Electricity Tariffs, Power Outages and Firm Performance: A Comparative Analysis

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Abstract

Many countries struggle to provide adequate electricity services to the private sector. While the importance of infrastructure for economic growth is widely acknowledge, limited research has been dedicated on how electricity sector outcomes impact firm performance. The paper presents new measures from the Doing Business Getting Electricity (GE) indicator for 190 economies, namely macro data for electricity tariffs and power outages. The objective of the paper is to test the relationship between electricity sector characteristics, as measured by Doing Business, and firm performance. I first show that power outages and electricity tariffs are associated to firm behavior in terms of the demand for energy inputs. I then employ a similar specification than Geginat and Ramalho (2015) using World Bank Enterprise Surveys to find that, in a cross sectional sample of 80 economies, outages are negatively associated with firm productivity. Electricity tariffs are also negatively associated to productivity but only for small and medium enterprises.

Over one billion people do not have access to electricity[1], and according to the World Bank, the same number do have access but receive electricity services that do not meet adequate reliability standards.[2] Lack of electricity affects welfare negatively by undermining such areas as education (Khandker et al., 2014) and healthcare (Adair-Rohani, 2013). One of the areas that is arguably the most affected by poor electricity services is firm performance. The 2016 World Bank Enterprise Surveys data report that 12% of business owners in developing economies[3] perceive electricity (or lack thereof) as the biggest obstacle for their activities, behind only access to finance (16%) and the informal sector (12%). Yet impediments to electricity access vary. For a newly incorporated startup, for instance, it may be the case that obtaining a new electricity connection is difficult due to a burdensome connection process (Geginat and Ramalho, 2015). It may also be the case that, once connected to the grid, a business faces blackouts that forces it to halt production or resort to self-supply through generators, which comes at a significant cost (Foster and Steinbuks, 2010). Lastly, electricity tariffs may hinder a firm where prices are high relative to income levels (Abeberese, 2016).

This paper has three main objectives. First, it seeks to introduce the new *Doing Business* Getting Electricity (GE) data measuring electricity tariffs and power outages for firms. The data on tariffs and outages are collected directly from utilities and do not rely on firm surveys as commonly used in the literature. The coverage spans across 190 economies, surpassing other existing electricity sector indicators (see table 1 in annex) which are aligned with the GE measures. Further adding to existing research, this paper also examines how power outages and electricity tariffs are related to firm behavior in terms of demand for energy inputs. A third and final objective is to test whether, consistent with the literature, interruptions and tariffs are inversely associated to firm performance when measured in terms of productivity. I do this employing a similar specification than Geginat and Ramalho (2015) on a cross section data analysis of 80 economies using Entreprise Surveys.

The analysis is divided into five succeeding sections. Section I provide a brief review of the literature on how firm performance is impacted by electricity sector outcomes, namely outages, tariffs and the connection process. Section II describes the data sample while showing that GE estimates are associated to other measures of reliability and tariffs. Section III gives a statistical summary of the data. Section IV, finally, provides the results on how electricity variables are associated with firm performance.

I.   End-user electricity variables and firm performance: literature overview

This section provides a selective overview of recent literature on the effects between electricity sector outcomes and firm performance, particularly with regards to service reliability, electricity tariffs and the ease of the connection process.

1.1 Power outages and firm performance

According to the World Economic Forum (WEF), infrastructure is one of the main pillars of competitiveness[4] – i.e. the set of institutions and factors that determine a country's productivity. While infrastructure

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[1] IEA World energy Outlook 2016
[2] World Bank Independent Evaluation Group, Main Report 2015.
[3] Developing economies exclude high-income economies as per the World Bank classification
[4] According to the WEF, infrastructure is one of four pillars that is a "basic requirement" for global competitiveness.

encompasses many types of facilities and systems, a country's electricity supply is one of the elements that has the strongest impact on firm productivity according to Escribano et al (2009). Additionally, several studies have found that reliable electricity services boost firm and country productivity (Fedderke and Bogetic, 2006; Kirubi et al., 2009; Grimm et al., 2012). Barnebeck et al (2012), for instance, estimate that the annual economic growth drag of a weak power infrastructure is about 2 percentage points in Sub-Saharan Africa.

To test how firm performance is impacted by electricity infrastructure, most studies use proxy measures of power outages. Some studies employ meteorological satellite data on lighting density to construct an objective measure of blackouts (e.g. Alam et al., 2014; Barnebeck et al., 2012), while others use industry level estimates such as the ratio of electricity generated to production capacity (Fisher-Vanden et al 2015).[5] Most research, however, uses firm level data where businesses self-report outages suffered over a period of time (Moyo 2012; Alby et al 2012; Scott et al 2014). Abotsi (2016), for example, uses Enterprise Surveys (ES) to conclude that power outages have a negative impact on the production efficiency of firms in Sub-Saharan Africa. And Iimi (2011) uses Business Environment and Enterprise Performance Survey (BEEPS) in Eastern Europe and Central Asia to find that eliminating outages could result in firms saving 1.5% on their operating costs.

As outages do not impact all actors alike, research has focused on how service reliability impacts businesses according to their size. Doe and Asamoah (2006) find that in Ghana power outages cause the most harm on the profitability of small and medium enterprises (SMEs) as they are unable to scale their production. Moyo (2013) shows that blackouts are particularly harmful to small firms because they typically lack resources to buy generators to mitigate service cuts. According to ES, 38% of SMEs in developing countries own a generator compared to 60% for large firms.[6] It is then more common for smaller businesses to stop production during outages according to Scott et al (2014). Alcott et al (2014) corroborate these findings by showing that plants without generators have larger output losses, and because of economies of scale in generator capacity, blackouts disproportionately affect small plants.

Industry type also matters when assessing the impact of outages as some activities are more impacted than others, as shown by Alam (2014) in India. Dollar et al. (2005) find that, in Bangladesh, China, Ethiopia, and Pakistan improvements in the reliability of the power supply is found to increase garment manufactures total factor productivity. On the other hand, Alby et al (2012) show that for sectors reliant on electricity (e.g. textile industries), power cuts undermine returns to investment disproportionately.

To sum up the literature, power outages have a negative impact (albeit not universal)[7] on firm performance. The impact, however, is greater for SMEs as well as firms in electricity intensive industries.

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[5] To assess the likelihood of blackouts, the ratio of thermal electricity generated to thermal electricity capacity is calculated.

[6] Author's calculation based on Enterprise Surveys data for all economies exclusive of High-Income OECD countries.

[7] Cissokho and Seck (2013) find that in Senegal outages had a positive effect on manufacturing firms and SMEs, because outages stimulate better management practices and less efficient, lower productivity firms go out of business.

1.2 Electricity tariffs and firm performance

Most studies on electricity tariffs have been concerned with how tariffs are set in the electricity market – and not how they impact firms since demand for energy inputs is often seen as inelastic.[8] Nonetheless, a limited but growing body of research is examining the impact of electricity tariffs on firm behavior, as business performance is sensitive to the cost of indirect inputs (Eifert et al., 2008) and energy bills can make up to 30% of operating costs for an average company (Jewell, 2006). Therefore, it is conceivable that electricity tariffs impact firm behavior and performance. Scott et al (2014), for instance, establish that in less developed countries the combined absence of service reliability and high end-user tariffs for most SMEs undermines firms. Legros et al (2011) come to a similar conclusion for Nepal.

Abeberese (2016) carries out what is perhaps the most thorough analysis yet on the effect of tariff changes. Using panel data on Indian manufacturing firms to see how they respond to exogenous tariffs increases, he concludes that firm performance is impacted as businesses reduce their electricity consumption and switch to less energy-intensive industries. A study in Nigeria infers that the closure of manufacturing firms can be partly attributed to high energy costs (Akuru et al., 2011). A report from the U.S. Department of Energy, finds that customers adjust their consumption patterns to changes in price as well as to changes in the structure of tariffs. Boonzaaier et al (2015) find that, in South Africa, electricity demand is becoming more elastic in the wake of tariff surges, and eroding profits may lead to a change in investment decisions. Still in South Africa, the Trade and Industrial Policy Strategies (2014) explores the impact of electricity price increases on mining industries using financial statements. The study establishes that certain industries, such as gold mining, were affected by the increases. Finally, Inglesi-Lotz and Blignaut (2011) through a panel data analysis of sector responses to electricity tariff increases find positive price elasticities for the commercial or transport sectors.

While there is increasing evidence that high tariffs, when pushed above a tipping point (Bonzaaier et al., 2015), may influence firm behavior in selected industries, there remains room for further research. Notably, to my knowledge, no large scale cross country study has been carried out. And data on electricity tariffs across economies has long been lacking. International databases like the International Energy Agency (IEA) or Eurostat have data for less than 40 economies (see table 1 in annex) and national statistical agencies publish electricity tariffs according to different reporting standards.

1.3 Ease of the connection process and firm performance

The performance of infrastructure services is associated to the quality of regulatory institutions according to several of studies (Kirkpatrick et al. (2002), Cubbin and Stern (2006), Andres et al. (2008)). In light of such research, Geginat and Ramalho (2015) developed the *Doing Business* GE indicator, measuring the process to get a new connection to the grid. Building on the work of Djankov et al (2002), they construct an index to proxy utility customer efficiency. The measure is based on the time, cost and interactions required to obtain new connections to the grid. They find that simpler and less costly electricity connection processes are associated with better firm performance - in particular in industries with high electricity needs.

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[8] A 2009 Deloitte study in South Africa finds that demand for electricity is inelastic even though the authors argue that there has been insufficient variation in price in the dataset to test the price effect sufficiently.

II.   Data

2.1 *Doing Business* variables

This paper is based on the data of the Getting Electricity (GE) indicator of *Doing Business,* which provides measures on (i) power outages, (ii) electricity tariffs and (iii) the connection process. The GE indicator was first piloted in 2010, and became part of the ease of *Doing Business* rankings in 2011. The GE indicator has historically focused on the connection process, offering insights on utility efficiency. Measures of outages and tariffs were subsequently added in 2015. The methodology used for the three measures is briefly summed-up below.

Reliability of service and power outages

To broaden the measures of electricity-related obstacles for firms, *Doing Business* now includes measures of power outages, which can be a major constraint for firms according to the literature. The GE indicator provides power outage data for each economy's largest business city (and the second largest city in 11 economies).[9] More specifically, *Doing Business* collects two commonly used indices from distribution utilities; the system average interruption duration index (SAIDI) and the system average interruption frequency index (SAIFI) (see table 6 in the annex for formulas). SAIDI and SAIFI provide data from the perspective of the average customer[10] over a calendar year and focus, respectively, on total outage duration (in hours) and frequency. SAIDI and SAIFI include all types of outages – including load shedding or planned power cuts for maintenance. The only exceptions are for power cuts caused by 'force majeure', which are confined to natural catastrophes. To ensure comparability in the data, the estimates count all interruptions that are, at the very least, 5 minutes long.[11] Once SAIDI and SAIFI are collected, the data are checked against estimates provided by the private sector to address the reporting bias utilities may have. In cases where there are significant discrepancies – or SAIDI/ SAIFI are not calculated by the utility – no data are published. This is the case for 48 of the 190 economies covered. For the remainder of the countries, data are available for calendar years 2015, 2014 and 2013.

To assess the accuracy of the *Doing Business* outage data, the SAIFI index can be compared with private sector estimates of power outages. The World Bank Enterprise Surveys (ES) collects such data by asking firms how many outages they suffer in a typical month. The sample data, available for 138 economies, can be disaggregated to consider only outages in the main business city and annualized. I find that SAIFI data are

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[9] The economies where two cities are measured are Bangladesh, Brazil, China, India, Indonesia, Japan, Mexico, Nigeria, Pakistan, the Russian Federation and the United States.

[10] Non-residential and residential clients are included in SAIDI/ SAIFI data as utilities typically do not disaggregate outages per client type. This is problematic for firm-level analyses; according to Moyo (2012) large businesses suffer less outages as they benefit from stable supply lines thanks to agreements with public authorities. At the global level, however, this is not supported by ES data which report that small firms report less outages than larger ones. Moreover, commercial and industrial clients typically account for the majority of the customer base of a utility, so power outages suffered by the residential sector have a minimal impact on SAIDI/SAIFI averages.

[11] Utilities have different reporting standards and often exclude from their calculations outages that are under a minimum time (typically 5 minutes). Therefore, it is important to recognize that the basis for SAIDI/ SAIFI data is not completely identical. The SAIDI and SAIFI for Nicaragua, for instance, considers all outages over 3 minutes in duration. In contrast, the minimum outage time in Belize is 5 minutes.

strongly correlated with the estimates of ES.[12] Another way to gauge whether *Doing Business* SAIDI/ SAIFI data are representative of a country's power reliability is to compare these metrics to the World Economic Forum *Quality of electricity supply*. I find that SAIDI and SAIFI are strongly correlated with the WEF measure (see figure 7 in the annex).[13]

Electricity tariffs

The other electricity variable newly examined by *Doing Business* is electricity tariffs. Based on a set of assumptions and a hypothetical monthly consumption, a bill for a commercial warehouse is computed. For comparability purposes, this bill is then brought back in cents (USD) per a unit of kilowatt-hour. The data are collected from utilities and regulatory agencies – and checked with sample bills sent by private sector professionals. As part of the assumptions, it is assumed that a commercial warehouse uses electricity 30 days a month, and consumes a total of 26,880 kilowatts for a subscribed capacity of 140 kVA.[14] For the calculation of the bill, different time-of-use tariff schedules may apply. Finally, all fees that go into the bill calculation are included – except for value added tax. Data are available for calendar years 2016, 2015 and 2014.

To determine the accuracy of the *Doing Business* estimates on end-user electricity tariffs, a comparison is made with Eurostat data, which provides electricity prices for non-residential customers for 35 economies in the European Union and neighboring economies.[15] Using data from 2015 and controlling for currency value, Eurostat tariff estimates are significantly correlated with the *Doing Business* tariffs.[16]

Ease of connection process

A final end-user electricity measure that is reported by *Doing Business* is the process of obtaining a permanent electricity connection, as laid out by Geginat and Ramalho (2015). Here, the procedures to get a new electricity connection are counted, along with the associated time and cost. To present an aggregate measure, I calculate the distance to frontier (DTF) score as defined by *Doing Business*. The DTF score captures the gap between an economy's performance and the best practice across the entire sample. For each economy, the number of procedures, the time and costs are normalized to a common unit from 0 to 100, where 0 represents the lowest performance and 100 represents the frontier. An average of these three scores is then computed and used for

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[12] The correlation coefficient between SAIFI (average from calendar years 2013-2015) and the ES measure of outage frequency is 0.54. When logging these variables, the coefficients becomes 0.72. All relationships are significant at the 1% level. Sample includes 96 cities and excludes Enterprise Surveys data before 2010.

