

The cost of power outages to Zambia's manufacturing sector



- In brief:**
- The researchers surveyed 146 large manufacturing firms in Zambia's industrial hubs in 2018 to assess the impacts of power outages on Zambia's manufacturing sector, and firms' coping mechanisms.
 - Following the outages of 2015 and 2016, manufacturing's share of energy delivered by Zambian energy utility ZESCO dropped and had not recovered by 2017.
 - The researchers find that:
 - Backup generation was associated with a reduction in production delays which was associated with reduced loss in clients;
 - Export-oriented firms are willing to pay more for reliable energy. Other firms are unwilling because of their distrust in ZESCO delivering;
 - That since the largest firms pay the highest marginal costs during outages for backup generation, it makes sense for ZESCO to charge them more if it helps ZESCO deliver more reliable service.
 - Parliament has a role to play in allowing the Energy Regulation Board to set cost-recovery tariffs for the mining sector.

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Overview of the research

We study the impacts of power outages on the manufacturing sector in Zambia (see the Project page, [Coffman et al., 2018](#)). ZESCO is a state-owned power company in Zambia and also its largest power company, producing about 80% of the electricity consumed in the country. In 2016, the manufacturing sector's share of ZESCO energy consumption dropped. This was the result of Zambia's worst power outages in 2015 and 2016, following poor rainfall, low reservoir levels and complete reliance on hydropower. By 2017, Zambia's manufacturing sector had not recovered to its 2015 level of energy consumption.

To determine the impact of the power outages, we interviewed 146 firms across Lusaka, Kitwe, and Ndola; Zambia's largest manufacturing hubs, between April and August 2018. This was undertaken on a representative stratified basis across these three cities and across manufacturing subsectors. The primary data was collected using a structured survey questionnaire. Face-to-face surveys were conducted with the accountants, production managers, and electrician managers, by a team of locally recruited enumerators trained by the investigation team.

The survey was designed to find:

1. When (months and years) firms experienced their worst power outages
2. The firms' coping strategies
3. The extent of costs incurred as a result of outages
4. Trends in the firms' on-grid energy use
5. Trends in the firms' off-grid energy use
6. Whether and how much more firms would be willing to pay for reliable on-grid energy after the latest tariff revisions of 1 September 2017
7. Whether firms experienced unplanned and planned outages differently
8. Correlations between firm characteristics, costs of power outages, coping mechanisms, and willingness to pay a premium on the latest tariff revisions for more reliable electricity.

Policy motivation for the research

The study's focus on the impact of power outages on the manufacturing sector is salient given the established association between manufacturing and economic growth. Africa in general, and Zambia in particular, have already seen a period of de-industrialisation. As Stiglitz (2017) and Barton (2016) suggest, this is a result of poor policy rather than a natural economic evolution. Given Zambia's more recent resurgence of industrialisation, undersupply of infrastructure poses a threat to its economic growth.

The research aims to provide information on the cost of power outages to Zambia's manufacturing firms, their coping mechanisms, and the efficacy of their coping mechanisms. Understanding this allows us to understand the role of the state and its arms to facilitate Zambia's continued industrialisation.

Research questions and key findings

Research questions	Summary of key findings
What are the costs of power outages on Zambia's manufacturing sector?	<p>In order of cost of <i>unplanned</i> outages:</p> <ul style="list-style-type: none"> • Extra staff costs, damage to equipment, damage to firm reputation, damage to inventory, extra security costs, loss in clients. <p>In order of cost of <i>planned</i> outages:</p> <ul style="list-style-type: none"> • Extra security costs, extra staff costs, damage to firm reputation, loss in clients, damage to equipment, damage to inventory. <p>The observed marginal cost of running diesel generators to mitigate against the cost of power outages is greater than USD 0.25/kWh.</p>
How well do coping strategies mitigate the impact of power outages?	<ul style="list-style-type: none"> • Firms using voltage regulators, capacitors, or power surge factor units reported damage to inventory or equipment half as often as firms that did not use these. • Self-generation determined whether or not production delays occurred, which in turn was associated with a loss in clients.
What characteristics of firms correlate with their ability to implement coping mechanisms?	<ul style="list-style-type: none"> • Predictors of installed self-generation capacity: Firm size, how many hours a week a firm manufactured, whether a firm exported, and whether it belonged to the food and beverage subsector. • Firms located in Kitwe reported using their generators to a <i>greater</i> extent. • Firms belonging to the basic metals subsector reported using their generators to a <i>lesser</i> extent.
What affects a firms' willingness to pay more for reliable energy?	<ul style="list-style-type: none"> • The likelihood of a firm that exports being willing to pay more for reliable energy was 90%. • Distrust in Zesco's ability to deliver reliable energy was a reason for many declining to pay a higher tariff. • A quarter of respondents reported that they never received notifications of outages or that they received inaccurate notifications. • Not wanting to subsidise Zambia's mining companies was another reason for not wanting to pay more. • Those willing to pay more were on average willing to pay USD 0.04/kWh more for reliable on-grid energy.

Policy recommendations

- **Retain import duty waivers for generators**

We recommend that the Ministry of Finance not change the waiver on import duties on back-up generators, since their acquisition results in their use to mitigate the impact of outages in more than 95% of observed cases. More than 50% of generators in use were bought in the years of the worst outages, 2015 and 2016

- **Improve customer service across the board**

We recommend that ZESCO improve its outage forecasting and communication with customers about when they can expect power outages to build confidence in its ability to deliver reliable energy at higher rates.

Regarding *tariffs*, we make four recommendations:

- **End subsidies to the mining sector**

To complement ZESCO's efforts in building trust with its clients, we recommend that Parliament allow the Energy Regulation Board to regulate ZESCO's tariffs to the Copperbelt Energy Corporation to address manufacturers' concern that they subsidise mining companies' low electricity tariffs.

- **Stop charging larger firms lower cost electricity and use the savings to provide better services**

We recommend that ZESCO stop charging larger consumers lower tariffs. The savings it could make from an incremental increase in these tariffs could be used to finance the installation of more power generation capacity, which larger firms would value given that their marginal cost of power outages is greater than the marginal cost of power outages for smaller firms when they self-generate electricity.

- **Initiate a premium service of electricity reliability to exporting manufacturers**

We recommend that ZESCO provide an initial premium service of reliable energy to exporters. This service offering should prove more popular with a broader array of clients once reliability has been demonstrated: That is, once ZESCO starts offering accurate outage forecast communications and it is perceived that the mining sector and larger consumers of electricity are not being subsidised.

- **Increase the tariff differential between peak hour and off-peak energy**

The tariff differential between Zesco's off-peak, peak and standard tariffs could be greater. Firms operating more than 84 hours a week operated slightly less during off-peak hours and slightly more during peak hours than if they had been operating steadily 24 hours a day. The circa \$0.01/kWh difference between peak and off-peak tariffs (compared with Zimbabwe's \$0.09/kWh) is not enough to induce alignment of firms' energy use with Zesco's baseload versus peak-load levelised costs of energy