

# Underpowered: Rolling blackouts in Africa disproportionately hurt the poor

Kobina Aidoo and Ryan C. Briggs

**Abstract:** Electricity demand exceeds supply in many parts of Africa, and this often results in rolling blackouts. This article argues that blackouts tend to concentrate on poorer places within countries, due to both economic and political factors. This argument is tested with an analysis of electricity availability across thirty-two neighborhoods in Accra and survey data from thirty-six African countries. Across these analyses, poorer people with a grid connection experience lower electricity supply than richer people. This article concludes by discussing implications for research on electricity availability, policymakers working on energy, and the distributive politics literature.

**Résumé:** La demande d'électricité dépasse l'approvisionnement dans de nombreuses régions d'Afrique résultant souvent en pannes d'électricité générale. Cet article soutient que les pannes d'électricité ont tendance à se concentrer sur les endroits les plus pauvres au sein des pays pour des facteurs économiques et politiques. L'argument de cet article repose sur une analyse de la disponibilité de l'électricité à travers trente-deux quartiers d'Accra et enquête sur les données de trente-six pays africains. Dans l'ensemble les résultats montrent que les pauvres ont un raccordement au réseau électrique plus faible que les personnes plus riches. Cet article conclut en examinant les implications de la recherche sur la disponibilité de l'électricité, les dirigeants travaillant sur l'énergie et la littérature politique distributive.

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**Resumo:** A procura de eletricidade é maior do que a oferta em muitas regiões de África, o que desencadeia frequentes *blackouts*. Neste artigo, argumenta-se que, tanto por razões económicas como políticas, os *blackouts* tendem a concentrar-se nas zonas mais pobres de cada país. Esta hipótese foi testada através da análise do abastecimento de eletricidade em 32 bairros de Acra (Gana) e de dados recolhidos em 36 países africanos. Em todas estas análises, verificou-se que, de entre as pessoas com acesso à eletricidade, as mais pobres usufruem de um abastecimento mais fraco do que as mais ricas. A encerrar o artigo, discutem-se as conclusões a retirar quanto à investigação sobre o abastecimento de eletricidade, à ação dos decisores políticos com responsabilidades sobre a energia e à literatura sobre políticas distributivas.

**Keywords:** blackouts; electricity; *dumsor*; Ghana; energy inequality

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“People who are ministers and government officials have electric running for them. [...] Ordinary people have constant blackouts. If you have political power, you have electricity.” (Baker from Nkawkaw [Ghana], quoted in Rupp [2013:112])

Access to electricity in Ghana increased from 24 percent of the population to 79 percent between 1990 and 2016 (World Bank 2018).<sup>1</sup> However, growth in electricity supply from the national grid has not matched the rapid growth in demand (Kemausuor & Ackom 2017). This is primarily due to large technical losses from outdated distribution equipment and a high reliance on variable hydroelectric generation (Kumi 2017; Mensah et al. 2014). As a result, Ghana has experienced electricity rationing via rolling blackouts, known locally as *dumsor* (pronounced doom-sor), the Twi word for “off/on,” from 2011 up to the time of writing.<sup>2</sup>

The problem of inadequate electricity is not unique to Ghana. In 2012, on-grid electricity generation capacity in sub-Saharan Africa (SSA) was about ninety gigawatts (GW), though in practice the amount of electricity available to be used was often much lower due to transmission losses and periods when generation was under capacity. To put this figure into context, consider that half of this capacity is due solely to South Africa, while the remaining forty-five GW is shared across the rest of SSA (International Energy Agency 2014:19). With supply unable to meet demand, electricity shortages are common. For example, in Nigeria in 2014, firms reported about thirty-three power outages in a typical month (World Bank 2017b).<sup>3</sup> On average, electricity in SSA is reported to be unavailable for what amounts to a total of about twenty-three days each year (International Energy Agency 2014:42). Due to both economic and political factors, these ongoing electricity interruptions may “reflect and reproduce urban inequality” (McFarlane 2010:132). In this way, infrastructure that is typically thought to “bind cities, regions and nations into functioning geographical or political wholes” may end up exacerbating inequality by splintering access to critical services (Graham & Marvin 2001:8).

The problem of inadequate electricity supply may get worse before it gets better. While generation capacity in Africa is growing, thanks to local investment and international initiatives such as Power Africa, demand in many countries is growing faster. Between 2000 and 2012, demand for electricity in SSA increased 45 percent, and about 145 million people gained access to the grid for the first time (International Energy Agency 2014:19–30).<sup>4</sup>

Given the importance of rolling blackouts in daily life across the continent, and given the range of positive social effects associated with households having electricity (Dinkelman 2011; Khandker et al. 2013; Grogan & Sadanand 2013; Rud 2012; Lipscomb et al. 2013), it is surprising that we lack even a basic understanding of the politics of rolling blackouts.<sup>5</sup> In particular, we currently lack answers to simple questions such as: who loses power in a rolling blackout? This study provides an answer to this question. We argue that for both economic and political reasons, the effects of blackouts are likely to fall disproportionately on the poor.