[13] The correlation coefficient between the WEF GCI; Quality of electricity supply and the natural logarithm of SAIDI (average for 2013-2015) is -0.84. This relationship is significant at the 1% level. Sample includes 116 economies cities.

[14] It is assumed, for simplicity purposes, that the power factor is 1 (1kVa = 1 kW).

[15] Non-EU economies included in Eurostat data are Norway, Liechtenstein, Iceland, former Yugoslav Republic of Macedonia (FYROM), Albania, Bosnia and Herzegovina, Montenegro, Serbia, Turkey and Kosovo.

[16] The correlation coefficient between *Doing Business* electricity tariffs (calendar year 2015) and the Eurostat tariffs for 2015 is 0.67. This relationship is significant at the 1% level. Sample includes 35 economies. Differences are expected given the distinct assumptions used. For instance, for calculation purposes, DB assumes that a warehouse is consuming electricity during peak-hours while Eurostat makes no such assumption, using a ratio of the average price paid by industrial end-users over a period. Eurostat also excludes all recoverable taxes/levies/fees whereas *DB* only excludes the VAT.

the analysis in the paper. I do not seek to validate the dataset since Geginat and Ramalho (2015) already determine that the connection process is a good measure for utility performance and corruption.[17]

2.2 Other variables

The main focus of this paper is to examine the relationship between end-user electricity variables – as measured by the GE data – and firm behavior as well as performance. I first examine firm behavior in terms of the demand for energy inputs in response to power outages, tariffs and the connection process. I do this as a first step to see if firms are reactive to electricity sector characteristics. As proxies for energy inputs, I use aggregate ES data on generator ownership and electricity consumption per capita from the International Energy Agency (IEA).

As a next step, I focus on firm performance using as the outcome variable total firm sales per worker from enterprise Surveys. Disaggregated ES firm-data are also used at it provides estimates on the characteristics of businesses (e.g. sales, employees and industry-type) and measures of the business environment (e.g. export and access to finance). Nominal values are adjusted using the GDP deflator from the World Development Indicators database. All values are presented in 2015 constant US dollars and the exchange rate is taken from the International Monetary Fund's International Financial Statistics database. As independent variables, the GE measures of interests are used, namely (i) power outages in terms of SAIDI, (ii) electricity tariffs, and (iii) the DTF score of connecting to the grid. In addition, other controls are incorporated from ES such as past sales per employee, average labor input (number of employees), capital input (proxied by investment), average international trade engagement (whether firms export directly at least 5% of their sales), and usage of bank finance (whether firms have a loan). Table 5 in the annex describes all the variables used in the study.

Since *Doing Business* measures are representative of the main commercial city of countries, only ES data matching the DB cities are used.[18] An exception is made for small economies where ES does not disaggregate data by location.[19] I use the latest ES data available for each country[20], and data before 2010 is excluded.[21] This results in a sample of over 5,000 firms across 80 countries (see table 7 in the annex).

III. Summary Statistics

The GE data show a lot of variability not only across economies, but also from one indicator to another. In Romania, for instance, electricity tariffs (8.8 cents per kilowatt-hour) are less than half of the global average, and firms in Bucharest experience under one outage a quarter. On the other hand, obtaining a new electricity connection in Bucharest is a difficult endeavor as it takes approximatively 6 months'– resulting in a low DTF

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[17] The correlation coefficient between the DTF score on the ease of connecting (DB2017) and the frequency of bribe payments of the WEF Global Competitiveness Index (GCI) for calendar year 2015 is 0.63. This relationship is significant at the 1% level. Sample includes 140 countries. The GCI utility bribe index is based on survey results from businesses which are asked how common it is for companies to make undocumented bribes in connection with public utilities (e.g. telephone, electricity). The index is scored from 1 to 7 [1 = very common; 7 = never occurs].

[18] For selected economies, ES disaggregates by region and not city. In such cases, ES data are used from the region where the main commercial city (as considered by *Doing Business*) is located.

[19] Economies where data are only available for the entire country are: Antigua and Barbuda; the Bahamas; Barbados; Belize; Dominica; Grenada; Guyana; St. Kitts and Nevis; St. Lucia; St. Vincent and the Grenadines; and Suriname.

[20] Each country is typically surveyed every 3 years, but this can vary varies.

[21] All ES data prior to 2010 is discarded as it is more than three years older than the latest DB data available.

score of 46 for the ease of connecting measure. In Niger, businesses face a different set of barriers. A new electricity connection takes only a few months to obtain but once connected to the grid, firms in Niamey experience frequent power outages (153 power cuts in 2015), and electricity tariffs (23.6 cents per kWh) are higher than the Sub-Saharan average (20.3 cents). Table 9 in the annex details such differences by presenting the aggregates for the *Doing Business 2017* GE dataset broken along both income and regional classifications as determined by the World Bank. Table 14 in the annex also gives the summary statistics of the data for all the cities covered by *Doing Business*. The main trends and observations are detailed below.

3.1 Power reliability is associated with a country's income level

Several observations emerge looking at SAIDI and SAIFI across economies. For instance, SAIDI and SAIFI data are highly correlated.[22] This is not surprising; SAIDI is a function of the number of service interruptions (i.e. SAIFI) as well as the average disruption time. For a cross sectional analysis, this implies that either variable can be used. The data also show that outages greatly vary from one country to another. In 2015, customers in nearly 50 countries experienced less than one hour of blackouts. These economies include the likes of Germany, Singapore or Costa Rica. On the upper boundary, power was interrupted for over 1,000 hours in 2015 in Comoros, Eritrea, Iraq, Nigeria, Pakistan, South Sudan and Swaziland. Owing to such extreme cases, the 2015 global SAIDI average was 148 hours compared to a median of 3.5 hours. Moreover, the 38 countries where no SAIDI/SAIFI data are available have, on average, more than twice more outages according to ES.[23] This is consistent with research reporting that countries that have considerable shortages often do not record or disclose high-quality data on the performance of public infrastructure (Alcott et al, 2014).

A country's income level is associated to its infrastructure development (Calderon et al, 2014). This is true when we proxy infrastructure development in terms of service reliability as illustrated in Figure 1.[24] A firm operating in a low-income economy in 2015 faced nearly 400 interruptions on average, while a business in a high-income economy experienced 1.5 power cuts.

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[22] The correlation coefficient between the logarithms of SAIDI and SAIFI (averages for 2013-2015) is 0.93. This relationship is significant at the 1% level.

[23] Controlling for sample size and the city considered, and for economies where no SAIFI data are available, there is an average 131 outages a year according to ES. The economies where SAIFI is available have an average of 60 outages a year.

[24] There is a negative correlation coefficient of -0.71 between the natural logarithm of outages and the logarithm of GNI per capita. The relationship is significant at the 1% level. Sample is 142 economies.

Figure 1 - The lower a country's income level, the more likely the outages
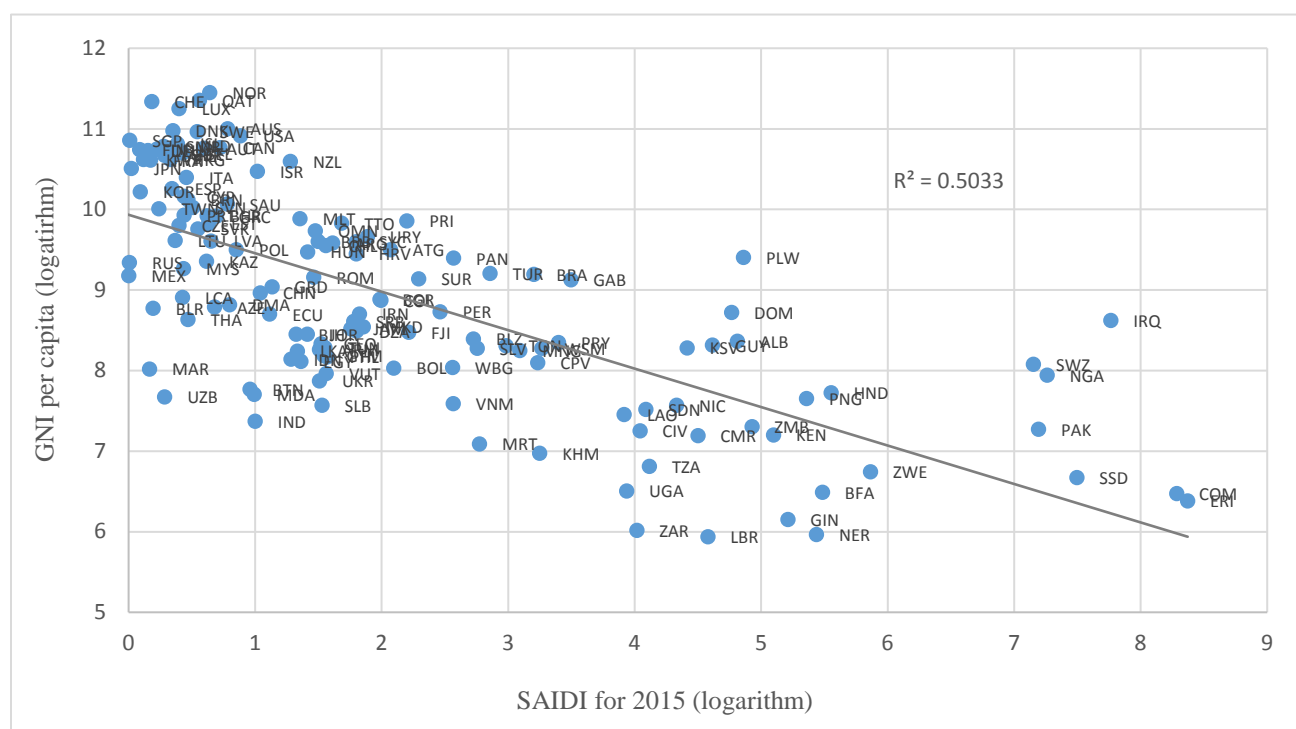
Source: Doing Business database. World Bank (World Development indicators 2015). Sample for 142 economies. Excludes economies where SAIDI and SAIFI data are not available.

Breaking down outage data along regional lines show that OECD-high income had the lowest levels of interruptions as they occurred on average less than once a year for utility customers in 2015. On the other hand, Sub-Saharan African economies suffer the most blackouts in terms of duration and frequency per customer, with an average of almost 741 hours over 241 interruptions in 2015 (Figure 2). South Asia and the Middle East North Africa follow as the second and third regions, respectively, struggling the most with blackouts. This is reflected in the obstacles businesses report; according to Enterprise Surveys, firms in the three aforementioned regions are much more likely to report electricity as a major obstacle or own generators.[25] And for some of the economies concerned, such as Afghanistan, Guinea-Bissau and Sierra Leone, electricity shortages are so chronic that utilities advise new perspective customers with moderate electricity needs to buy their own generators instead of hooking up to the grid (Geginat, 2009).

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[25] According to World Bank Enterprise Surveys, electricity is perceived as major constraint by 39% of firms in Sub-Saharan Africa, 41% in the Middle East and North Africa and 46% in South Asia. These are the highest share of all regions.

Figure 2 - Power outages are most common in Sub-Saharan Africa and South Asia
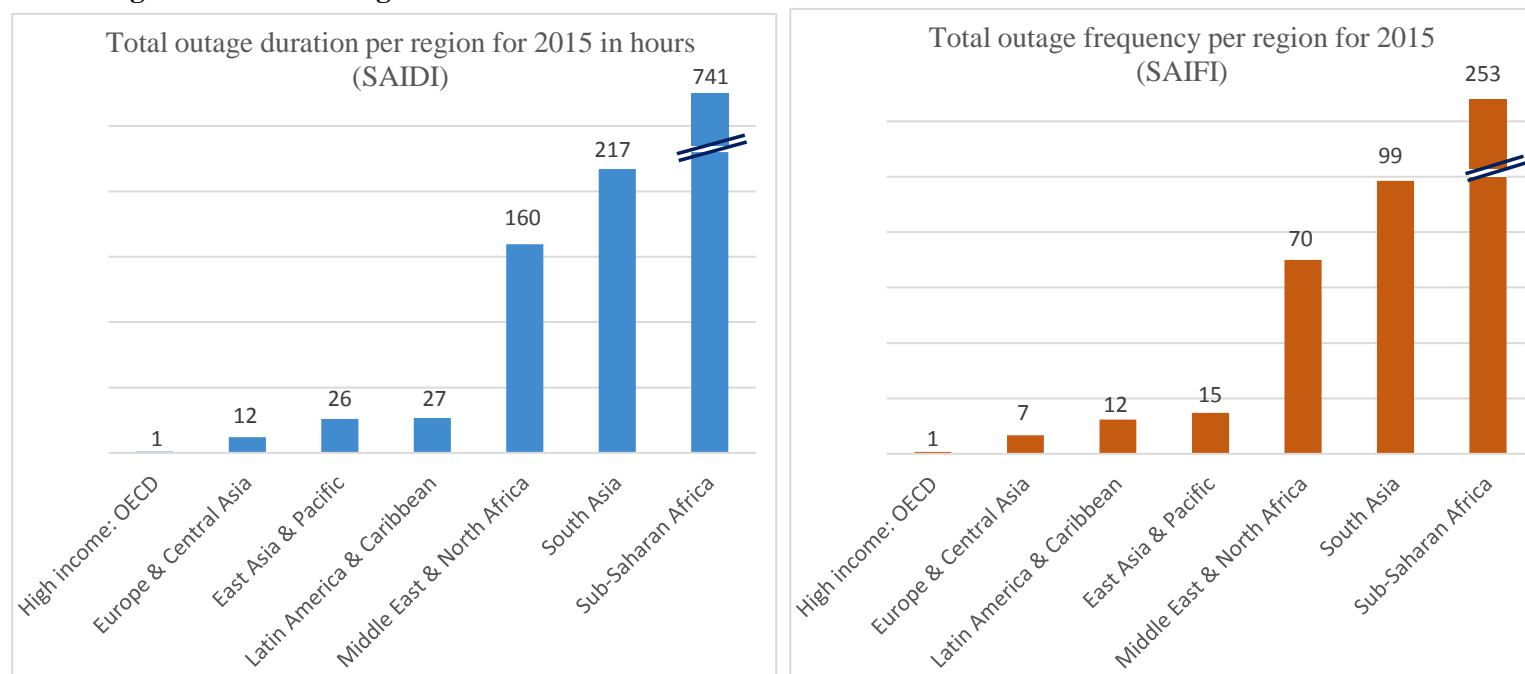
Source: Doing Business database. Sample of 142 economies.

