power supply which consumes a lot of power.’ (Uganda stakeholder)

Impact of unreliable electricity on start-up decisions

Several stakeholders expressed that electricity costs are factored in to any start-up decision, regardless of sector. However, some said that reliability of electricity had a low impact on start-up decisions, either because it had to be factored in regardless of sector if a business is to be started, or because it is not the biggest consideration. Stakeholders noted biases towards urban businesses, businesses with low start-up and running costs and a general reluctance to start manufacturing SMEs because of the higher initial costs, linked to costs of power and the risks of production problems. It was mentioned that entrepreneurs may prefer to start in a non-manufacturing sector and move across once they are making sufficient profit to invest at a reasonable scale.

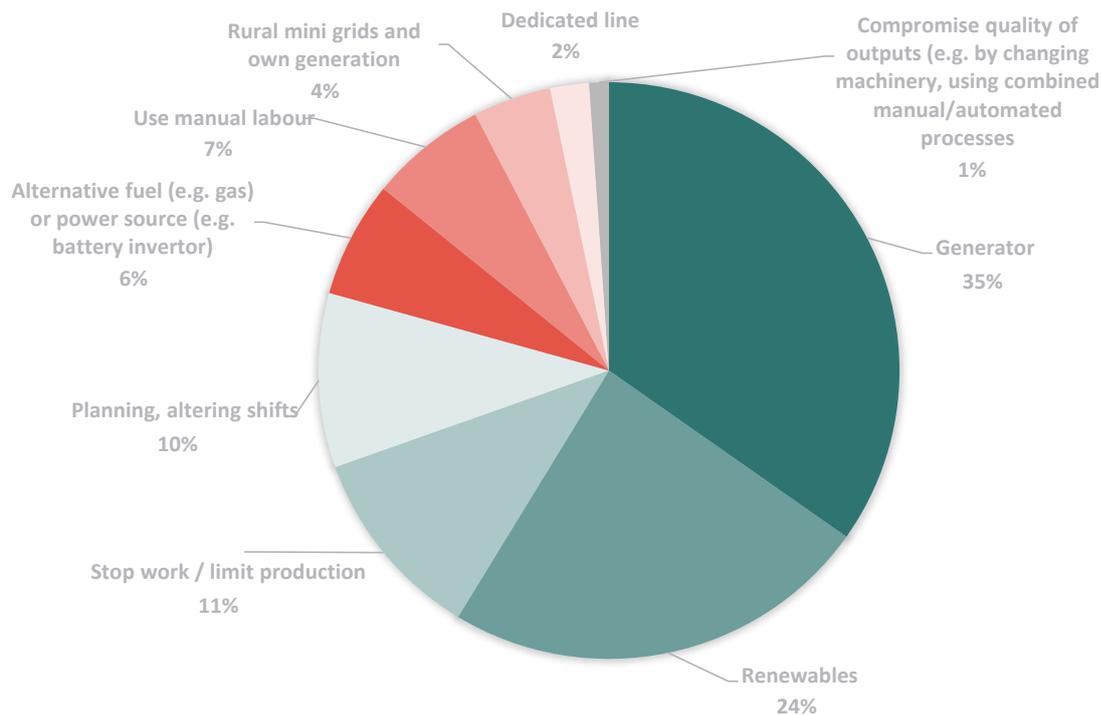
‘Most of the SMEs feel real problem of unreliable electricity after starting a business; but not at the beginning.’ (Nepal stakeholder)

‘The manager explained to me that most entrepreneurs he meets do not have preferences in certain sector; they are mostly driven by profit. Consequently, their focus would be on how to use generators instead on general electricity supply. So start-up decisions for electricity supply is centred mostly on availability of generators rather than depending on general supply.’ (Nigeria stakeholder)

Table 12: Alternatives to grid electricity for SMEs (by percentage for each type of electricity use)

Alternative	Lighting	Motive Power	Heat	Comms and IT
Alternative fuel	0.00%	3.33%	22.73%	0.00%
Stand-by generator	50.88%	45.00%	45.45%	54.05%
Manual labour	0.0%	15.00%	4.55%	0.00%
Limit hours of operation	12.28%	31.67%	22.73%	10.81%
Changes in process	3.51%	5.00%	0.00%	0.00%
Renewable Energy	5.26%	0.00%	0.00%	5.41%
Batteries, inverters, candles	19.30%	0.00%	4.55%	29.73%

Figure 5: How SMEs cope – Stakeholder perceptions (% of times mentioned)



Mitigation strategies

As Table 12 clearly shows, generators are by far the most common back-up option, although limiting hours of operation is also a popular solution for lack of motive power. Renewable energy and batteries and inverters are not used for motive power. In addition to the categories set out in Table 12 and used during the interviews, a further coping strategy was identified – changing processes, managing production times, processes and staff use in order to make best use of power when available.