One reason for the lack of research on rolling blackouts is that data collection is difficult. We address this by analyzing an original dataset of electricity availability at the level of neighborhood-days in Ghana's capital of Accra. Our dataset has an unusually high level of spatial and temporal detail.<sup>6</sup> Using this dataset, we show that poorer neighborhoods receive lower electricity supply than richer neighborhoods. We corroborate this result with an analysis of survey data from thirty-six African countries and show that, across the continent, poorer people with access to the grid have less electricity availability than richer people with grid access.

Our findings reinforce research that argues that simply having access to the grid is not a reliable measure of electricity availability (Min 2015; Thurlow et al. 2015). However, our results go further, to show that proxying for *availability of electricity* with a seemingly reasonable variable such as, *does the house have a grid connection?* is likely to overestimate how much the poor (relative to the rich) have electricity. Our work also shows that blackouts can be aimed. Most analyses of the politics of electricity examine who receives grid extensions (e.g., Briggs 2012; Kroth et al. 2016).<sup>7</sup> In showing that rolling blackouts can be aimed, we also show that electricity rationing presents an opportunity for distributive politics, as it allows those with control over the grid to direct electricity to some areas and not to others.<sup>8</sup>

### Why electricity cuts may fall on the poor

We expect electricity cuts will fall on the poor and avoid the wealthy for three main reasons. The first is about short-term economics, the second is about short-term politics, and the third is about longer-term political and economic considerations. The short-term economic reason is that, as is the case in Ghana, the utility responsible for distribution may be cash strapped, and so may have an incentive to target electricity to the places where they think they can earn the greatest profit. This is likely to mean targeting richer neighborhoods, where there is higher demand, higher marginal tariff rates, as well as

higher and faster potential rates of payment.<sup>9</sup> An example of this kind of reasoning can be seen in the response of Dr. Charles Wereko-Brobby, former Chief Executive of Ghana's Volta River Authority, to early evidence that dumsor was favoring the wealthy: "The only schedule that matters is where ECG thinks it will get paid" (Aidoo 2015).<sup>10</sup> While prioritizing profit when targeting limited electricity is reasonable, it will have the effect of concentrating blackouts on poorer areas. In this way, "utilitarian bureaucratic decision rules limit the recognition of systematically-patterned and unequal service disruptions" (Liévanos & Horne 2017:202).

Aside from short-term economic considerations, electricity cuts may also fall disproportionately on the poor because they lack the political power to forestall such cuts.<sup>11</sup> This could occur in two different ways. First, elites such as national politicians and high-level ECG staff have to live somewhere, and if these elites have influence over who gets electricity during load shedding, then they may take actions to protect the places where they live from cuts. For example, when one of the authors of this article was doing fieldwork in Lilongwe (Malawi) during a period of frequent power outages in 2011, some (wealthier) neighborhoods were rumored to be much more attractive places to rent because they shared a section of the national grid with the President's house and so had more consistent electricity. To the extent that local elites have influence over allocation of electricity supply and live in concentrated areas, it is plausible that they will act to ensure that the places where they live receive a higher availability of electricity than might otherwise be expected.<sup>12</sup>

Second, the link between political influence and a higher supply of electricity could be less direct, with wealthier citizens either being more willing to voice their concerns to political representatives or with politicians being more concerned with the opinions of wealthier individuals. Looking outside the continent, consider that wealthy Americans are much more likely to have contacted their political representatives than poorer Americans (Page et al. 2013) and that U.S. government policy mirrors the policy preferences of the affluent more than the policy preferences of the less well-off (Gilens 2012). In sum, "there can be little doubt that the wealthy exert more political influence than the less affluent do" (Page et al. 2013:51). If one believes that wealth can typically be transformed into *de facto* political power (Acemoglu & Robinson 2008), then this pattern will generalize broadly.