Since only three years of SAIDI/SAIFI data are published (2013-2015), it is difficult to determine any global trend overtime in service reliability. What is apparent, however, is that blackouts fluctuate from year to year. Holding the sample constant,[26] outages fluctuate by as much as 20% across income groups on a yearly basis (Figure 3).[27] Within countries, such swings can be more dramatic. In Zambia in 2015, for example, SAIDI and SAIFI more than doubled compared to the previous year due to low water reserves at hydropower dams caused by insufficient rainfall (Mutale, 2015). Due to such swings in reliability, the yearly average for outages (2013 to 2015) is used in the analysis on firm performance to offset potential yearly anomalies.

Figure 3 – Power outages fluctuate from year to year
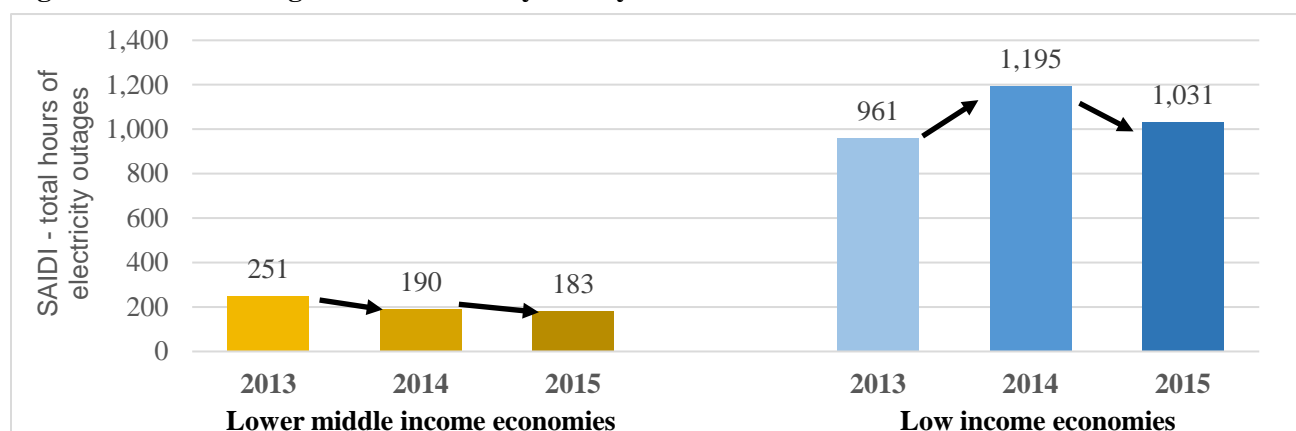
Source: Doing Business database. Sample of 93 economies.

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[26] Economies where SAIDI/SAIDI data was not available for any of the calendar years between 2013 and 2015 are excluded.
[27] In low income economies from 2013 to 2014 the average duration of outages increased from 961 hours to 1195 hours – an increase of 24%.

3.2 Electricity tariffs and geography are linked

By calculating a standard commercial electricity bill in 190 economies and 201 cities, end-user tariffs can be benchmarked. Electricity tariffs in 2016 varied from less than 1 cent per kWh in Kuwait to 96 cents in the Solomon Islands.[28] The global average in 2016 was 18.8 cents per kWh compared to median of 16.0.

The data show that, unlike outages, end-user tariffs are not associated to the income of countries.[29] At the regional level (Figure 4), electricity tariffs are the lowest on average in the Middle East and North Africa (11 cents per kilowatt-hour) as well as Central Asia and Europe (11 cents). They are the highest in East Asia and the Pacific (24 cents). Electricity tariffs also fluctuate from year to year. In 2016, for instance, tariffs decreased by 7% on average at the global level – and as much as 10% in Latin America and the Caribbean. Nonetheless, it is not possible to determine if such a decrease represents an overall trend since only three years of tariffs data are made available at the time of this paper. Due to such swings, the yearly average for tariffs from 2014 to 2016 is used in the analysis on firm performance to offset potential yearly anomalies.

Figure 4 – Regions with resource-rich economies have the lowest electricity tariffs
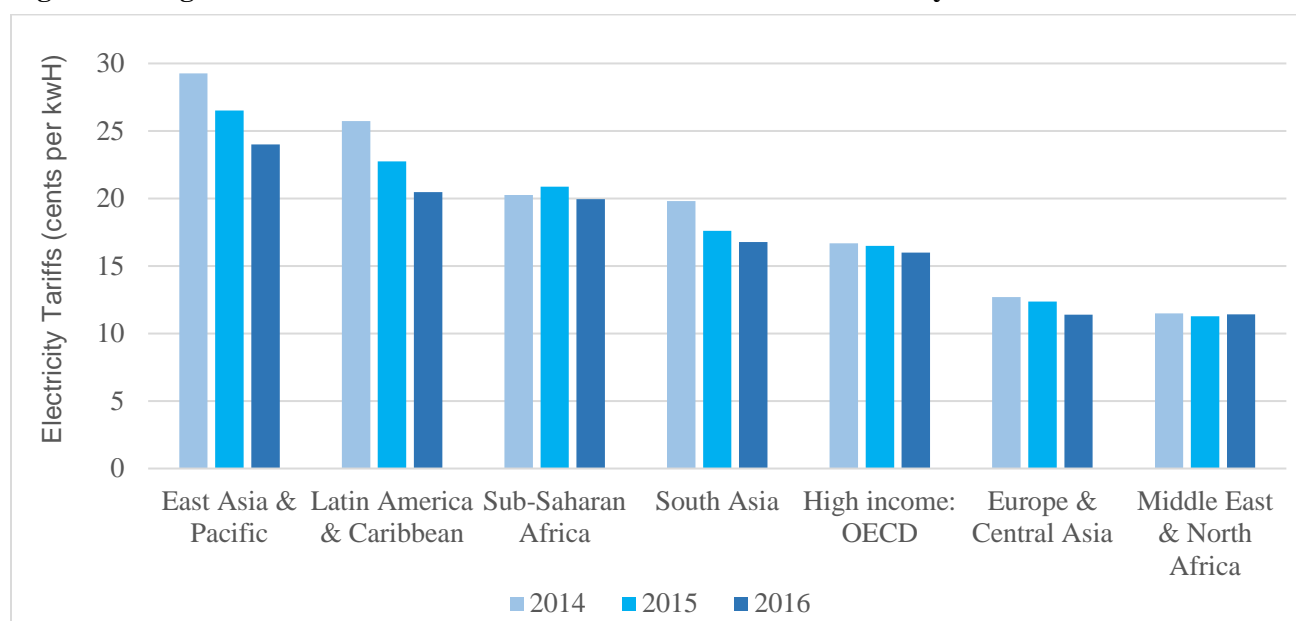
Source: Doing Business database. Sample of 189 economies. Venezuela is excluded as it is an outlier. Somalia is also excluded as no data for 2014 are available.

Several resource-rich economies offer the lowest electricity tariffs, while economies with low natural resource endowment relying on oil and gas imports for generation purposes have the highest tariffs. The latter group includes several small island countries[30] such as the Solomon Islands (96 cents), Kiribati (56 cents), and Antigua

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[28] I exclude Venezuela from the sample as it is an outlying observation due to currency conversion.

[29] The correlation coefficient between tariffs and GNI is 0.12. This relationship is not significant. Results are identical if the natural logarithm of GNI is used.

[30] 13 out of the 15 economies where commercial electricity tariffs are the highest are small islands: Solomon Islands; Kiribati; Antigua and Barbuda; Micronesia; Fed. Sts.; Tonga; Samoa; Vanuatu; Marshall Islands; Papua New Guinea; Bahamas; Seychelles; St. Lucia; and Dominica.

and Barbuda (44 cents). In contrast, countries with the lowest tariffs include Kuwait (1 cents), Algeria (3 cents), Qatar (5 cents) and Bahrain (5 cents). One way to proxy natural resource endowment is the share of fuel exports (% of merchandise exports)[31] (Asiedu et al 2013), which can be compared to electricity tariffs. I find that there is a significant relationship, especially for countries that export a considerable share of fuels (Figure 5).[32]

Figure 5 – Low electricity tariffs are associated with high natural resource endowment
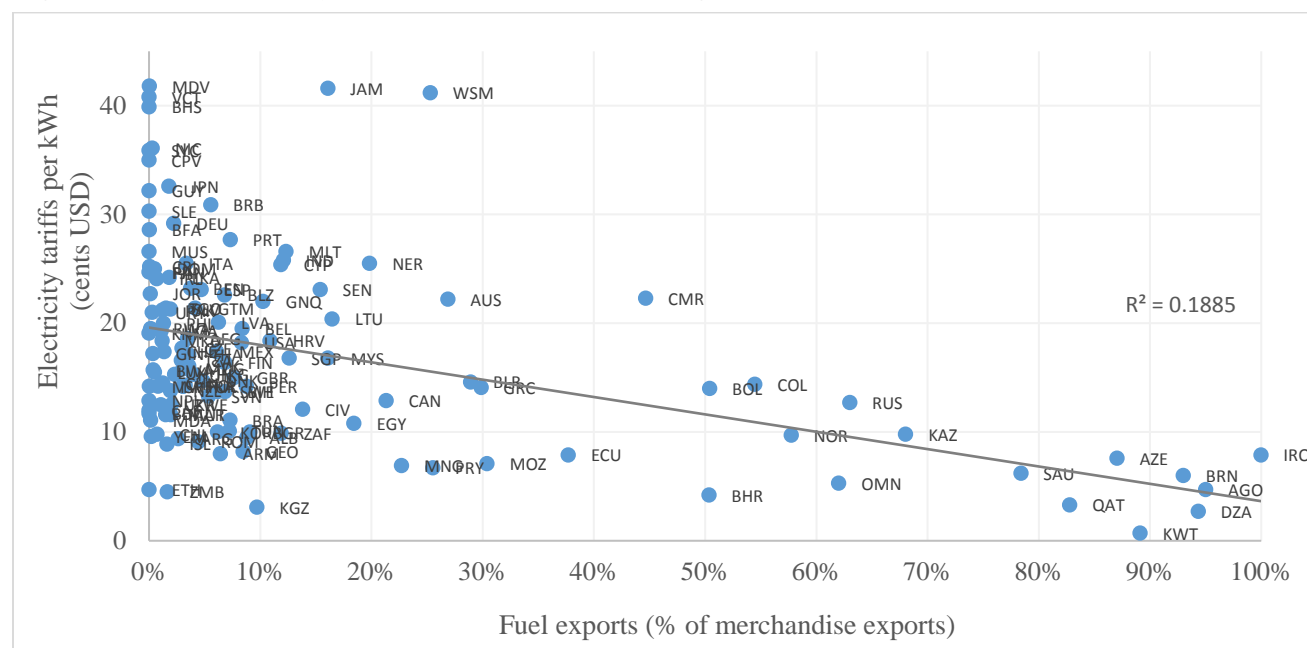
Source: Doing Business database. World Bank staff estimates from the Comtrade. Sample for 127 economies

3.3 The ease of the connection process varies both between and within regions

As detailed by Geginat and Ramalho (2015), the process to connect to electricity varies significantly among countries and regions (see table 8 in annex).[33] For instance, in South Asia, it takes on average 138 days to obtain a new connection – the most out of any region – compared to 62 days in Latin America and the Caribbean. Regarding the number of procedures, it takes 3 procedures to get a new connection in Germany or the United Arab Emirates compared to 9 procedures in Nigeria or Bangladesh. And the higher the number of interactions customers have, the higher the time to get connected to the grid. Economies where three procedures are necessary have an average connection time of 67 days, compared to 245 days where it takes 9 procedures.

Normalizing the estimates on the procedures, time and costs to connect into a DTF score, it can be observed that the higher the income-group, the easier the connection process. OECD high-income economies have the highest average DTF (see table 8 in annex). In contrast, Sub-Saharan Africa has the lowest score – yet

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[31] See table 5 in annex for description of the variable.

[32] The correlation coefficient between tariffs fuel exports is -0.43. This relationship is significant at the 1% level.

[33] As of 1 July 2015, low-income economies are defined as those with a GNI per capita, calculated using the *World Bank Atlas* method, of $1,045 or less in 2014; middle-income economies are those with a GNI per capita of more than $1,045 but less than $12,736; high-income economies are those with a GNI per capita of $12,736 or more. Lower-middle-income and upper-middle-income economies are separated at a GNI per capita of $4,125.

performance sharply differs from one country to another. Rwanda, for instance, has a DTF of 81, whereas Uganda obtains 43.

3.4 Power outages are correlated to a difficult connection process, while electricity tariffs are not associated to either measure

Comparing how economies fare across the different GE metrics, it appears that power outages are negatively associated with the efficiency to connect to the grid (Figure 6).[34] This is consistent with Geginat and Ramalho (2015) who find that an easier connection process is associated to a more reliable supply, suggesting that utilities ensuring better customer service are more likely to ensure better service reliability.