Renewable energy was not mentioned at all by informants in the three African countries, nor was alternative fuel use. Generator use is the most common alternative to lack of grid power across the countries, although it has an overall lower mention rate in Asia. Manual labour was mentioned most in Nigeria, and least in Uganda. Limiting hours of operation is more common in Nigeria and Uganda, less so in Nepal.

Stakeholder perceptions of alternatives used by SMEs were similar to those of the SMEs themselves, although the proportion of mentions of generator use was slightly lower. Other alternatives were suggested by stakeholders, including access to a dedicated line from the grid (which a company pays a premium for, to have preferential supply when a supply is available), compromising the quality of outputs (by changing the machinery used, as well as using partially or wholly manual processes) and the use of mini grids and own generation by SMEs. See Figure 5 below.

Sharing Generators

Stakeholders were prompted about whether they thought generator sharing happened or could happen. There was

some limited experience of sharing taking place, but not typically between manufacturing SMEs, and there was general scepticism that sharing could work, outside of formal industrial parks or cooperative systems.

'[Generator sharing is] only seen in market places, where there is a cluster of shops selling different goods (and some services), rather than manufacturing units in dispersed places. If a small manufacturing unit used generator (shared or own), the purpose would mostly be lighting and fans, seldom motive power.' (Bangladesh Stakeholder)

Renewable Energy

As per Figure 5 above, few of the SMEs mentioned that renewable energy was a source of alternative power, and none used it for motive power. Renewable energy use (particularly solar PV) seems to be much more prevalent in Nepal and Bangladesh, on the basis of stakeholder interviews, than in Africa, particularly in Nigeria.

'RE for consumptive power not productive purposes. Same with battery backup.' (Bangladesh stakeholder)

'RE is new in Nigeria, not yet seen in factories.' (Nigeria stakeholder)

Suggested coping solutions

In addition to existing practices, stakeholders were also asked about how best they thought SMEs should mitigate

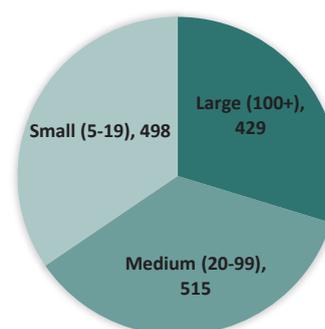
Table 13: Stakeholder perceptions on how should SMEs cope (% of times mentioned)

	Bangladesh	Nepal	Nigeria	Uganda	Total
Generators are the only or best solution/Improve generator technology	0	0	2	1	3
Invest in own generation	0	0	1	3	4
Local independent power companies and mini grid systems	1	2	1	0	4
Share generators	1	0	0	5	6
Change to policy/increase govt capacity to provide reliable grid energy	2	0	3	4	9
Improved load shedding schedules	0	0	1	0	1
Increase renewable energy access and use	2	3	2	8	15
Industrial clusters/business parks with power supply	1	1	4	0	6
Management of staff (inc providing housing) and timing of processes	1	1	2	1	5
Energy efficiency measures/technologies	1	0	1	5	7

Table 14: Bangladesh MSMEs by Sector (2003)

Sector	% of SMEs
Wholesale & Retail	40%
Agriculture & Fishing	26%
Manufacturing	14%
Hotels & Restaurants	5%
Other	4%
Transport & Storage	3%
Real Estate & Renting	3%
Other Services	3%
Construction	1%
Health & Social Work	1%

Source: IGE (2003)

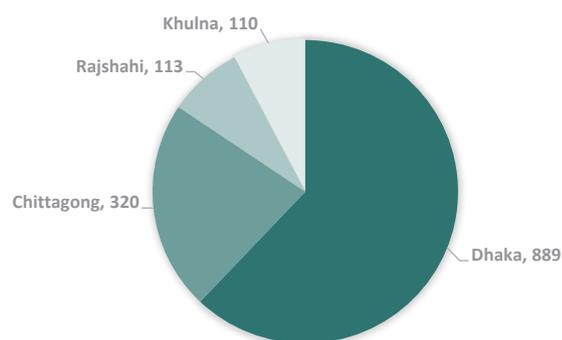
Figure 6: SME size, Bangladesh Enterprise Survey 2013

Source: Enterprise Surveys, <http://www.enterprisesurveys.org>, The World Bank, 2013

Table 15: Bangladesh Enterprise Survey – Key SME Indicators

Subgroup Level	Age (years)	Percent of firms with a female top manager	Capacity utilization (%)*	Number of permanent full-time workers	Proportion of permanent full-time workers that are female (%)
All	18.5	4.8	84.0	184.0	15.8
Small (5-19)	18.9	3.6	79.0	11.1	5.2
Medium (20-99)	17.8	2.7	83.2	37.0	8.0
Large (100+)	19.0	9.4	88.8	629.3	41.4

Figure 7: SME location, Bangladesh Enterprise Survey 2013



Source: Enterprise Surveys, <http://www.enterprisesurveys.org>, The World Bank, 2013

the impact of unreliable electricity (see Table 13). Use of renewable energy was mentioned frequently, as was the need for government to improve the capacity of the grid (in spite of the question being worded to ask what should be done when the grid fails). Related to this, it was suggested directly by one stakeholder that improved and reliable load shedding schedules would assist SMEs with planning, if not directly mitigating lack of electricity supply.