There is less research on the political influence of income or wealth in SSA.<sup>13</sup> This is in part because the traditional understanding of the relationship between state power and wealth in SSA posits that people gain access to the state in order to gain wealth, rather than wealth being created independently and then used to sway the choices of political elites (Sklar 1979; Diamond 1987). From the point of view of resource targeting, this distinction is immaterial. Political or economic elites should be able to take actions that influence the government so as to shelter themselves from resource cuts. To the extent that the rich seem to participate in politics less than the poor in much of Africa, this is because the rich do not fear taxation in low-capacity

states (Kasara & Suryanarayan 2015). The underlying logic is thus consistent: the rich can turn their wealth into political power if they choose to do so, but they do not always feel such need. If one makes the assumption that people in general would like to avoid electricity cuts, then such cuts should concentrate on the relatively poor and spare the relatively wealthy.

Third and finally, governments may under-invest in electricity infrastructure and the maintenance of such infrastructure in poorer areas. In this case, governments may not literally be directing power cuts in the moment of a blackout towards the rich and away from the poor, but rather this outcome will come about because the places where the relatively rich live have newer and better maintained infrastructure.<sup>14</sup> The reasons for these differences in infrastructure investment mirror the logics described above. First, disparities in wealth across neighborhoods may mean that utilities find it easier to recoup costs in richer neighborhoods. Second, wealthier people may have more influence over politics. Thus, for both economic and political reasons, we would expect that when blackouts occur, they will be concentrated in the areas where the relatively poor live and will be felt least in the places where the relatively rich live.

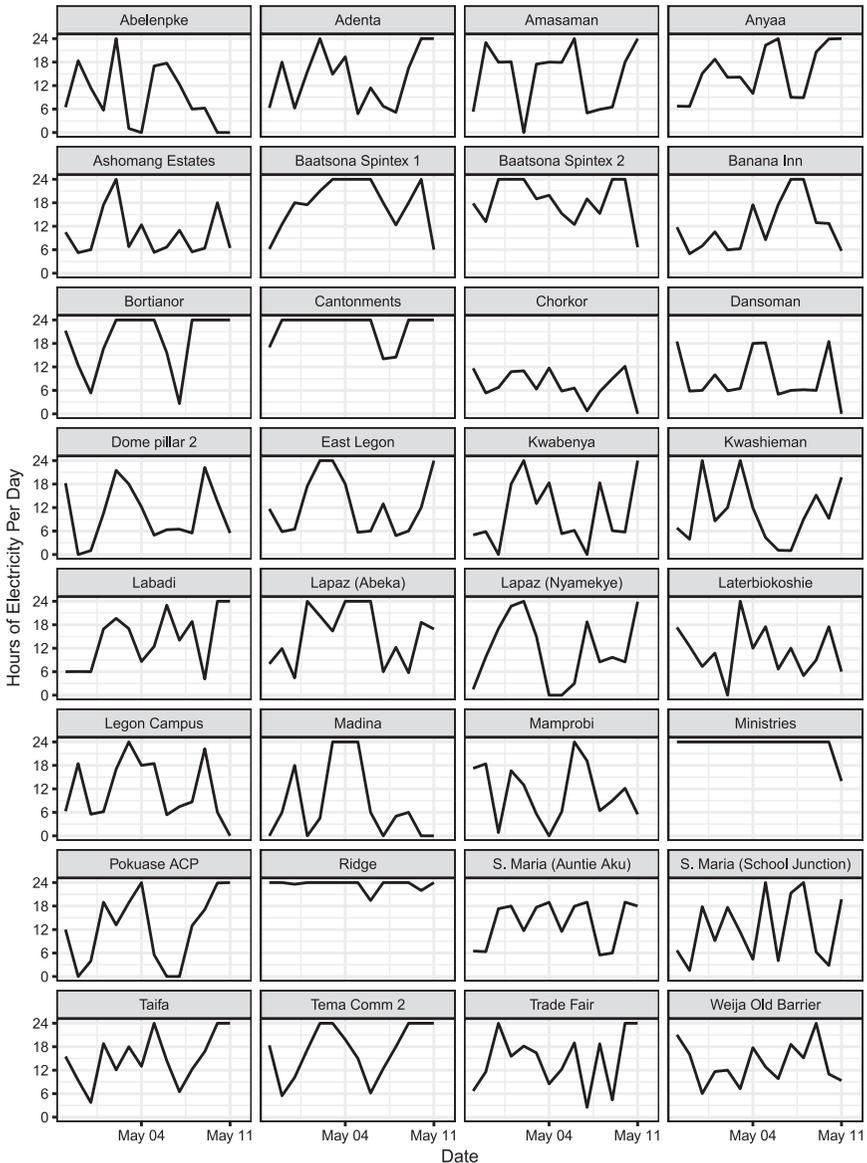
## Ghana

Our case study examines neighborhood-level data on access to electricity across Greater Accra.<sup>15</sup> Accra is a useful case because the city has seen widespread and enduring rolling blackouts, or *dumsor*, and because almost everyone in Accra is on the grid.<sup>16</sup> Further, in Ghana *dumsor* was supposed to proceed using a schedule set by the state-owned Electricity Company of Ghana (ECG). During our period of study, electricity was to cycle in a staggered fashion across three groups of neighborhoods on a cadence of twelve hours off and twenty-four hours on.<sup>17</sup> It is quite difficult to collect fine-grained spatial and temporal data on actual access to electricity, so one contribution of this study is to analyze a unique dataset reporting when electricity was on or off across thirty-two neighborhoods in Accra over a two-week period in 2015.