Figure 6 - Outages are associated to a burdensome connection process
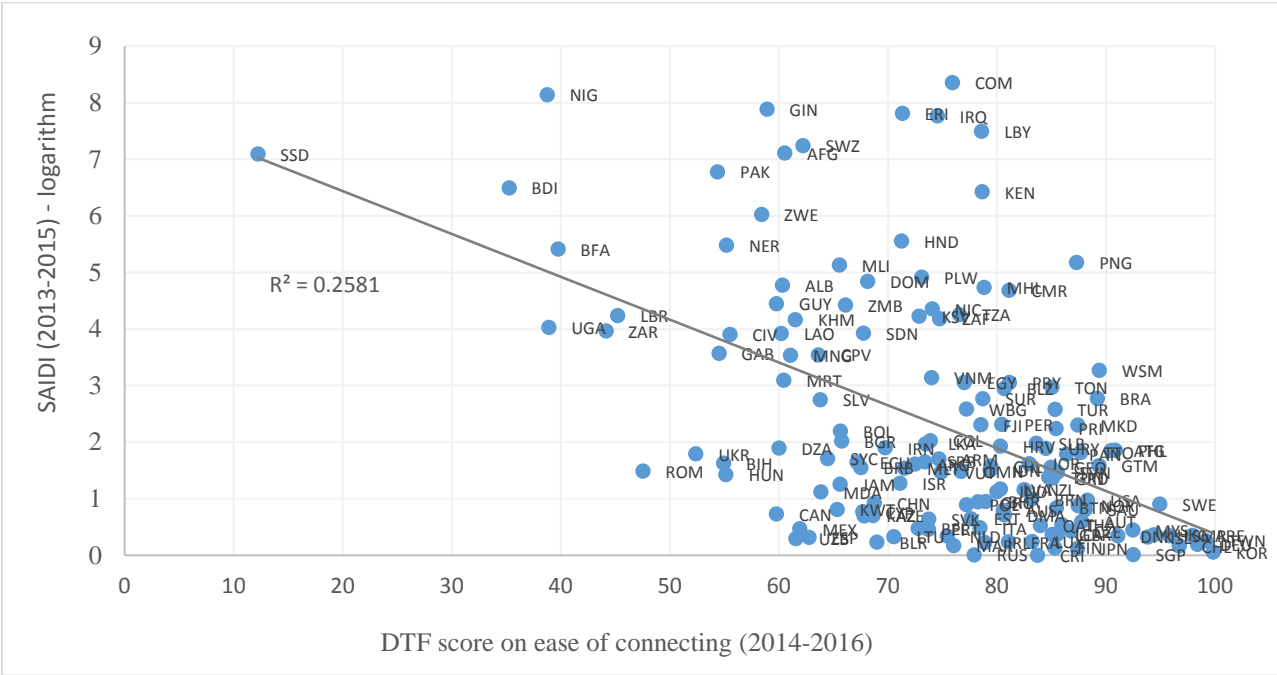
Source: Doing Business database. Sample of 142 economies

On the other hand, electricity tariff data are not associated to outages or the DTF measure (see table 2 in annex). Electricity tariffs are subject to a wide-array of forces beyond utilities' control, and as such they do not always act as efficient price signals (Viera et al, 2016). On the demand side, market size impacts the extent to which production can be scaled. Demand is also influenced be exogenous events such as weather conditions. On the supply side, tariffs are impacted by a country's natural resource endowment as well as regulations in place. Governments may choose to subsidize tariffs to make electricity consumption affordable for the population through public fund transfers or cross-subsidization between consumer groups. Given all these influencing factors, end-user tariffs are not always reflective of a country's ability to meet peak demand - or the utility's performance as captured by the DTF measure.

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[34] The correlation coefficient between the DTF ease of connection score (2014-2016 average) and SAIDI (2013-2015 average) is -0.52. This significant is significant at the 1% level.

IV. Results of econometric analysis

This section examines how firm performance is related to macro electricity variables as measured by GE in terms of (i) outages, (ii) electricity tariffs, and (iii) the ease of connection. I first test whether the variables are related to measures of firm behavior in terms of energy inputs. Secondly, I examine whether firm productivity is associated with electricity sector outcomes.

4.1 Firm behavior

As a first step, I test whether firms are potentially reactive to electricity sector characteristics. More particularly, I examine if electricity variables are associated to firm behavior in terms of the demand for energy inputs. A first aspect of firm behavior that is examined as a dependent variable is the ES percentage of firms using a generator, as it could be expected that where electricity services are unfavorable to businesses (high tariffs, high outages, low 'ease of connecting' score), firms rely on off-grid solutions. The regression results corroborate this; all sector outputs as measured by the GE indicator are associated with generator ownership.

The regression uses three year averages for GE data as the survey year for ES varies from country to country. ES data prior to 2010 is excluded and the weighted aggregates for each major business city are selected. For outages, a logarithm of total duration of interruption in hours is used to normalize the data (i.e. SAIDI). SAIDI is used instead of SAIFI as duration measures are more common in the literature. However, the results presented below show little change regardless of which variable is used. The correlation coefficients between the explanatory variables are displayed in table 10 in the annex, while the results are displayed below (table 1). A robust regression is used to minimize the impact of outliers.

When income is controlled for in terms of logarithm of GNI, I find that for an increase in 1% in the level of outages, the share of businesses owning a generator is expected to increase by 8 percentage points. An improvement in one point in the DTF metric is associated with a decrease in generator ownership of 0.2%. For electricity tariffs, an increase in 1 cent is expected to lead to an increase of 0.6% in the share of generator ownership.

Table 1 – Robust regression analysis of the percentage of firms owning a generator (city level)			
Outages (Log of SAIDI)	8.383***	8.099***	8.387***
	(1.021)	(1.254)	(1.149)
Electricity Tariffs (cents per kWh)	0.618***	0.610***	0.619***
	(0.13)	(0.13)	**(0.133)**
Ease of connecting (DTF)	-0.260**	-0.241*	-0.219*
	(0.13)	(0.12)	(0.128)
Income (Log of GNI)	-	**(1.19)**	-
	-	(2.01)	-
Country Income Dummies	-	-	Yes
Observations	96	96	96
R-squared	0.661	0.662	0.669
Standard errors in parentheses	*** p<0.01, ** p<0.05, * p<0.1		

Source: Doing Business database and Enterprise Surveys Sample excludes all ES data prior to 2010.

Another outcome that is examined is electrical power consumption. While power outages undermine electricity supply, electricity tariffs are likely to impact firm demand. The IEA provides data on electricity consumption per capita (kW) for year 2013. This is calculated as total net electricity generation plus net electricity import/export minus electricity distribution losses. Even though some net domestic generation is intended for households, the majority of electricity consumption typically comes from commercial and industrial activities.[35] Therefore, I use the IEA measure as a proxy for firm electricity consumption and regress it against the GE variables for the closest calendar year available (i.e. 2014). GE data are extrapolated to the country level since the IEA does not provide a breakdown of consumption by city. No weights are, therefore, applied to the respective datasets. The correlation coefficients between the explanatory variables are displayed in table 11 in the annex, while the results are displayed below (table 2). A robust regression is used to minimize the impact of outliers.

I find that outages are negatively associated to the logarithm of electricity consumption. It is therefore expected that the more the blackouts at the macro level, the less the electricity consumption. More interestingly tariffs are also negatively associated to consumption. This relationship is significant at the 1% level when controlling for income, suggesting that electricity demand is not completely inelastic and tariff levels do impact the consumption levels of firms. Regarding the ease of the connection process, I find that it is significantly related to consumption only if income is controlled for via income groups dummies. This is likely because the majority of high-income and middle high-income economies have achieved full electrification rates. Therefore, a higher DTF score for these countries is not associated to increased electricity consumption.

Table 2 – Robust regression analysis of electricity consumption per capita (logarithm)			
Outages (Log of SAIDI)	**-0.405***	**-0.108***	**-0.137***
	(0.074)	(0.040)	(0.051)
Electricity Tariffs (cents per kWh)	**-0.034***	**-0.031***	**-0.032***
	(0.011)	(0.007)	(0.007)
Ease of connecting (DTF)	**0.028***	**0.004**	**0.1035****
	(0.009)	(0.005)	(0.005)
Country Income (Log of GNI)	-	**0.786***	-
	-	(0.061)	-
Country Income Dummies	-	-	**Yes**
Observations	109	109	109
R-squared	0.594	0.843	0.828
Standard errors in parentheses	*** p<0.01, ** p<0.05, * p<0.1		

Source: Doing Business database and International Energy Agency (IEA) statistics

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[35] According to the US Energy Information Association, commercial and industrial customers account for 60% of electricity consumption https://www.eia.gov/tools/faqs/faq.cfm?id=447&t=1

4.2 Firm performance

The results above show that the proxy measures for power outages and tariffs at the macro level are associated to firm behavior in terms of electricity and generator demand. This section examines whether these same proxies are also associated with firm performance.

Econometric Specification

As a measure of firm performance I focus on firm productivity measured by total sales per employee. I use a similar model to Geginat and Ramalho (2015), who use a comparable specification to the ones used by Seker (2009) and Hallward-Driemeier et al (2003). The analysis is carried both at the firm and industry level. No causal inferences can be made since the specifications analyzed do not control for simultaneity between productivity and electricity service measures, i.e. just as reliable and efficient electricity services would increase productivity, highly productive firms may have access to more reliable and efficient electricity services. Furthermore, simultaneity could happen between outages and tariffs due to a third variable. For example, rapid economic growth can cause an increase in electricity demand, resulting in more outages and hikes in tariffs.

As explained in detail in section II, all the data come from Enterprise Surveys except the electricity sector variables which are obtained from the Doing Business GE indicator set. The analysis is based on the following regression model:

$$(1) \quad \gamma_{ijy} = \beta_0 + \beta_1 E_c + \beta_2 X_{ijc} + \beta_3 I_j + \beta_4 M_j * E_c + \beta_5 S_i * E_c + e_{ijc}$$

where Ec represents electricity sector characteristics which are proxied by the GE data:
- **(i) For power outages: ln (SAIDI + 1)**
- **(ii) For electricity tariffs: USD per kWh**
- **(iii) For the ease of connection: DTF score**

y_{ijc} denotes the dependent variable of total sales per employee in firm i, industry j and country c; *Ec* represents city-wide macro electricity sector outcome for firms, which are proxied by the GE measures. *Xijc* is a control variable to capture firm characteristics which are as follows: capital input (proxied by the total investment in fixed assets), firm size (proxied by a dummy for SMEs as defined by ES) [36], the international trade engagement of the firm (proxied by a dummy if the firm exports[37] directly 5% of its output), and access to finance (dummy if firm used banks or other financial institutions to finance its investments). Ij is for industry characteristics, which are captured by dummies defined at the 2-digit ISIC code, as well as dummies for the calendar year of the ES data

Ij*Ec represents the interaction term between a manufacturing dummy and the GE electricity measures. Si * Ec represents the interaction term between firm size and the GE variables. The coefficients measure whether

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[36] ES defines large firms as firms with over 100 employees. Therefore, I consider SMEs all firms with less than 100 employees.

[37] Trade engagement could further be proxied by another dummy on whether firms directly import at least 5% of their inputs (Geginat and Ramalho, 2015). However, ES data for this measure is incomplete and results in a decreased of nearly 50% of observations, while not altering the results. Therefore, trade engagement for this paper is only proxied through exports.

productivity in manufacturing (comparing to services) or for SMEs is more affected by electricity sector characteristics. Eijc is the residual term.

Productivity is a function of the existing production capacity, which is controlled for using a variable of past productivity (i.e. real sales per employees three fiscal years ago), variable inputs (e.g. firm size, capital, etc) and other variables that may impact productivity. While much of the factors influencing firm productivity have already been covered extensively, the aim here is to test which electricity sector output(s) are associated with productivity and to what extent.

I used a natural logarithm for the variables that are not normally distributed, namely power outages (see Figure 9 in annex)[38], productivity as the ratio of sales to employees, capital input and GNI per capita. Three year averages for the GE data are used for outages (2013-2015), tariffs (2014-2016) and the DTF score (2014-2016). I do this because it is not possible to match the years between the ES and GE data for the majority of countries. Power outages and tariffs also fluctuate on a yearly basis as detailed in the summary statistics, so a historical average offsets potential yearly anomalies. For outages, SAIDI is used since time measurements of blackouts are more commonly in the literature. Using SAIFI as a measure for outages, however, yields identical results.

As *Doing Business* measures are representative of the main commercial city of countries (and the second most important city for 11 large countries), ES firm-level observations are restricted to the main business cities.[39] An exception is made for small economies where ES data does not disaggregate firms by location. I use the latest data available for each country as provided by ES, and take 3 year averages for GE data. All monetary ES estimates are adjusted in real terms and data collected before 2010 is discarded.[40] Finally the regression presented does not use the ES sampling weights, although the covariance of interest do not significantly change when weights are used (see table 13 and 14 in the annex).

In the specification, outliers are controlled for using a multivariate outlier control at the 5% level. Income is controlled for using GNI per capita. Intra country clustering effects are controlled for so the standard errors are adjusted (not using clustered standard errors may otherwise lead to incorrect inference). I do not use ES sampling weights in the main analysis presented, yet using them yields almost identical results (see table 13 in the annex). Finally, to avoid multicollinearity I check the correlation coefficients between all predictor variables; no correlation coefficient is above 0.60 (see table 12 in the annex).

Since the firm level regression presented above produces statistically significant results given the large number of observations, it is important to verify if the results remain significant once the data are collapsed at the industry level. It's also important to do this since some countries have a lot more observations than others, which may skew the results. Like Geginat and Ramalho (2015), I use here a specification developed by Klapper, Laeven and Rajan (2004), who focus on how the business environment impacts firm creation by interacting industry characteristics with country characteristics. Their specification is adapted by changing the dependent

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[38] 1 is added to the raw SAIDI value for the calculation of the natural logarithm of SAIDI so that that there are no negative observations which would introduce bias.

[39] For selected economies, ES disaggregates by region and not city. In such cases, ES data are used from the region where the main commercial city (as considered by Doing Business) is located.

[40] All ES data prior to 2010 is discarded as it is more than three years older than the latest DB data available.

variable from firm entry to firm productivity, thereby inputting industry and country level controls. Furthermore, a variable on past productivity is added as a proxy of existing production capacity. The ordinary least square specification used here is:

$$(2) \quad \gamma_{jc} = \beta_0 + \beta_1 E_c + \beta_2 X_{jc} + \beta_3 M_j * E_c + e_{jc}$$

y_{jc} stands for the average sales per employee in industry j (defined at the 2-digit ISIC) and country c. The other variables remain similar as in (1) except for X_{jc} which now represent average industry characteristics. These are as follows: average past sales per employees, average firm size (measured by the share of SMEs in industry j country c), capital input (proxied by investment), average international trade engagement (measured by the percentage of firms that export directly 5% or more in industry j country c), and the average usage of bank finance (proxied by the share of firms in industry j and country j that have a bank loan).

Results of firm level analysis
The regression results for the firm level specification displayed in equation 1 are presented in Table 3 below. The first column shows the results under the basic specification where I only control for country characteristics in terms of income, industry characteristics and some firm level characteristics (past productivity and capital inputs). The coefficient related to power outages and electricity tariffs are negative. Moreover, the coefficients are significantly different from zero at the one and ten percent levels, respectively. In other words, firms with lower productivity are expected to have frequent power outages and high electricity tariffs. Productivity is also higher where capital input is greater. No such significant relationship emerges when looking at electricity connections, inferring that firms are not more productive where the connection process is easy. This could be because the majority of firms surveyed by ES are already connected to the grid and are thus not impacted by a burdensome connection process.