Stakeholders also suggested sharing generators, development of industrial parks and industrial clusters, improving energy efficiency of processes and equipment, and improved management practices to adapt practices to the realities of power availability. Three stakeholders felt that generators are the only viable solution, and improving generator technology was the best alternative. Further suggestions were that SMEs invest in their own generation or gain access to mini grid systems.

Bangladesh

SMEs

IFC data from 2003 estimates that there are just under three million MSMEs (2,987,560) in Bangladesh (MSME Country Indicators, IFC). Bangladesh data are limited in both availability and time-period. The latest data on MSMEs cover the 2005/06 period, through a Bangladesh Bureau of Statistics survey carried out in 2006.

SME distribution by sector shows that the majority of Bangladeshi SMEs operate in the wholesale and retail sector (40%), followed by the agricultural sector (26%) and the manufacturing sector (14%).

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Of the 1442 firms interviewed for the 2013 enterprise survey (Enterprise Surveys, <http://www.enterprisesurveys.org>, The World Bank), Figures 6 and 7 show their location and size. Table 15 shows key indicators from the survey.

The survey found that firms reported annual employment growth of 4.7%, but real annual sales growth of 0.1% and therefore an annual labour productivity growth of 4.6%. For manufacturing firms, capacity utilisation was 84% (Enterprise Surveys, <http://www.enterprisesurveys.org>, The World Bank).

Electricity Quality

The quality of Bangladesh's electricity supply ranks 133 out of 148 countries in the World Economic Forum's *Global Competitiveness Report 2013-2014*, and 113 out of 129

Table 16: Electricity indicators from the 2013 Bangladesh Enterprise Survey

	Overall	Small	Medium	Large
Number of electrical outages in a typical month	64.5	64.5	73.1	53
Duration of a typical electrical outage (hours)	0.9	0.8	1.1	0.7
If there were outages, average duration of a typical electrical outage (hours)	1.2	1.1	1.4	1.1
Losses due to electrical outages (% of annual sales)	3.7	4.8	3.3	2.8
If there were outages, average losses due to electrical outages (% of annual sales)	5.5	7	4.4	4.9
Percent of firms owning or sharing a generator	62.9	47.8	58.9	89.2
Proportion of electricity from a generator (%)	14.2	5.8	11.9	24.8
If a generator is used, average proportion of electricity from a generator (%)	27.4	27.5	26.3	28
Days to obtain an electrical connection (upon application)	84.7	40.5	78.5	103.5
Percent of firms identifying electricity as a major constraint	52	42.6	66	46.5

Table 17: Nepal Enterprise Survey – Key SME Indicators

Subgroup Level	Age (years)	Percent of firms with a female top manager	Capacity utilization (%)*	Number of permanent full-time workers	Proportion of permanent full-time workers that are female (%)
All	14.2	17.2	70.4	13.3	18.2
Small (5-19)	12.6	17.4	69.3	7.1	17.7
Medium (20-99)	20.1	7.6	74.0	31.4	19.4
Large (100+)	34.5	66.7	73.3	121.2	28.6

countries for energy security in the World Energy Council's Energy Sustainability Index.

The electricity indicators from the 2013 Enterprise Survey shed further light on the quality of Bangladesh's electricity supply, see Table 16.

Details from interviews

Interviewee profile

All but one of the SMEs interviewed in Bangladesh were located in urban areas and almost half were in the textile industry. Stakeholders interviewed were predominantly business associations and financial institutions. Most SMEs reported suffering several outages a day and stakeholders rated electricity insecurity as being an important constraint for SMEs.

Cost-competitiveness and productivity

SMEs in Bangladesh did not report the cost of electricity to their business as being high, compared to other countries interviewed for the study, and 60% said that electricity

insecurity had not affected sales costs. Half of Bangladeshi firms thought their prices were lower than competitors.

Investment

Several stakeholders mentioned that electricity problems are considerably worse in rural than in urban areas, impacting investment decisions. Just over half of SMEs had not invested in their business in the last year, and half said that electricity insecurity influenced investment decisions, although the impact was low compared to other countries. Stakeholders reported that investors consider electricity access and security.