This dataset was formed by cleaning and collating status updates submitted by Ghanaians via text message to The *Dumsor Report*. The *Dumsor Report* is a civil society project that uses social media to encourage citizens to report electricity outages. Our data for this study come from one project where the goal was to collect data on access to electricity in and around Greater Accra. Respondents volunteered to submit updates on changes in electrification status in their neighborhood for one month, and in total thirty-two neighborhoods were represented. When possible, multiple people were added per neighborhood to increase reporting accuracy. The project tracked updates on electricity in 2015 from April 11 to May 11. However, we dropped the first half of the data because during this time a majority of volunteers had trouble reporting information.<sup>18</sup> Our analysis focuses on the latter two weeks (April 28 to May 11) with consistent data.

The full dataset is presented graphically in Figure 1. This figure reveals that there is a high degree of variation in electricity availability over time and especially across neighborhoods. Some rich neighborhoods (e.g., Cantonments, Ridge) have almost complete electricity coverage while other poor ones (e.g., Chorkor) receive a much lower and more uncertain supply. We next more formally examine the relationship between wealth and electricity supply.

**Figure 1. Electricity availability across neighborhoods.**



In addition to the data on electricity availability, our analysis makes use of two measures of wealth. The first is a neighborhood-level measure of housing quality. This variable is drawn from a map produced by John R. Weeks et al. (2012). Each neighborhood is placed in a housing quality quintile (five = wealthiest) based on its rank across all of Accra's 108 neighborhoods. We were able to locate twenty-five of the thirty-two neighborhoods shown in Figure 1 within the Weeks et al. (2012) housing quality map.<sup>19</sup>

Our second measure of wealth is the neighborhood's tax class. Tax classes are created by the Accra Metropolitan Assembly (AMA) and are used to assess property taxes. While the housing quality measure is based on objective features of houses and created by outside researchers, the AMA tax class codifies local knowledge about the level of wealth of each neighborhood.<sup>20</sup> We have tax class information on eighteen of the neighborhoods shown in Figure 1.<sup>21</sup> Neither wealth variable varies over time in our two-week period, but both wealth measures vary across neighborhoods. Table 1 shows how the two wealth measures correlate using data from the eighteen neighborhoods that have data on both measures.<sup>22</sup> Cells with no neighborhoods are blank. The two measures align well.

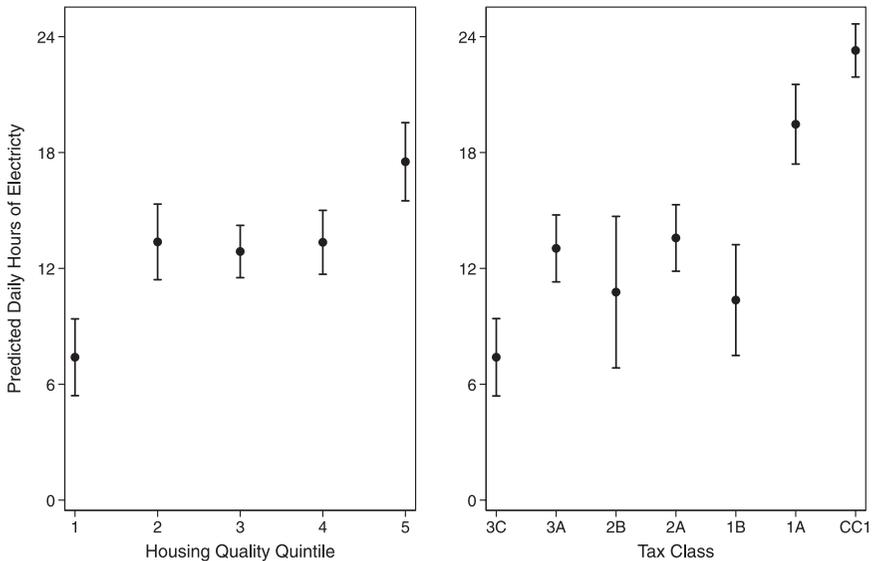
We now turn to the analysis of electricity availability by wealth. The results are presented graphically in Figure 2. Each panel comes from a separate OLS regression, where the independent variables are a set of dummies marking the levels of the relevant wealth measure and the expected amount of electricity per neighborhood-day from the ECG schedule. The dependent variable is the number of hours of electricity per neighborhood-day. The figure shows point estimates and 95 percent confidence intervals for the effect of each level of each wealth variable on the number of hours of electricity in a hypothetical day when the ECG schedule pledges to provide twelve hours of electricity to each neighborhood.<sup>23</sup>

The left panel shows that the lowest housing quality quintile receives an average of about 7.5 hours of electricity per day, while the highest receives about 17.5 hours. The middle three quintiles fall between these two extremes.