As more controls are inserted - such as bank financing (column 2), or trade engagement (column 3) - the observations hold. More particularly, power outages and electricity tariffs are still inversely associated to firm productivity. When controlling for both access to finance and trade, for a 1% increase in the total duration of power outages, productivity is expected to decrease by 0.10%. And if electricity tariffs were to decrease by 1 cent per kWh, productivity is expected to increase by 0.36%.

Column 4 shows the specification with all the covariates included, plus the interaction terms between firm size (proxied by an SME dummy) and the electricity variable. Similarly, column 5 focuses on the interactions with operation type (proxied by a dummy for manufacturing firms). Several observations can be made. For example, the interaction terms between firm size and electricity tariffs suggest that the productivity of SMEs is associated with lower electricity tariffs, yet no such relationship exists for large firms. A possible explanation is the SMEs typically have smaller margins than large firms (OECD, 2016) and so they are less capable to absorb high energy prices.

The interaction terms between the manufacturing dummy and electricity tariffs reveal that electricity tariffs are more negatively associated to productivity for firms in services. This may suggest that, in the manufacturing sector as a whole, electricity consumption is more inelastic and/or tariffs can be more easily passed on to

consumers. For outages, the interaction terms are not significantly different from 0, suggesting that the productivity in the service and manufacturing sectors are equally impacted by power cuts. When industry is interacted at the ISIC level for outages, some interaction terms are negative and significant for industries such as manufacturing refined petroleum (ISIC 19), manufacture non-mineral products (ISIC 20), Computer programming (ISIC 62) and Scientific research and development (ISIC 72).

Table 3 – Regression results for specifications on firm-level productivity with cluster control

OLS Specification with log of annual sales per employees as dependent variable					
Variable	(1) = Basic	(2) = (1) + Access to finance	(3) = (2) + Trade	(4) = (3) + Interactions: GE variables* SME	(5) = (3) + Interactions: GE variables* Industry
Outages (log of SAIDI)	-0.0962***	-0.0961***	-0.0965***	-0.0895***	-0.0899***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.024)
Electricity tariff (cents per kWh)	-0.00344*	-0.00342*	-0.00365*	-0.00122	-0.00522**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ease to connect (DTF)	0.00177	0.00222	0.00258	0.00046	0.00585**
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Past sales per employees (log)	0.906***	0.905***	0.905***	0.905***	0.905***
	(0.010)	(0.011)	(0.010)	(0.010)	(0.011)
Capital input (log investment)	0.0793***	0.0810***	0.0801***	0.0802***	0.0802***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Access to finance dummy	-	-0.0476*	-0.0443*	-0.0460*	-0.0452*
		(0.025)	(0.025)	(0.025)	(0.025)
Direct export (5% dummy)	-	-	-0.0332*	-0.0317	-0.0299
			(0.019)	(0.019)	(0.019)
Interaction terms (SME*SAIDI)	-	-	-	-0.00771	-
Interaction terms (SME *tariffs)	-	-	-	0.00415***	-
Interaction terms (SME *DTF)	-	-	-	0.00267	-
Interaction terms (Industry*SAIDI)	-	-	-	-	-0.00894
Interaction terms (Industry*tariffs)	-	-	-	-	-0.00311***
Interaction terms (Industry*DTF)	-	-	-	-	0.00267
GNI (log; real)	-0.134*	-0.130*	-0.131*	-0.130*	-0.127*
Industry dummies (ISIC codes)	Yes	Yes	Yes	Yes	Yes
Income dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
SME dummy	Yes	Yes	Yes	Yes	Yes
Observations	5,319	5,303	5,283	5,283	5,283
R-squared	0.988	0.988	0.988	0.988	0.988

*** p<0.01, ** p<0.05, * p<0.1

Result of Industry Level Analysis

As a next step, the firm data are collapsed at the industry level, with the results displayed on table 4 below. Once again, the sample is restricted the main *Doing Business* cities only. The specifications at the industry level use the same covariates than in the firm level regressions.

The results at industry levels are similar than the firm level regressions although the value of the coefficients do change. For instance, compared to the firm level regressions, the coefficients for past productivity and capital input increase. The coefficients for electricity sector variables on outages and electricity tariffs decrease slightly but remain both negative and significant. These results hold when several controls are added (columns 2 and 3). When controlling for both trade and access to finance, an increase of 1% of outage duration at the city level is associated with an increase of over 0.07% in industry productivity. Similarly, a decrease in electricity tariffs of one cent per kWh is associated with an increase in 0.37% in firm productivity. On the other hand, the ease of the connection process is not significantly associated to industry productivity.

Table 4 – Regression results for specifications on firm-level productivity collapsed by industry

	OLS Specification with productivity collapsed at the industry level			
	(1) = Basic	**(2) = (1) + Access to finance**	**(3) = (2) + Trade**	**(4) = (3) + Interactions: GE variables* Industry**
Outages (log of SAIDI)	-0.0755***	-0.0743***	-0.0741***	-0.0795***
	(0.0144)	(0.0144)	(0.0144)	(0.0236)
Electricity tariff (cents per kWh)	-0.00361**	-0.00351**	-0.00366**	-0.00534***
	(0.0014)	(0.0014)	(0.0015)	(0.0019)
Ease to connect (DTF)	0.000797	0.00152	0.00148	0.00487*
	(0.0018)	(0.0018)	(0.0018)	(0.0025)
Past sales per employees (log)	0.911***	0.912***	0.912***	0.911***
	(0.0131)	(0.0132)	(0.0132)	(0.0133)
Capital input (log investment)	0.0704***	0.0701***	0.0701***	0.0705***
	(0.0124)	(0.0125)	(0.0126)	(0.0127)
Access to finance dummy	-	-0.0397	-0.0422	-0.0432
		(0.0498)	(0.0500)	(0.0500)
Direct export (5% dummy)	-	-	0.0164	0.0147
			(0.0482)	(0.0507)
Interaction terms (Industry*SAIDI)	-	-	-	0.00649
Interaction terms (Industry*tariffs)	-	-	-	0.00318
Interaction terms (Industry*DTF)	-	-	-	-0.00635**
GNI (log; real)	-0.148***	-0.142***	-0.142***	-0.141***
Industry dummies (ISIC codes)	Yes	Yes	Yes	Yes
Income dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
SME dummy	Yes	Yes	Yes	Yes
Observations	1,206	1,205	1,203	1,203
R-squared	0.989	0.989	0.989	0.989

*** p<0.01, ** p<0.05, * p<0.1

Conclusion

This paper had three main objectives. First, it sought to introduce the expanded Doing Business GE data, which now encompasses estimates on power outages as well as electricity tariffs for 190 economies. Secondly, it explored whether electricity sector characteristics – as measured by the GE data – are associated to firm behavior in terms of energy inputs. Lastly, the paper has examined if, consistent with the literature, interruptions and tariffs are inversely associated to firm performance when measured in terms of productivity.

The statistical relationships presented show that power outages and electricity tariffs are in line with estimates collected from the private sector and other agencies. It is therefore suggested that the GE dataset can serve as a useful proxy for macro electricity sector outputs from the perspective of end-users, thereby aiding future research or policy makers. Moreover, the data show that power outages and electricity tariffs vary considerably from country to country, but both measures are not associated to one-another.

This paper finds that electricity tariffs and power outages are associated to metrics of firm behavior vis-à-vis their demand for energy inputs. For example, firm generator ownership is linked with high levels of outages as well as tariffs. More importantly, when using Enterprise Surveys data for a cross section analysis in 88 cities, power outages and electricity tariffs are found to be negatively associated with firm level productivity. This is consistent with the literature and holds when controlling for various characteristics at the firm, industry and country level. However, interaction terms reveal that electricity tariffs are only associated to the productivity of SMEs but not large firms'. The interaction terms between the manufacturing dummy and outages do not suggest that power outages are any more associated to the productivity of firms in manufacturing vs. services. For policy-makers this then suggests that reliability is important for all private sector actors and efforts to improve it need not be targeted to particular groups of firms.

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V. Annex

Table 5 – Description of variables used

Variable	Source	Year	Definition
SAIDI	Doing Business Report 2017 (www.doingbusiness.org)	2013-2015	System Average Interruption Duration Index (SAIDI). SAIDI is the average total duration of outages over the course of a year for each customer served. It is measured in hours.
SAIFI	Doing Business Report 2017 (www.doingbusiness.org)	2013-2015	System Average Interruption Frequency Index (SAIFI). SAIFI is the average number of service interruptions experienced by a customer in a year. It is measured in units of interruptions.
Electricity Tariffs (*Doing Business*)	Doing Business Report 2017 (www.doingbusiness.org)	2014-2016	Price of electricity measured in U.S. cents per kilowatt-hour. Cost is determined on the basis of a monthly consumption of 26,880 kWh for a commercial warehouse.
Procedures Getting Electricity	Doing Business Report 2017 (www.doingbusiness.org)	2014-2016	Number of procedures required to complete a connection to electricity of a newly built construction with a 140 kVA load demand.
Time Getting Electricity	Doing Business Report 2017 (www.doingbusiness.org)	2014-2016	Time in days required to connect a newly built construction to electricity starting from the first procedure required for the connection and until electricity starts flowing.
Cost as % of GNI per capita Getting Electricity	Doing Business Report 2017 (www.doingbusiness.org)	2014-2016	Cost in % of GNI per capita paid to utility, contractors and other agencies for completion of an external electricity connection for a newly built warehouse with a 140 kVA load.
DTF on ease of connection	Doing Business Report 2017 (www.doingbusiness.org)	2014-2016	Composite score based on the procedures, time and cost to obtain a new connection. Computation is based on the measure of the distance to frontier (DTF). It measures the distance of each economy to the "frontier" – i.e. the best performance observed on each of the indicators across all economies. An economy's distance to frontier is reflected on a scale from 0 to 100, where 0 represents the lowest performance and 100 represents the frontier.
Electricity tariffs (Eurostat)	Eurostat electricity tariffs	2015	Electricity prices for industrial end-users, related to the first semester of reference year 2015. Eurostat electricity prices are collected under the methodology set by European Commission Decision (2007/394/EC). Tariffs are expressed in Euro but converted to USD using the World Bank Atlas method.
Electricity Consumption	International Energy Agency (IEA)	2014	Electric power consumption measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants.
Quality of Electricity Supply Score	World Economic Forum – Executive Opinion Survey, Global Competitiveness Indicators	2015-2016	How would you assess the quality of the electricity supply in your country (lack of interruptions and lack of voltage fluctuations)? [1 = insufficient and suffers frequent interruptions; 7 = sufficient and reliable]
Frequency of Bribes to Public Utilities Score	World Economic Forum – Executive Opinion Survey, Global Competitiveness Indicators	2015-2016	In your country, how common is it for firms to make undocumented extra payments or bribes connected with public utilities? Answers ranges from 1 (very common) to 7 (never occurs).
Firms' current sales	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Firm total annual sales in local currency
Firms' labor input	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Number of firms' full time workers.

Variable	Source	Year	Definition
Firms' productivity	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Total annual sales per full time worker. Converted in 2015 constant US dollars using the World Bank Atlas method and GDP deflator data
Firms' capital input (investment)	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Total annual expenditure in local currency for purchases of machines, equipment and buildings.
Direct Export 5%	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Measure of firms' international trade engagement: Dummy variable equal to 1 if the firm exports directly at least 5% of its sales
Firms' usage of bank finance	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Dummy variable equal to one if the firm uses banks or other financial institutions to finance its investments or working capital.
Number of power outages per month experienced by firms	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Average number of power outages observed by the firm in a typical month.
Generator Ownership	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Percent of firms owning or sharing a generator
ISIC codes	World Bank, Enterprise Surveys (http://www.enterprisesurveys.org/)	2010-2016	Enterprise Surveys collects firm-level data from the manufacturing and services sectors. This corresponds to firms classified with ISIC codes 15-37, 45, 50-52, 55, 60-64, and 72 (ISIC Rev.3.1).
Fuel exports (% of merchandise exports)	World Bank staff estimates using the Comtrade database maintained by the UN Statistics Division.	2015	Share of fuels exports to total merchandise exports. Fuel comprise SITC section 3 (mineral fuels).
GNI per capita 2015	World Bank (World Development indicators 2016)	2016	The gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population
Foreign currency exchange	World Development Indicators 2016	2016	Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. Local currency units relative to the U.S. dollar.
GDP deflator	World Bank national accounts data, and OECD National Accounts data files.	2015	The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency. The base year varies by country.