'They [external investors] look for the viability of a project. Non-availability of electricity or areas affected by severe load-shedding often do not qualify for support by different authorities and external investors of SMEs. Banks won't lend to projects that suffer from availability of electricity.' (Bangladesh stakeholder)

Table 18: Electricity indicators from the 2013 Nepal Enterprise Survey

	Overall	Small	Medium	Large
Number of electrical outages in a typical month	8.7	9.3	6.3	1.3
Duration of a typical electrical outage (hours)	1.2	1.2	1.0	0.1
If there were outages, average duration of a typical electrical outage (hours)	3.6	3.5	4.0	2.2
Losses due to electrical outages (% of annual sales)	10.4	11.0	7.9	9.3
If there were outages, average losses due to electrical outages (% of annual sales)	17.0	17.1	17.7	10.7
Percent of firms owning or sharing a generator	50.5	46.2	66.4	99.0
Proportion of electricity from a generator (%)	20.9	18.8	27.7	51.4
If a generator is used, average proportion of electricity from a generator (%)	41.3	40.6	41.8	51.9
Days to obtain an electrical connection (upon application)	21.3	9.3	70.3	14.2
Percent of firms identifying electricity as a major constraint	68.8	68.2	69.8	84.5

Table 19: Coping Strategies for Scarce Electricity, Manufacturing & Services Firms in Nepal

	Manufacturing		Services	
	Likely	Unlikely	Likely	Unlikely
Installed Generator	63%	37%	57%	43%
Altered Operation Hours	69%	31%	37%	63%
Reduced Operation Hours	67%	33%	32%	68%
Special Arrangements with NEA	24%	74%	1%	99%
Installed Inverter & Batteries	23%	77%	69%	31%
Installed Solar System	1%	99%	1%	99%

Source: Margon (2013)

Mitigation

For Bangladeshi SMEs, generator use is by far the most common solution to grid outages, including for motive power. Limiting hours of work is also cited by half of the SMEs in response to lack of grid electricity for motive power. In Bangladesh, 3 SMEs said that they use renewable energy for lighting during outages. Stakeholders responded similarly, reiterating the high prevalence of generator use as a solution, and there were several mentions of renewable energy use. Stakeholders in Bangladesh provided the most mention of changing operating practices to deal with electricity unreliability. Stakeholders suggested change to government policy and increased use of renewable energy as the foremost suggestions for future mitigation.

Nepal

SMEs

2007 IFC data estimates that there are just 46,959 (formal) MSMEs in Nepal (MSME Country Indicators, IFC). Nepalese SMEs are concentrated within the manufacturing sector (46.2%), followed by the service sector (29%) and in the tourism sector (18%) (DOI, 2012).

Of the 482 firms interviewed for the 2013 enterprise survey, 283 were small (5-19 staff) and 340 were located in the Central region, which contains the capital Kathmandu (Enterprise Surveys, <http://www.enterprisesurveys.org>, The World Bank). Table 17 below shows key indicators from the enterprise survey.

Electricity Quality

The quality of Nepal's electricity supply ranks 144 out of 148 countries in the World Economic Forum's *Global Competitiveness Report 2013-2014*, and 125 out of 129 countries for energy security in the World Energy Council's Energy Sustainability Index in 2013.

The electricity indicators from the 2013 Enterprise Survey shed further light on the quality of Nepal's electricity supply are found in Table 18.

Data from a Margon Survey (2013) on the impact of insufficient access to electricity on Nepalese firms, shows that 61% of all surveyed firms generated their own electricity supply, and 65% of manufacturing sector firms did so. The survey also showed that just above a third of small firms generated their own electricity, increasing to over three quarters of medium sized firms, whilst all surveyed large firms generated their own electricity supply, although it is unclear to what extent they relied on this self-generated electricity (Margon, 2013).

Coping strategies for manufacturing firms rely mainly on the use of generators (for both manufacturing and services firms) as well as changing or reducing operational hours (mainly for manufacturing firms). Arrangements to supply electricity with the Nepal Electricity Authority (the sole distributor of electricity in the country) were low but still represented a quarter of manufacturing firms (but only 1% of service firms).

Coping strategies between small and medium firms shows a preference for generators for medium industries (80% state that they are likely to use one) whilst smaller firms are more reliant on installed inverters and batteries or altering and reducing operational hours (although the difference between small and medium firms is negligible in regards to operational time changes).

The survey also provides some information on the impacts of scarce electricity on firms. Both manufacturing and services firms report that the greatest impact is on their profits followed by their ability to sell their products. Service firms state a greater impact on competitiveness than manufacturing firms, which in turn state a greater impact on their production costs. Employment seems to be largely unaffected by electricity for both manufacturing and services firms.

Details from interviews

Interviewee profile

As with Bangladesh, most of the Nepalese SMEs interviewed were small in size (6-50 employees). The largest number

worked in food and beverages; textiles, cosmetics, handicrafts and construction materials firms were also interviewed. Two of the SMEs were in rural locations, one in a peri-urban area, the remainder in urban areas in Kathmandu.

The Nepalese stakeholders for the study were mostly business associations and government or donor agencies, as well as two electricity sector organisations and a financial institution. SMEs reported that there are more electricity outages in dry seasons and in rural areas. It was noted by stakeholders that Nepal has a reasonably reliable load shedding schedule, with power frequently out in the afternoon, back in the evening and night. According to stakeholders, electricity seems to be a slightly bigger constraint for Nepali SMEs than their Bangladeshi counterparts.

Cost-competitiveness and productivity

The cost of electricity insecurity to business in Nepal was slightly higher than in Bangladesh, lower than in the African countries, according to the SMEs. The SMEs reported that their prices were all similar to other businesses, or higher, in contrast with Bangladesh.

Investment

The vast majority, 80%, of SMEs in Nepal had not invested in the past year, and half said that electricity insecurity impacted on this decision, and a slightly higher perceived impact than in Bangladesh. Two stakeholders suggested that electricity is very important to investment decisions. Most spoke about the general challenges faced by SMEs in seeking capital.

‘Investment process – electricity is a huge part. 99% of investment to SMEs will involve providing backup generators. If they buy equipment alone, the power situation will mean it can’t be used and loans can’t be repaid.’ (Nepal Stakeholder)

Mitigation

Generator use was by far the most mentioned solution to grid outages by SMEs in Nepal. Batteries, inverters and even candles for lighting were mentioned more in Nepal than elsewhere. Stakeholders suggested mini grids and self-generation, renewable energy use and industrial parks and management of processes as alternative solutions to deal with electricity insecurity.

‘SMEs are very used to coping and try to find ways to manage power outages. Many have to work at night because of load shedding during the day, but this is difficult – women have housework and childcare obligations in the evenings and for enterprises operating outside the home, factories and offices need to close for employees to go home.’ (Nepal stakeholder)

Nigeria

SMEs

2004 IFC data estimates that there are 8.4 million MSMEs in Nigeria (MSME Country Indicators, IFC). The Nigerian Bureau of Statistics (2010) provides data on SME distribution (by sector) and shows that the SMEs are clustered in the manufacturing sector (29%), the wholesale & retail sector (17.6%), the healthcare and social work sector (11.6%) and the financial intermediation sector (10.1%).

The overwhelming majority (81%) of Nigerian micro-enterprises (reported separately from small and medium enterprises) report start-up capital and assets of less than \$ 330. Capital sources for the surveyed micro enterprises show that 85% relied on personal savings. For larger SMEs personal savings were lower (54.4%) but still represented the majority of initial capital, followed by commercial loans (22%) and family loans or savings.

Table 20 below shows key indicators from the enterprise survey.

Table 20: Nigeria Enterprise Survey – Key SME Indicators

Subgroup Level	Age (years)	Percent of firms with female participation in ownership	Capacity utilization (%)*	Number of permanent full-time workers	Proportion of permanent full-time workers that are female (%)
All	9.6	20.0	66.8	16.2	16.1
Small (5-19)	9.0	22.5	67.6	8.9	15.2
Medium (20-99)	10.6	13.7	66.2	35.0	18.2
Large (100+)	19.0	1.4	60.6	106.2	5.3

Table 21: Nigerian SME Alternative Energy Use by Sector (% of surveyed SMEs), 2010

Sector	1 – 5 hours	6 – 10 hours	11 – 15 hours	16 – 20 hours
Agriculture	39.4	29.4	17.1	14.1
Extractives	36.6	39.8	9.7	14
Manufacturing	36	37.4	13.3	13.2
Construction	34			
Wholesale & Retail	48.6	35.7	9.1	6.6
Hotels & Restaurants	25.2	30.8	25.5	18.5
Transport & Storage	56.5	29.2	4.5	9.7
Financial Intermediation	39	39	11	11
Education	56.9	28.4	10.8	3.9
Healthcare & Social Work	32.1	31.7	15.4	20.8
Other	40.7	38.2	13.8	7.3
Average	39.8	34.9	13.3	12

Source: NBS, 2010

The Nigerian government (through its National Bureau of Statistics) carried out a survey of MSMEs in 2010. The survey reveals that 39.8% of SMEs need to make a daily use of alternative (to grid supplied) sources of electricity for 1 to 5 hours a day, 34.9% need to use alternative sources for between 6 to 10 hours a day whilst 12% need to use alternative sources of electricity for between 16 to 20 hours a day. Sectoral differences are not wholly apparent but they may be due to greater emphasis on required working hours: i.e. hotels and restaurants have a high prevalence of 16 to 20

hours' use due to their (potential) continuous need, similarly healthcare SMEs may need to run critical equipment for their patient's needs for the majority of the day (and night).

Electricity Quality

The quality of Nigeria's electricity supply ranks 141 out of 148 countries in the World Economic Forum's *Global Competitiveness Report 2013-2014*, and 13 out of 129 countries for energy security in the World Energy Council's Energy Sustainability Index.