Table 6 – SAIDI and SAIFI formula

$$SAIFI = \frac{\sum Nix}{Ntx} \qquad SAIFI = \frac{\sum(ri * Nix)}{Ntx}$$

Nix = Total number of customers interrupted over year x.
Ntx = Total number of customers served over year x.
Ri = Average restoration time (in hours)

Table 7 – Enterprise Surveys Sample data

	Year Surveyed	Number of Observations	% of total observations
East Asia & Pacific			
Cambodia	2016	79	1.49%
China	2012	33	0.62%
Indonesia	2015	7	0.13%
Lao PDR	2016	33	0.62%
Malaysia	2015	44	0.83%
Mongolia	2013	93	1.75%
Papua New Guinea	2015	9	0.17%
Philippines	2015	52	0.98%

	Year Surveyed	Number of Observations	% of total observations
Solomon Islands	2015	77	1.45%
Thailand	2016	2	0.04%
Vietnam	2015	94	1.77%
Europe & Central Asia			
Albania	2013	9	0.17%
Armenia	2013	46	0.86%
Azerbaijan	2013	4	0.08%
Belarus	2013	25	0.47%
Bosnia and Herzegovina	2013	18	0.34%
Bulgaria	2013	35	0.66%
Croatia	2013	86	1.62%
FYR Macedonia	2013	64	1.20%
Georgia	2013	23	0.43%
Kazakhstan	2013	15	0.28%
Kosovo	2013	35	0.66%
Latvia	2013	17	0.32%
Lithuania	2013	19	0.36%
Moldova	2013	38	0.71%
Romania	2013	38	0.71%
Russia	2012	64	1.20%
Serbia	2013	35	0.66%
Turkey	2013	41	0.77%
Uzbekistan	2013	46	0.86%
High income: OECD			
Chile	2010	372	6.99%
Czech Republic	2013	48	0.90%
Estonia	2013	63	1.18%
Hungary	2013	14	0.26%
Israel	2013	39	0.73%
Poland	2013	24	0.45%
Slovak Republic	2013	9	0.17%
Slovenia	2013	75	1.41%
Sweden	2014	75	1.41%
Latin America & Caribbean			
Argentina	2010	343	6.45%
Bolivia	2010	45	0.85%
Colombia	2010	274	5.15%
Costa Rica	2010	143	2.69%
Dominican Republic	2010	68	1.28%
Ecuador	2010	77	1.45%
El Salvador	2016	115	2.16%
Guatemala	2010	142	2.67%
Jamaica	2010	48	0.90%
Mexico	2010	246	4.62%
Nicaragua	2010	5	0.09%
Panama	2010	11	0.21%
Paraguay	2010	89	1.67%
Peru	2010	424	7.97%
Trinidad and Tobago	2010	35	0.66%
Uruguay	2010	214	4.02%
Middle East & North Africa			
Egypt	2013	67	1.26%
Iraq	2011	45	0.85%
Jordan	2013	51	0.96%
Morocco	2013	24	0.45%
Tunisia	2013	57	1.07%
West Bank And Gaza	2013	50	0.94%

	Year Surveyed	Number of Observations	% of total observations
South Asia			
Afghanistan	2014	3	0.06%
Bhutan	2015	43	0.81%
India	2014	34	0.64%
Pakistan	2013	35	0.66%
Sri Lanka	2011	30	0.56%
Sub-Saharan Africa			
Burundi	2014	25	0.47%
Cameroon	2016	48	0.90%
DRC	2013	57	1.07%
Kenya	2013	148	2.78%
Mali	2016	33	0.62%
Mauritania	2014	25	0.47%
Nigeria	2014	39	0.73%
South Sudan	2014	62	1.17%
Sudan	2014	20	0.38%
Swaziland	2016	28	0.53%
Tanzania	2013	39	0.73%
Uganda	2013	40	0.75%
Zambia	2013	88	1.65%
Zimbabwe	2011	49	0.92%
TOTAL		**5319**	**100%**

Table 8 – Getting Electricity dataset by region and income groups for years 2015 and 2016 - as published in *Doing Business 2017*

Income group classification	Average Procedures to connect	Average Time to connect	Average Cost (%GNI)	Ease of Connecting DTF score	SAIDI Average	SAIFI average	Electricity Tariff ($ kwH)
High income	4.75	71.68	89.89	82.13	1.54	1.47	0.16
Upper middle income	5.37	91.45	757.03	73.93	79.87	37.89	0.17
Lower middle income	5.45	97.43	1,248.05	68.92	174.44	54.13	0.19
Low income	5.14	130.79	5,582.18	52.79	1,031.30	384.07	0.22
Global Average	**5.17**	**92.95**	**1,410.07**	**71.68**	**148.54**	**54.95**	**0.18**

Regional classification	Average Procedures to connect	Average Time to connect	Average Cost (%GNI)	Ease of Connecting DTF score	SAIDI Average	SAIFI average	Electricity Tariff ($ kwH)
East Asia & Pacific	4.56	73.88	714.62	80.29	25.83	14.76	0.24
Europe & Central Asia	5.60	111.92	375.23	70.59	12.03	6.73	0.11
High income: OECD	4.75	75.53	62.20	81.72	0.92	0.70	0.16
Latin America & Caribbean	5.50	66.37	999.74	76.37	26.74	12.40	0.20
Middle East & North Africa	5.00	81.58	771.78	72.67	159.57	69.98	0.11
South Asia	5.63	137.75	1,207.21	65.92	216.95	98.52	0.17
Sub-Saharan Africa	5.33	120.50	3,872.48	58.48	740.86	252.65	0.20
Global Average	**5.17**	**92.95**	**1,410.07**	**71.68**	**148.54**	**54.95**	**0.18**

Source: Doing Business database. For tariff data, the sample excludes Venezuela as it is an outlying observation due to currency conversion

Table 9 - Summary statistics of Getting Electricity dataset across the cities covered by *Doing Business*.

	Observations (number of cities)	Mean	Median	Standard Deviation	Minimum	Maximum
SAIDI (hours)	158	184.02	4.01	603.11	0.00	4,240.00
SAIFI (frequency)	158	57.39	3.11	167.08	0.00	1,008.00
Tariffs (cents USD per kWh)	200	18.81	15.97	11.75	0.73	98.20
DTF score	201	71.39	74.59	16.51	12.23	99.84

Source: Doing Business database. Estimates are three year averages from 2013 to 2015 for outages. For the DTF score and tariffs, averages are from 2014 to 2016. For tariff data, the sample excludes Venezuela as it is an outlying observation due to currency conversions

Figure 7 – The WEF score on the quality of electricity supply and the SAIDI measure of outages are highly correlated
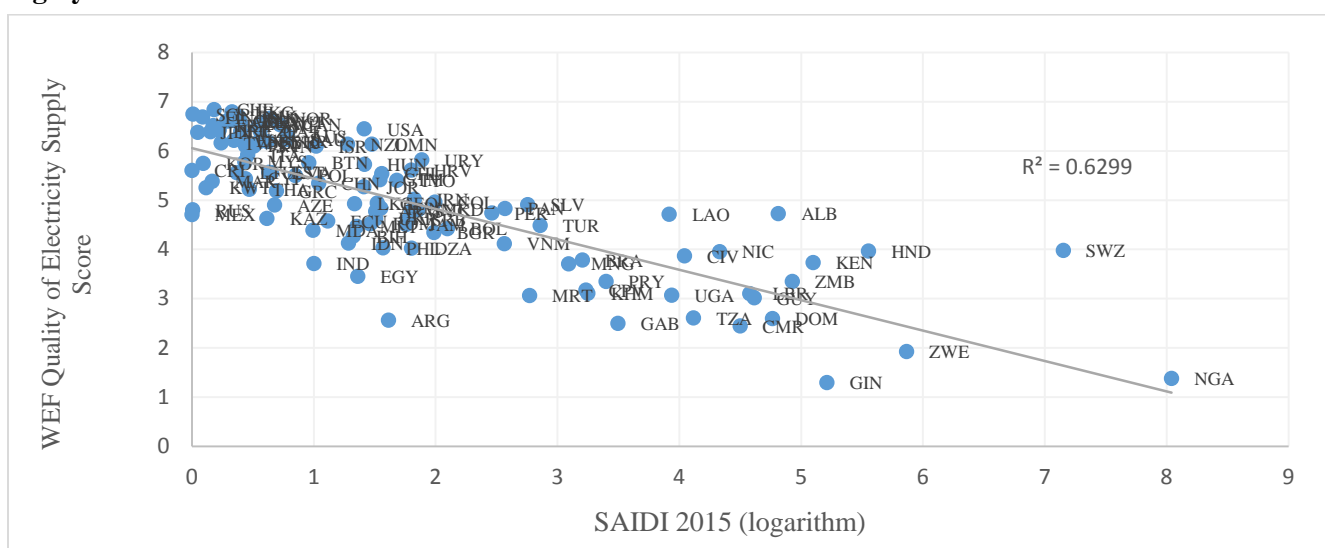
Source: Doing Business database and World Economic Forum 2015. Sample covers 116 economies. WEF Score: 1 = insufficient and suffers frequent interruptions; 7 = sufficient and reliable

Figure 8 – The more complex the connection process, the higher the likelihood of utility corruption
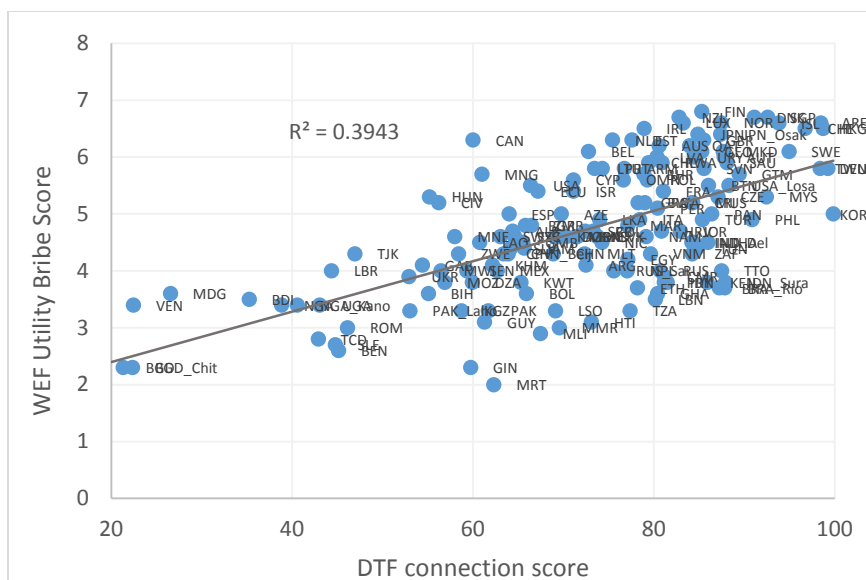
Source: Doing Business database and World Economic Forum 2015. Sample of 140 economies.

Figure 9 – Average SAIFI and SAIFI (2013 to 2015): natural logarithmic distribution
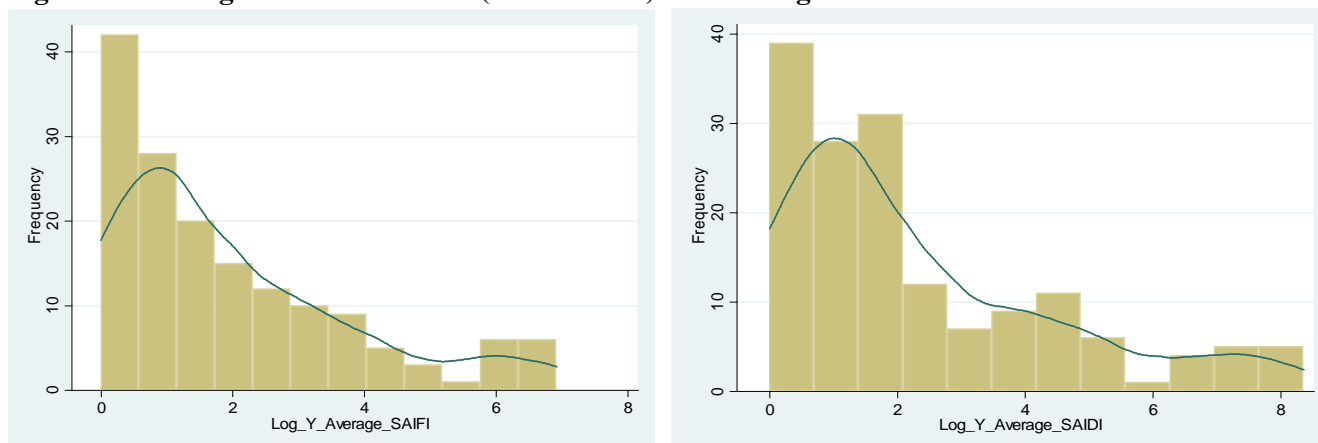
Source: Doing Business data. Sample for 158 Doing Business cities. Note: 1 is added to the raw SAIDI value for the calculation of the natural logarithm of SAIDI so that that there are no negative observations which would introduce bias.

Table 10 – Correlation matrix between GE indicators and generator ownership

	SAIDI (log) 2013-2015	Electricity tariffs (cents per kWh) 2014-2016	Ease of connection DTF score 2014-2016	Generator ownership (%of firms)	GNI per capita (log)
SAIDI (log): 2013-2015	1				
Electricity tariffs (cents per kWh): 2014-2016	0.1744* 0.0423	1			
Ease of connection DTF: 2014-2016	-0.5127* 0.0000	0.0919 0.2361	1		

Generator ownership (%of firms)	0.7633* 0.0000	0.2284* 0.0111	-0.4183* 0.0000	1	
GNI per capita (log)	-0.6813* 0.0000	-0.1413 0.0142	0.5233* 0.0142	-0.4755* 0.0000	1

*Source: Doing Business data. Entreprise Surveys 2010-2016. * $p<0.05$. Sample of 96 cities.*

Table 11 – Correlation matrix between GE indicators and electricity consumption

	SAIDI (log) 2013	Electricity tariffs (cents per kWh) 2014	Ease of connection DTF score 2014	Electricity Consumption (kWh per capita) 2013	GNI per capita (log)
SAIDI (log): 2013	1				
Electricity tariffs (cents per kWh): 2014	0.1420 0.0907	1			
Ease of connection DTF: 2014	-0.5100* 0.0000	0.1029 0.1600	1		
Electricity Consumption (kWh per capita) 2013	-0.7155* 0.0000	-0.1806* 0.0375	0.5201* 0.0000	1	
GNI per capita (log)	-0.7349* 0.0000	-0.1138 0.0142	0.6124* 0.0142	0.8910* 0.0000	1

*Source: Doing Business data. International Energy Association 2013. * $p<0.05$. Sample of 109 countries.*

Table 12 – Correlation matrix between GE indicators and predictor variables for productivity specification at the firm level

	SAIDI (log) 2013-2015	Electricity tariffs (cents per kWh) 2014-2016	Ease of connection DTF score 2014-2016	GNI per capita	Investment – capital input (log)
SAIDI (log): 2013-2015	1				
Electricity tariffs (cents per kWh): 2014-2016	0.0864* 0.0000	1			
Ease of connection DTF: 2014-2016	-0.5793* 0.0000	0.1085* 0.0000	1		
GNI per capita:	-0.6293* 0.0000	0.1041* 0.0155	0.5301* 0.0000	1	
Investment (log)	0.0301* 0.0000	-0.0786* 0.0000	-0.0634* 0.0000	-0.1350* 0.0000	1

*Source: Doing Business data and Entreprise Surveys. * $p<0.05$.*

Table 13: table for specifications on firm-level productivity weighted according to ES sampling