Table 22: Electricity indicators from the 2007 Nigeria Enterprise Survey

	Overall	Small	Medium	Large
Number of electrical outages in a typical month	25.2	25.0	25.2	29.0
Duration of a typical electrical outage (hours)	7.8	7.9	7.6	8.4
If there were outages, average duration of a typical electrical outage (hours)	8.2	8.3	7.9	8.5
Losses due to electrical outages (% of annual sales)	8.5	8.5	8.4	6.9
If there were outages, average losses due to electrical outages (% of annual sales)	8.9	9.0	8.8	7.2
Percent of firms owning or sharing a generator	85.7	85.1	86.1	97.2
Proportion of electricity from a generator (%)	47.5	45.4	50.3	60.7
If a generator is used, average proportion of electricity from a generator (%)	60.9	60.9	60.4	62.5
Days to obtain an electrical connection (upon application)	7.5	7.8	6.8	6.3
Percent of firms identifying electricity as a major constraint	75.9	77.1	72.4	71.3

Table 23: Uganda Enterprise Survey – Key SME Indicators

Subgroup Level	Age (years)	Percent of firms with a female top manager	Capacity utilization (%)*	Number of permanent full-time workers	Proportion of permanent full-time workers that are female (%)
All	10.5	26.4	73.6	14.5	40.0
Small (5-19)	10.1	26.8	69.9	8.0	40.5
Medium (20-99)	11.4	25.9	76.2	23.9	40.7
Large (100+)	14.4	22.0	81.6	95.9	23.6

The electricity indicators from the 2013 Enterprise Survey shed further light on the quality of Nigeria’s electricity supply are found in Table 22.

The survey states that improvements in the energy supply are one of the top priority issues for SME assistance that the government should address (ranked 3rd after the provision of financial assistance and the provision of access to markets infrastructure). Power supply is a major hindrance for SMEs, second in importance only to high tax rates, according to surveyed firms.

Details from interviews

Interviewee profile

The Nigeria survey of informants is distinct from the other three in that research was conducted in Anambra state, rather than in the largest city – Lagos, or capital – Abuja, as in other countries.

Just over half of the SMEs interviewed were small, with two large, one medium and one micro-enterprise interviewed. Just under half were food and beverage SMEs, others produced machinery, wood products, cosmetics and plastics. All 10 were located in an urban area. One SME, a small enterprise of 12 staff, did not use grid electricity at all and was wholly dependent on generators. Most of the stakeholders in Nigeria were business associations and government or donor agencies. One financial institution and two electricity sector organisations were also interviewed.

Cost-competitiveness and productivity

Nigeria suffers the most frequent, long-lasting and erratic power outages of all four countries where interviews were conducted, and has no reliable load shedding schedule. The cost of electricity to business was seen by both SMEs and stakeholders to be very important, and although there was not total agreement about whether grid electricity was cheap or not, there was consensus that the unreliability of grid power is a cost, with the reliance on back-up generators and costs to production being very high.

60% of the Nigerian SMEs said that electricity insecurity has an impact on sales costs. Most said that their prices were equivalent to other similar businesses, or higher.

Investment

Although half of the Nigerian SMEs had invested in their business in the past year, 80% said that electricity insecurity has a big impact on investment. Stakeholders expressed that investors are interested in overall returns, not necessarily paying specific attention to electricity reliability, but as backup capacity was fundamental to ability of a business in Nigeria to function, investors would overtly or indirectly avoid businesses that did not have reliable mitigation solutions.

‘Where SMEs cannot guarantee investors return on investment, they will not attract external investors. The effect of unreliable electricity translates to every aspect of the business including production cost; this is why local SMEs cannot compete.’ (Nigeria Stakeholder)

Mitigation

Unlike the other three countries studied, several interviewees in Nigeria said that a generator is essential for businesses of almost any size and sector to function in the country.

SMEs reported limiting hours of production, using manual labour and changing processing practices as mitigation solutions, but generator use was by far the most common solution. No alternative fuel or power source was mentioned, and stakeholders said that renewable energy is not yet readily available in Nigeria. Nigerian stakeholders broadly confirmed this pattern, also speaking about the existence of industrial parks in Anambra state, but generally saying that these were not being run effectively to provide power or attract SMEs. Improving industrial parks was the most mentioned solution opportunity by stakeholders, followed by improved management practices, use of renewables and preference to use and improve generator technology.

Uganda

SMEs

2006 IFC data estimates that there are 185,089 MSMEs in Uganda (MSME Country Indicators, IFC). The division of

Ugandan SMEs by sector shows that a significant proportion of SMEs operate within the hotels & restaurants (16.6%), in the education sector (11.8%) and in the wholesale sector (10.9%) (UIA, 2011). Manufacturing is the fourth most important sector for SMEs, representing 8.6% of companies (UIA, 2011).

The UIA (2011) survey highlights that 60.4% of surveyed firms are less than ten years old (i.e. relatively new). The MSMEs were overwhelmingly geared towards local markets, since only 1.7% of interviewed MSMEs stated that they exported their products. Table 23 below shows key indicators from the enterprise survey.

Electricity Quality

The quality of Uganda's electricity supply ranks 126 out of 148 countries in the World Economic Forum's *Global Competitiveness Report 2013-2014*.

The electricity indicators from the 2013 Enterprise Survey shed further light on the quality of Uganda's electricity supply are found in Table 24.

Around 42.1% of SMEs perceived their access to electricity to be satisfactory to very good. 3.6% of MSMEs thought they had 'very good' access to electricity, 19.8% report 'good' access, and 18.7% report 'satisfactory' access. 32% of MSMEs state that their access to electricity was 'poor' and 21.3% state that it was 'very poor'. Just over half of Ugandan MSMEs state that access to electricity (53.3%) was not adequate to their needs.

A report on the impact of electricity on industry in Uganda uses less recent survey data (from 2006) but shows some interesting results. Even though most surveyed industrial firms have bought a standby electricity generator, only 36.6% use them at full capacity, whilst 18.3% use about a third capacity and 45% of firms use 20% to 75% capacity. The firms

prioritised certain operations that the generators would be used for and kept them in reserve (for those who did not use them to their full capacity) for when priority tasks needed to be carried out (Power Networks, 2006).

Details from interviews

Interviewee profile

Six of the SMEs interviewed in Uganda were small, one micro and three medium size. They were mostly engaged in machinery and wood products, also food and beverages, construction materials, textiles and metals. None were based in rural areas, although two were in peri-urban rather than urban locations. Two of the SMEs were located in industrial estates.

SMEs perceive outages as occurring on average several times a week, and for several hours at a time. Uganda has the widest variety in terms of SME experience of outages, one experiencing only a one-hour outage once a week, others suffering outages 3-5 times a day or for up to 12 hours at a time.

Cost-competitiveness and productivity

Half of Ugandan SMEs said outages impact on sales costs, and the cost of electricity insecurity to business was perceived to be higher than for the Asian SMEs, but not quite as significant as in Nigeria. Half of SMEs think that their prices are lower than other similar companies, the other half think they are similar.

'Unlike other businesses that can survive on one phase line of power supply, SMEs in manufacturing require a three phase line of power supply which consumes a lot of power.' (Uganda stakeholder)

Table 24: Electricity indicators from the 2013 Uganda Enterprise Survey

	Overall	Small	Medium	Large
Number of electrical outages in a typical month	6.3	5.3	10.5	4.5
Duration of a typical electrical outage (hours)	7.1	6.8	8.3	6.4
If there were outages, average duration of a typical electrical outage (hours)	10.5	10.1	12.1	10.5
Losses due to electrical outages (% of annual sales)	6.6	6.0	9.9	5.9
If there were outages, average losses due to electrical outages (% of annual sales)	11.5	10.7	14.4	13.7
Percent of firms owning or sharing a generator	51.7	45.8	64.9	65.8
Proportion of electricity from a generator (%)	8.4	6.8	14.6	12.0
If a generator is used, average proportion of electricity from a generator (%)	17.7	15.9	22.8	19.6
Days to obtain an electrical connection (upon application)	25.4	15.2	38.8	n.a.
Percent of firms identifying electricity as a major constraint	27.9	26.8	28.6	43.6

Key literature consulted on the effects of electricity and electricity insecurity on SMEs

Table 25: Key literature consulted on the effects of electricity and electricity insecurity on SMEs

Authors	Location	Survey
Abeberese (2012)	India	Analysis of manufacturing Survey of Industries (ASI) for the years 2001 to 2008, covering, c. 30,000 firms.
ADB (2005)	China, India, Thailand	China: panel survey data of 1,143 households, field survey of 624 households India: survey of approx. 2,600 rural households; Thailand: survey of approx. 1,100 rural and urban households
ADB (2010)	Bhutan	1,276 electrified and 822 un-electrified households
Adenikinju (2005)	Nigeria	2,390 manufacturing establishments using Federal Office of Statistics covering three main industrial zones: the Lagos/Ibadan axis, the Kano/Kaduna axis and the Onitsha/Nnewi/Aba axis
Akuru and Okoro (2011)	Nigeria	Cross country comparison based on national statistics and literature.
Alby, Dethier and Straub (2011)	87 countries	Analysis of data from the Enterprise Surveys which have data on number of power outages, covering a total of 46,606 firms over the period 2002-2006.
Arnold, Mattoo and Narciso (2006, 2008)	10 African countries	Approx. 1,000 manufacturing enterprises
Barnes and Binswanger (1986)	India	Surveys conducted in 108 villages in 1966 and 1980
Battiwa and Reddy (1996)		Various – household surveys
Bernard et al. (2009)	Ethiopia	Survey of 800 households
Blalock and Veloso (2007)	Indonesia	20,000 manufacturing enterprises
Chakravorty, Beyza and Marchand (2012)	India	Household panel survey (12,000 households) to determine the effect of electrification on household income. Included reliability variable (proximity to transmission line).
Cissokho and Seck (2013)	Senegal	Survey of 528 manufacturing and service sector SMEs; econometric analysis to identify impact of electricity insecurity on cost and technical efficiencies.
Dzobo, Gaunt and Herman (2012)	South Africa	Random sample of 275 businesses, mostly small-scale industries. Regression analysis of customer interruption costs.
Dinkelman (2008)	South Africa	Census and other data on electrified and non-electrified areas in KwaZulu-Natal province.
Eifert, Gelb and Ramachandran (2008)	17 African countries	Enterprise surveys
Escribano, Guasch and Pena (2009)	26 African countries	Investment climate surveys
ESMAP (2002)	Philippines	Survey of approx. 28,000 domestic, commercial, industrial and irrigation units with and without electricity
ESMAP (2005)	Tanzania	Enterprise survey with 320 connected and non-connected SMEs