	Specification with log of annual sales/employees as dependent variable				
	(1) = Basic	(2) = (1) + Access to finance	(3) = (2) + Trade	(4) = (3) + Interactions: GE variables* SME	(5) = (3) + Interactions: GE variables* Industry
	Weighted	Weighted	Weighted	Weighted	Weighted
Outages (log of SAIDI)	-0.0601***	-0.0765***	-0.0761***	-0.0671***	-0.0652***
	(0.0169)	(0.0168)	(1.68E(02))	(0.0259)	(0.0239)
Electricity tariff (cents per kWh)	-0.0088***	-0.00911***	-0.00930***	-0.00682**	-0.0085***
	(0.00117)	(0.00117)	(0.00119)	(0.00315)	(0.00149)
Ease to connect (DTF)	-0.00059	-0.00053	-0.00012	-0.00743	0.00231
	(0.00218)	(0.00219)	(0.00219)	(0.00492)	(0.00268)
Past sales per employees (log)	0.917***	0.916***	0.918***	0.919***	0.917***
	(0.0102)	(0.0104)	(0.0105)	(0.0104)	(0.0104)
Capital input (log investment)	0.0574***	0.0592***	0.0578***	0.0565***	0.0571***
	(0.0102)	(0.0106)	(0.0106)	(0.0106)	(0.0105)
Access to finance dummy	-	0.0301	0.0366	0.0331	0.0375
		(0.0458)	(0.0459)	(0.0457)	(0.0454)
Direct export (5% dummy)	-	-	-0.0286	-0.0269	-0.0225
			(0.0412)	(0.0409)	(0.041)
Interaction terms: SME*SAIDI	-	-	-	-0.0117	-
Interaction terms: SME *tariffs	-	-	-	-0.00293	-
Interaction terms: SME *DTF	-	-	-	0.00809	-
Interaction terms: Industry*SAIDI	-	-	-	-	-0.031
Interaction terms: Industry*tariffs	-	-	-	-	-0.00175
Interaction terms: Industry*DTF	-	-	-	-	-0.00835***
GNI (log; real)	-0.243***	-0.231***	-0.232***	-0.226***	-0.231***
Industry dummies (ISIC codes)	Yes	Yes	Yes	Yes	Yes
Income dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
SME dummy	Yes	Yes	Yes	Yes	Yes
Observations	5,319	5,303	5,283	5,283	5,283
R-squared	0.983	0.984	0.984	0.984	0.984

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 14 – Regression table for specifications on firm-level productivity weighted according to ES sampling and collapsed for industry

	Specification with log of sales per employee as dependent variable - Collapsed by industry and country			
	(1) - Basic	**(2) = (1) + Access to finance**	**(3) = (2) + Trade**	**(4) = (3) + Interactions: GE variables* Industry**
	Weighted	Weighted	Weighted	Weighted
Outages (log of SAIDI)	-0.0731***	-0.0719***	-0.0717***	-0.0828***
	(0.0145)	(0.0145)	(0.0145)	(0.0237)
Electricity tariff (cents per kWh)	-0.0037**	-0.00359**	-0.0038**	-0.0055***
	(0.00146)	(0.00145)	(0.00148)	(0.00185)
Ease to connect (DTF)	0.00104	0.00169	0.00163	0.00491*
	(0.00183)	(0.00178)	(0.00179)	(0.00255)
Past sales per employees (log)	0.907***	0.909***	0.909***	0.908***
	(0.0135)	(0.0135)	(0.0136)	(0.0137)
Capital input (log investment)	0.0745***	0.0735***	0.0736***	0.0742***
	(0.013)	(0.013)	(0.0131)	(0.0132)
Access to finance dummy	-	-0.0275	-0.0304	-0.0276
		(0.047)	(0.0471)	(0.0472)
Direct export (5% dummy)	-	-	0.0306	0.0316
			(0.0481)	(0.0497)
Interaction terms (Industry*SAIDI)	-	-	-	0.0172
Interaction terms (Industry*tariffs)	-	-	-	0.00323
Interaction terms (Industry*DTF)	-	-	-	-0.00620*
GNI (log; real)	-0.157***	-0.152***	-0.152***	-0.151***
Industry dummy	Yes	Yes	Yes	Yes
Income dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
SME dummy	Yes	Yes	Yes	Yes
Observations	1,206	1,205	1,203	1,203
R-squared	0.988	0.989	0.989	0.989

*** p<0.01, ** p<0.05, * p<0.1

Table 15 – Getting Electricity dataset

Economy	City Covered	Region	Income group	Process of connecting (average 2014-2016)				Outage data (average 2013-2015)		Electricity tariffs (average 2014-2016)
				Connection time (days)	Procedures	Cost (% of GNI)	Score (DTF)	SAIDI (hours)	SAIFI (frequency)	Cents per kWh
Afghanistan	Kabul	South Asia	Low income	114.00	6.00	2,160.90	60.53	1,220.00	435.00	17.67
Albania	Tirana	ECA	Upper middle income	162.67	6.00	496.43	60.32	117.36	51.42	9.77
Algeria	Algiers	MENA	Upper middle income	180.00	5.00	1,315.47	60.00	5.65	9.02	2.80
Angola	Luanda	SSA	Upper middle income	145.00	7.00	823.57	55.98	N/A	N/A	5.63
Antigua and Barbuda	St. John's	LAC	High income	42.00	4.00	119.77	90.47	5.34	9.05	46.47
Argentina	Buenos Aires	LAC	High income	92.00	6.00	33.00	72.47	4.00	15.11	8.40
Armenia	Yerevan	ECA	Lower middle income	152.00	4.00	86.73	74.67	4.48	4.62	8.47
Australia	Sidney	HI OECD	High income	75.00	5.00	12.43	80.58	1.20	0.75	20.97
Austria	Austria	HI OECD	High income	23.00	5.00	98.37	87.76	0.81	0.78	10.80
Azerbaijan	Baku	ECA	Upper middle income	77.67	7.00	120.27	68.64	1.01	1.82	7.03
Bahamas, The	Nassau	LAC	High income	67.00	5.00	142.97	81.20	N/A	N/A	34.40
Bahrain	Manama	MENA	High income	85.00	5.00	53.43	78.96	1.59	0.90	4.60
Bangladesh	Chittagong	South Asia	Lower middle income	517.00	9.00	3,097.93	20.58	N/A	N/A	9.20
Bangladesh	Dhaka	South Asia	Lower middle income	404.00	9.00	3,381.60	19.42	N/A	N/A	9.20
Barbados	Bridgetown	LAC	High income	87.00	7.00	62.70	67.52	3.70	6.35	23.70
Belarus	Minsk	ECA	Upper middle income	109.67	6.00	259.87	68.98	0.26	0.07	19.53
Belgium	Brussels	HI OECD	High income	88.00	6.00	99.03	72.78	0.61	0.56	18.53
Belize	Belize City	LAC	Upper middle income	66.00	5.00	311.27	80.65	18.05	12.98	21.47
Benin	Cotonou	SSA	Low income	90.00	5.00	13,841.23	45.12	N/A	N/A	23.03
Bhutan	Thimphu	South Asia	Lower middle income	64.33	4.00	552.77	85.45	1.31	1.41	5.10
Bolivia	La Paz	LAC	Lower middle income	42.00	8.00	754.43	65.64	7.98	11.45	15.67
Bosnia and Herzegovina	Sarajevo	ECA	Upper middle income	125.00	8.00	434.30	54.93	4.08	0.97	13.17
Botswana	Gaborone	SSA	Upper middle income	91.67	5.00	320.57	76.89	N/A	N/A	13.83
Brazil Rio de Janeiro	Rio de Janeiro	LAC	Upper middle income	56.67	4.00	37.83	88.68	14.42	7.10	17.20
Brazil	Sao Paulo	LAC	Upper middle income	53.00	4.00	40.47	89.21	14.99	5.39	14.33
Brunei Darussalam	Bandar Seri Begawan	EAP	High income	56.00	4.67	44.30	83.20	1.70	0.77	5.67
Bulgaria	Sofia	ECA	Upper middle income	130.00	6.00	325.80	65.76	6.54	4.75	10.83

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Burkina Faso	Ouagadougou	SSA	Low income	165.33	4.00	10,434.10	39.76	222.83	169.96	27.33
Burundi	Bujumbura	SSA	Low income	158.00	5.00	16,533.40	35.27	660.00	330.00	11.43
Cabo Verde	Praia	SSA	Lower middle income	88.00	7.00	973.53	63.63	33.55	19.73	34.23
Cambodia	Phnom Penh	EAP	Lower middle income	179.00	4.00	2,334.60	61.50	63.29	48.47	18.53
Cameroon	Douala	SSA	Lower middle income	64.00	4.00	1,622.20	81.10	106.87	29.33	19.93
Canada	Toronto	HI OECD	High income	138.67	7.00	127.63	59.76	1.07	1.43	13.67
Central African Republic	Bangui	SSA	Low income	99.33	7.00	16,122.93	32.66	N/A	N/A	11.37
Chad	N'Djamena	SSA	Low income	67.00	6.00	7,954.97	44.08	N/A	N/A	25.27
Chile	Santiago	HI OECD	High income	43.00	6.00	68.30	79.43	3.85	1.58	10.13
China	Beijing	EAP	Upper middle income	141.00	6.00	421.27	63.77	1.24	0.57	14.10
China	Shanghai	EAP	Upper middle income	145.00	5.00	420.83	68.75	1.51	0.23	14.60
Colombia	Bogota	LAC	Upper middle income	106.67	5.00	520.40	73.90	6.57	6.86	14.57
Comoros	Comoros	SSA	Low income	120.00	3.00	2,261.93	75.91	4,240.00	970.00	31.13
Congo, Dem. Rep.	Kinshasa	SSA	Low income	58.33	6.00	15,385.63	44.15	51.70	35.10	11.57
Congo, Rep.	Brazzaville	SSA	Lower middle income	135.00	6.00	4,950.47	46.00	N/A	N/A	11.53
Costa Rica	San Jose	LAC	Upper middle income	48.33	5.00	190.10	83.71	0.00	0.00	25.13
Côte d'Ivoire	Abidjan	SSA	Lower middle income	57.67	8.00	2,665.93	55.50	48.44	28.89	12.87
Croatia	Zagreb	ECA	High income	68.33	5.00	312.33	80.31	5.87	1.89	17.67
Cyprus	Nicosia	ECA	High income	160.33	5.00	137.67	67.69	1.15	0.38	21.37
Czech Republic	Prague	HI OECD	High income	70.00	4.00	27.20	86.80	0.54	0.32	15.60
Denmark	Copenhagen	HI OECD	High income	38.00	4.00	112.37	91.08	0.41	0.45	17.23
Djibouti	Djibouti City	MENA	Lower middle income	125.00	4.00	6,651.67	51.56	N/A	N/A	23.00
Dominica	Roseau	LAC	Upper middle income	61.00	5.00	474.60	80.70	1.03	0.35	38.80
Dominican Republic	Santo Domingo	LAC	Upper middle income	77.00	7.00	267.00	68.13	125.27	36.43	23.83
Ecuador	Quito	LAC	Upper middle income	74.00	7.00	610.63	67.15	4.19	5.44	9.50
Egypt, Arab Rep.	Cairo	MENA	Lower middle income	54.00	6.00	274.13	76.99	20.15	3.00	11.07
El Salvador	San Salvador	LAC	Lower middle income	61.00	8.00	534.30	63.79	14.63	6.88	18.17
Equatorial Guinea	Malabo	SSA	Upper middle income	106.00	5.00	753.23	73.04	N/A	N/A	22.67
Eritrea	Asmara	SSA	Low income	59.00	5.00	2,825.87	71.32	2,470.00	734.67	22.50

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Estonia	Tallinn	HI OECD	High income	91.00	5.00	166.47	77.62	0.90	0.44	11.03
Ethiopia	Addis Ababa	SSA	Low income	95.00	4.00	1,443.43	77.34	N/A	N/A	4.60
Fiji	Suva	EAP	Upper middle income	81.00	4.00	1,651.70	78.52	9.02	9.33	23.63
Finland	Helsinki	HI OECD	High income	42.00	5.00	28.93	85.29	0.14	0.34	14.47
France	Paris	HI OECD	High income	71.00	5.00	41.67	81.04	0.26	0.25	14.33
Gabon	Libreville	SSA	Upper middle income	148.00	7.00	1,075.33	54.51	34.37	57.94	22.00
Gambia, The	Banjul	SSA	Low income	78.00	5.00	3,955.00	63.92	N/A	N/A	26.03
Georgia	Tbilisi	ECA	Upper middle income	71.00	4.00	439.87	84.95	3.73	2.00	8.63
Germany	Berlin	HI OECD	High income	28.00	3.00	42.40	98.38	0.21	0.23	28.10
Ghana	Accra	SSA	Lower middle income	79.00	4.00	1,524.80	79.33	N/A	N/A	23.93
Greece	Athens	HI OECD	High income	51.00	6.00	69.87	78.26	1.57	1.30	17.30
Grenada	St. George's	LAC	Upper middle income	38.00	5.00	215.63	85.10	2.89	3.97	31.17
Guatemala	Guatemala City	LAC	Lower middle income	39.00	4.00	497.17	89.36	3.87	2.74	17.40
Guinea	Conakry	SSA	Low income	69.00	4.00	6,839.67	58.91	2,657.95	321.12	16.87
Guinea-Bissau	Bissau	SSA	Low income	455.00	7.00	1,784.77	37.10	N/A	N/A	30.63
Guyana	Georgetown	LAC	Upper middle income	92.00	8.00	419.80	59.77	84.15	97.67	30.53
Haiti	Port au Price	LAC	Low income	60.00	4.00	3,614.47	73.48	N/A	N/A	34.33
Honduras	Tegucigalpa	LAC	Lower middle income	39.00	7.00	851.60	71.23	257.00	19.41	20.43
Hong Kong SAR, China	Hong Kong	EAP	High income	31.00	3.67	1.47	94.41	0.43	0.18	15.27
Hungary	Budapest	HI OECD	High income	253.67	5.00	101.27	55.14	3.15	1.46	18.90
Iceland	Iceland	HI OECD	High income	22.00	4.00	11.77	93.82	0.38	0.37	8.87
India	Delhi	South Asia	Lower middle income	101.33	5.67	599.67	70.64	12.99	4.80	18.70
India	Mumbai	South Asia	Lower middle income	51.67	5.67	77.83	79.99	2.08	3.63	25.30
Indonesia	Jakarta	EAP	Lower middle income	73.33	5.00	366.67	79.36	3.50	2.41	12.97
Indonesia	Surabaya	EAP	Lower middle income	70.33	4.67	366.67	81.65	2.42	2.11	13.20
Iran, Islamic Rep.	Teheran	MENA	Upper middle income	88.00	6.00	839.20	69.73	5.67	4.94	8.10
Iraq	Baghdad	MENA	Upper middle income	72.00	6.00	239.67	74.52	2,352.00	1,008.00	10.03
Ireland	Dublin	HI OECD	High income	85.00	5.00	72.00	78.88	0.26	0.16	22.97
Israel	Tel Aviv	HI OECD	High income	102.00	6.00	12.70	71.11	2.58	2.82	14.13

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Italy	Rome	HI OECD	High income	124.00	4.00	161.10	78.42	0.62	2.18	23.63
Jamaica	Kingston	LAC	Upper middle income	95.00	7.00	247.60	65.60	2.51	2.67	30.03
Japan	Tokyo	HI OECD	High income	105.00	4.00	0.00	87.39	0.12	0.11	28.70
Japan	Osaka	HI OECD	High income	84.00	3.00	0.00	84.88	0.63	0.02	20.57
Jordan	Amman	MENA	Upper middle income	50.00	5.00	314.73	82.96	4.03	2.08	23.90
Kazakhstan	Almaty	ECA	Upper middle income	85.33	7.00	54.50	67.80	1.01	1.70	9.57
Kenya	Nairobi	SSA	Lower middle income	117.33	3.67	795.23	78.63	614.50	28.33	20.77
Kiribati	Tarawa	EAP	Lower middle income	97.00	6.00	4,413.37	53.72	N/A	N/A	51.53
Korea, Rep.	Seoul	HI OECD	High income	18.00	3.00	39.73	99.84	0.06	0.07	9.70
Kosovo	Pristina	ECA	Lower middle income	39.33	7.00	447.80	72.84	67.23	36.23	14.93
Kuwait	Kuwait City	MENA	High income	64.00	8.00	54.70	65.33	1.24	0.65	0.73
Kyrgyz Republic	Bishkek	ECA	Lower middle income	125.00	7.00	918.23	58.49	N/A	N/A	3.70
Lao PDR	Vientiane	EAP	Lower middle income	134.00	6.00	1,532.83	60.21	49.28	9.42	10.93
Latvia	Riga	ECA	High income	107.00	4.00	298.13	80.32	2.22	1.92	17.23
Lebanon	Beirut	MENA	Upper middle income	75.00	5.00	100.63	80.21	N/A	N/A	13.23
Lesotho	Maseru	SSA	Lower middle income	114.00	5.00	1,565.83	68.53	N/A	N/A	14.83
Liberia	Monrovia	SSA	Low income	465.00	4.00	3,863.70	45.21	68.23	22.60	54.20
Libya	Tripoli	MENA	Upper middle income	118.00	4.00	333.03	78.58	1,799.45	576.48	16.87
Lithuania	Vilniaus	ECA	High income	105.00	6.00	47.33	70.53	0.39	0.37	14.47
Luxembourg	Luxembourg	HI OECD	High income	56.00	5.00	38.83	83.22	0.27	0.26	14.17
Macedonia, FYR	Skopje	ECA	Upper middle income	98.33	3.00	232.10	87.40	8.99	14.88	17.87
Madagascar	Antananarivo	SSA	Low income	450.00	6.00	6,165.97	24.63	N/A	N/A	14.63
Malawi	Blantyre	SSA	Low income	142.00	6.00	4,505.97	46.82	N/A	N/A	14.47
Malaysia	Kuala Lumpur	EAP	Upper middle income	31.00	4.00	27.37	92.45	0.56	0.51	15.50
Maldives	Maldives	South Asia	Upper middle income	91.00	6.00	336.67	71.37	N/A	N/A	34.13
Mali	Bamako	SSA	Low income	120.00	4.00	3,432.47	65.54	168.00	62.50	15.80
Malta	Malta	MENA	High income	126.00	5.00	419.97	71.51	3.65	3.16	23.67
Marshall Islands	Marshall Islands	EAP	Upper middle income	67.00	5.00	722.23	78.82	113.00	47.00	43.63
Mauritania	Nouakchott	SSA	Lower middle income	70.67	5.00	5,055.00	60.45	21.00	23.33	21.43

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Mauritius	Port Louis	SSA	Upper middle income	81.00	4.00	261.57	84.24	N/A	N/A	25.73
Mexico	Mexico City	LAC	Upper middle income	117.33	7.00	359.83	61.90	0.59	1.28	12.87
Mexico	Monterrey	LAC	Upper middle income	47.33	6.00	234.73	78.12	0.01	0.33	9.57
Micronesia, Fed. Sts.	Pohnpei	EAP	Lower middle income	105.00	3.00	376.87	85.84	N/A	N/A	45.03
Moldova	Chisinau	ECA	Lower middle income	104.33	6.67	793.77	63.85	2.06	1.90	10.63
Mongolia	Ulan Bator	EAP	Lower middle income	79.00	8.00	566.67	61.05	33.33	12.85	7.13
Montenegro	Podgorica	ECA	Upper middle income	142.00	7.00	461.10	57.91	N/A	N/A	10.93
Morocco	Casablanca	MENA	Lower middle income	53.33	5.00	1,881.13	76.03	0.18	0.83	12.47
Mozambique	Maputo	SSA	Low income	91.00	7.00	2,406.20	57.30	N/A	N/A	7.53
Myanmar	Yangon	EAP	Lower middle income	84.00	6.00	1,823.37	66.26	N/A	N/A	11.60
Namibia	Windhoek	SSA	Upper middle income	37.00	6.00	362.00	79.09	N/A	N/A	17.97
Nepal	Kathmandu	South Asia	Low income	70.00	5.00	1,153.97	76.60	N/A	N/A	11.57
Netherlands	Amsterdam	HI OECD	High income	110.00	5.00	31.27	75.43	0.40	0.35	11.77
New Zealand	Auckland	HI OECD	High income	60.00	5.00	76.63	82.49	2.18	1.43	13.77
Nicaragua	Managua	LAC	Lower middle income	55.00	6.00	949.43	74.06	76.83	40.27	35.07
Niger	Niamey	SSA	Low income	115.00	4.00	5,855.55	55.19	239.33	159.56	24.77
Nigeria	Kano	SSA	Lower middle income	186.00	9.00	446.17	40.48	1,665.67	185.00	19.83
Nigeria	Lagos	SSA	Lower middle income	198.00	9.00	446.17	38.74	3,433.33	540.00	20.83
Norway	Oslo	HI OECD	High income	66.00	4.00	11.57	87.44	1.40	1.73	11.30
Oman	Muscat	MENA	High income	62.00	6.00	64.83	76.69	3.39	2.29	5.50
Pakistan	Lahore	South Asia	Lower middle income	117.00	5.00	1,453.07	63.03	999.56	425.37	19.20
Pakistan	Karachi	South Asia	Lower middle income	215.00	6.00	1,446.97	54.36	877.31	391.07	19.97
Palau	Koror	EAP	Upper middle income	125.00	5.00	73.77	73.08	135.00	45.33	31.13
Panama	Panama City	LAC	Upper middle income	35.00	5.00	9.53	86.39	4.98	3.75	24.60
Papua New Guinea	Port Moresby	EAP	Lower middle income	66.00	4.00	46.47	87.30	175.28	128.67	40.03
Paraguay	Asuncion	LAC	Upper middle income	67.00	5.00	156.70	81.14	20.24	18.47	6.47
Peru	Lima	LAC	Upper middle income	67.00	5.00	328.50	80.44	9.09	4.33	13.97
Philippines	Quezon city	EAP	Lower middle income	42.00	4.00	28.60	90.85	5.40	3.11	19.00
Poland	Warsaw	HI OECD	High income	136.33	4.00	19.77	77.21	1.44	1.48	14.87

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Portugal	Lisbon	HI OECD	High income	45.00	7.00	38.70	73.71	0.58	0.74	25.20
Puerto Rico (U.S.)	San Juan	LAC	High income	32.00	5.00	348.97	85.42	8.40	4.53	25.90
Qatar	Doha	MENA	High income	90.00	4.00	9.53	83.97	0.69	0.33	3.87
Romania	Bucharest	ECA	Upper middle income	172.00	8.00	579.43	47.52	3.41	3.41	8.77
Russian Federation	Moscow	ECA	Upper middle income	154.00	3.33	126.37	77.92	0.01	0.01	11.30
Russian Federation	Saint Petersburg	ECA	Upper middle income	192.00	3.33	165.70	72.25	0.01	0.00	10.23
Rwanda	Kigali	SSA	Low income	34.00	4.00	2,909.50	80.15	N/A	N/A	18.73
Samoa	Apia	EAP	Lower middle income	34.00	4.00	667.03	89.38	25.25	23.33	39.87
San Marino	San Marino	ECA	High income	45.00	3.00	59.27	95.84	0.41	2.03	15.47
São Tomé and Príncipe	São Tomé	SSA	Lower middle income	89.00	4.00	894.70	80.47	N/A	N/A	34.20
Saudi Arabia	Riyadh	MENA	High income	61.00	4.00	27.70	88.10	1.24	0.89	6.87
Senegal	Dakar	SSA	Low income	90.00	6.67	4,439.13	50.93	N/A	N/A	22.33
Serbia	Belgrade	ECA	Upper middle income	129.00	4.67	310.37	73.38	4.21	3.59	12.90
Seychelles	Seychelles	SSA	High income	137.00	6.00	393.23	64.47	4.52	1.61	36.63
Sierra Leone	Free Town	SSA	Low income	82.00	8.00	4,240.43	45.50	N/A	N/A	29.50
Singapore	Singapore	EAP	High income	30.67	4.00	26.10	92.50	0.01	0.01	12.07
Slovak Republic	Bratislava	HI OECD	High income	121.00	5.00	54.77	73.74	0.89	0.67	15.30
Slovenia	Ljubljana	HI OECD	High income	38.00	5.00	114.10	85.52	3.33	2.14	13.97
Solomon Islands	Honiara	EAP	Lower middle income	53.00	4.00	1,399.87	83.61	6.24	7.40	98.20
Somalia	Mogadishu	SSA	Low income	N/A	N/A	N/A	N/A	N/A	N/A	65.00
South Africa	Johannesburg	SSA	Upper middle income	131.33	4.33	349.00	74.73	64.28	N/A	11.53
South Sudan	Juba	SSA	Low income	468.00	6.00	3,236.90	12.23	1,200.00	633.33	37.07
Spain	Madrid	HI OECD	High income	115.33	7.00	224.03	62.75	0.37	0.56	21.37
Sri Lanka	Colombo	South Asia	Lower middle income	101.33	5.00	821.07	73.43	6.17	6.13	21.53
St. Kitts and Nevis	Basseterre	LAC	High income	18.00	4.00	265.47	93.35	N/A	N/A	33.40
St. Lucia	Castries	LAC	Upper middle income	26.00	5.33	194.17	85.08	0.44	0.40	34.23
St. Vincent and the Grenadines	Kingstown	LAC	Upper middle income	52.00	3.00	56.90	94.84	N/A	N/A	33.57
Sudan	Khartoum	SSA	Lower middle income	70.00	5.00	3,305.60	67.75	49.73	20.97	5.77

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Suriname	Paramaribo	LAC	Upper middle income	113.00	4.00	479.23	78.70	14.90	7.67	7.13
Swaziland	Mbabane	SSA	Lower middle income	137.00	6.00	940.53	62.22	1,390.92	677.73	18.07
Sweden	Stockholm	HI OECD	High income	52.00	3.00	33.93	94.93	1.46	1.07	13.00
Switzerland	Zurich	HI OECD	High income	39.00	3.00	58.43	96.72	0.18	0.13	16.17
Syrian Arab Republic	Damascus	MENA	Lower middle income	95.00	5.00	484.40	75.74	N/A	N/A	12.73
Taiwan, China	Taipei	EAP	High income	22.67	3.00	43.27	99.15	0.29	0.25	13.60
Tajikistan	Dushanbe	ECA	Lower middle income	133.00	9.00	854.77	46.48	N/A	N/A	7.50
Tanzania	Dar Es Salaam	SSA	Low income	109.00	4.00	1,140.67	76.56	69.44	61.28	16.13
Thailand	Bangkok	EAP	Upper middle income	37.00	5.00	45.27	85.95	0.72	1.55	16.27
Timor-Leste	Dili	EAP	Lower middle income	73.00	3.00	849.43	88.53	N/A	N/A	23.13
Togo	Lomé	SSA	Low income	73.67	3.33	5,593.63	67.06	N/A	N/A	20.97
Tonga	Nukualofa	EAP	Lower middle income	42.00	5.00	91.53	85.03	18.45	14.12	42.33
Trinidad and Tobago	Port Of Spain	LAC	High income	61.00	4.00	127.40	87.69	5.14	4.55	7.20
Tunisia	Tunis	MENA	Lower middle income	65.00	4.00	704.33	84.73	2.98	2.45	10.30
Turkey	Istanbul	ECA	Upper middle income	65.33	4.00	550.07	85.32	12.14	6.21	14.13
Uganda	Kampala	SSA	Low income	94.67	6.00	9,494.80	38.89	55.04	30.90	20.97
Ukraine	Kiev	ECA	Lower middle income	269.00	5.00	771.87	52.38	5.00	2.13	11.73
United Arab Emirates	Dubai	MENA	High income	31.67	3.00	24.13	97.92	0.42	0.19	11.50
United Kingdom	London	HI OECD	High income	79.00	4.00	27.23	85.49	0.44	0.22	15.37
United States	New York City	HI OECD	High income	60.00	6.00	40.80	88.30	1.65	0.42	18.97
United States	Los Angeles	HI OECD	High income	134.00	4.00	14.23	66.35	1.93	0.69	17.43
Uruguay	Montevideo	LAC	High income	48.00	5.00	13.33	84.49	5.60	3.12	19.77
Uzbekistan	Tashkent	ECA	Lower middle income	89.00	7.00	1,437.90	61.57	0.34	0.10	6.37
Vanuatu	Port Vila	EAP	Lower middle income	120.00	4.00	1,159.43	74.89	3.34	7.76	41.53
Venezuela, RB	Caracas	LAC	Upper middle income	188.00	6.00	7,121.53	44.16	N/A	N/A	937.80
Vietnam	Ho Chi Minh City	EAP	Lower middle income	70.00	5.33	1,338.90	73.99	22.10	11.21	11.73
West Bank and Gaza	Ramallah	MENA	Lower middle income	58.33	5.00	1,423.17	77.19	12.25	11.73	16.67
Yemen, Rep.	Sanna	MENA	Lower middle income	110.00	4.00	3,492.60	22.25	N/A	N/A	10.00
Zambia	Lusaka	SSA	Lower middle income	117.00	6.00	696.97	66.12	82.36	9.21	4.37

Economy	City Covered	Region	Income group	Process of connecting (average 2014-2016)				Outage data (average 2013-2015)		Electricity tariffs (average 2014-2016)
				Connection time (days)	Procedures	Cost (% of GNI)	Score (DTF)	SAIDI (hours)	SAIFI (frequency)	Cents per kWh
Zimbabwe	Harare	SSA	Low income	106.00	6.00	2,958.57	58.40	412.53	77.48	11.83