Table 25: Key literature consulted on the effects of electricity and electricity insecurity on SMEs (continued)

Authors	Location	Survey
Fan et al. (2005)	Tanzania	Household Budget Survey (HBS) of approx. 22,000 households; Multistage; stratified sample
Fedderke and Bogetic (2006)	South Africa	Labour productivity and TFP growth.
Fernandes (2008)	Bangladesh	575 manufacturing enterprises
Fishbein (2003)	27 countries	Analysis of information from 35 projects and initiatives.
Fisher-Vanden, Mansur and Wang (2011)	China	Analysis of National Bureau of Statistics data on 22,000 medium and large-scale industrial firms to determine responses to power shortages.
Goedhuys and Sleuwaegen (2010)	11 African countries	Firm-level data from the World Bank Investment Climate Survey.
Grimm et al. (2011)	6 African countries	Survey of 5,409 informal enterprises and 248 informal tailors
Grogan (2008)	Guatemala	LSMS individual and household level data, plus community-level survey of 485 communities
Grogan and Sadanand (2009)	Guatemala	LSMS individual and community-level data
Hill and Kalijaran (1993)	Indonesia	2,250 small clothes producers
Isaksson (2009)	79 countries, classified by income level	Regression analysis of electricity generation data in UNIDO's INSTAT3 Database
Khandker (2009a)	Vietnam	Panel survey data (2002 and 2005) from 1,100 rural households
Khandker (2009b)	Bangladesh	Cross-sectional survey of approx. 20,000 rural households
Kirubi, Jacobsen, Kammen and Mills (2009)	Kenya	12 carpentry and 5 tailoring workshops
Kooijman-van Dijk (2008, 2012)	India	Qualitative survey of 264 small businesses
Kooijman-van Dijk (2011)	India	Qualitative survey of 264 small businesses
Lee and Anas (1991)	Nigeria	Stratified random sample of 179 manufacturing enterprises. Survey on all infrastructure services.
Maleko (2005)	Tanzania	Semi-structured interviews with SMEs in three villages
Mensah, Tribe and Weiss (2007)	Ghana	Survey data from small-scale manufacturing enterprises in Central Region, Ghana
Moyo (2012)	Nigeria	World Bank's Investment Climate Surveys (ICS) on manufacturing sectors in Nigeria, 2007 covering 2,387 establishments
Neelsen and Peters (2013)	Uganda	200 micro-enterprises in central Uganda
Oseni (n.d.)	12 African countries	Analysis of cross-sectional data of 7,353 firms

Table 25: Key literature consulted on the effects of electricity and electricity insecurity on SMEs (continued)

Authors	Location	Survey
Peters, Vance and Harsdorff (2011)	Benin	276 manufacturing enterprises in five electrified and five non-electrified villages, interviewed between April and May 2008.
Power Networks (2006)	Uganda	Enterprise survey
Roos (2005)	Denmark, Finland, Norway, Sweden	Electricity network data.
Rud (2012a)	India	National statistics for industrial development and performance indicators, including real per capita manufacturing output, stock of fixed capital, number of factories and investment.
Sambo, Garba, Zarma and Gaji (n.d.)	Nigeria	Information about the national electricity network.
Steinbuks and Foster (2010)	25 African countries	Statistical analysis on data from 8,483 firms in World Bank Enterprise Surveys, sampled between 2002 and 2006.
UNDP (2011)	Nepal	Household survey conducted in communities with and without access to electricity from micro-hydropower schemes

Investment

Seven of the Ugandan SMEs had invested in their business in the last year and eight said that electricity insecurity impacted on investment decisions, although the level of impact is lower in Uganda than in Nigeria. As with other countries, stakeholders suggested that investors are predominantly interested in the overall viability of the investment, but that electricity supply is recognised to be a significant part of this. Two stakeholders spoke about examples of foreign investors choosing to locate in other East African countries, in direct response to the direct and indirect costs of electricity insecurity.

Mitigation

As elsewhere, generator use is the main back-up alternative cited by SMEs. Limiting production was also frequently mentioned, although resorting to manual labour was only mentioned once, less than elsewhere. Stakeholders also mentioned generators most frequently, but renewable energy got a higher rate of mentions than other countries. Sharing generators was a more popular suggestion in Uganda than anywhere else. Renewable energy promotion, change to government policy and support to become more energy efficient were also mentioned as possible solutions to the problem of electricity insecurity.

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