**Table 1.** Relationship between wealth measures

Tax Class	Wealth Quintile					Total
	1	2	3	4	5	
CC1			1			1
1A					3	3
1B				1	1	2
2A			2	3		5
2B				1		1
3A		3	2			5
3C	1					1
Total	1	3	5	5	4	18

$\chi^2$  statistic for no relationship between wealth measures – 47.8 ( $p < 0.01$ ).

**Figure 2. Predicted electricity supply by neighborhood wealth.**

The difference in expected hours of electricity between the lowest quintile and the others is statistically significant ( $p < 0.01$ ), as is the difference between the richest quintile and the others. The right panel shows similar patterns, with the lowest tax rate neighborhood receiving far less electricity than the others while the neighborhoods in the top residential and commercial tax classes receive close to 24 hours of electricity per day.<sup>24</sup>

While these results directly contradict the load shedding schedule published by the ECG, they conform closely to our theoretical expectations. We expected that poorer neighborhoods would receive less electricity because they generate less money for the utility and because they are comprised of people who typically lack the political clout to effectively demand from the government equity (or favoritism) in resource allocation. Richer neighborhoods would be privileged because they generate more money and have both political clout and more direct connections to those with power.

### Cross-national results

While the above results come from fine-grained data, they only cover a small number of neighborhoods over a two-week period in one city. Thus, one may be concerned that the results reveal something about Accra more than something about electricity provision more generally. In this section we offer a preliminary check on the results from Accra using data from Afrobarometer round six (Afrobarometer 2016). Afrobarometer conducts nationally-representative surveys of public attitudes across Africa.

Round six included a new question about electricity provision and was conducted in thirty-six countries.

Our dependent variable comes from a question that first asked respondents “Do you have an electric connection to your home from the mains?” and then, if they said yes, followed up with “How often is electricity actually available?” The possible responses to the latter question are: All of the time, most of the time, about half of the time, occasionally, and never. Of the 53,935 respondents in round six, 22,243 (41 percent) reported that they had no connection from the electricity grid to their home. This article is concerned with the availability of electricity for those on the grid, and so we dropped respondents without a grid connection from the following analysis.<sup>25</sup>

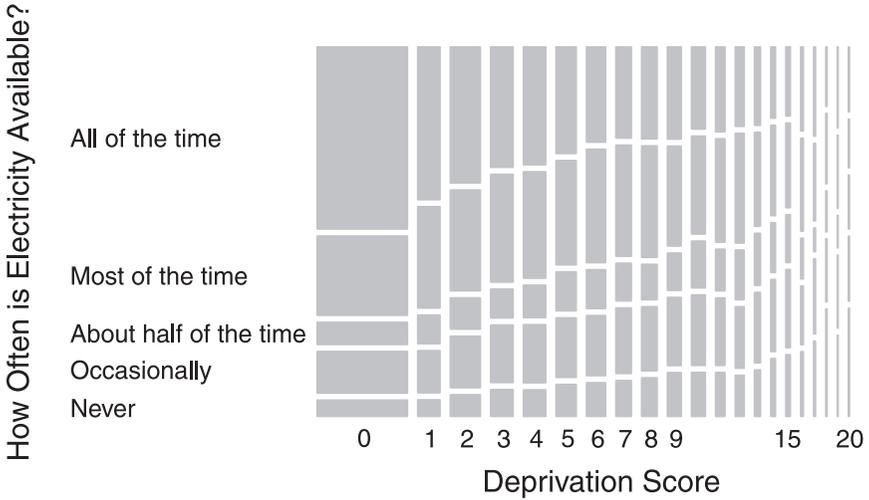
Our key independent variable is a deprivation score. Afrobarometer has a series of questions asking how often over the past year the respondents went without: enough food to eat, enough clean water for home use, medicines or medical treatment, enough fuel for cooking food, and a cash income. For each question, the possible answers are: Never, just once or twice, several times, many times, and always. We sum these five questions, where “never” counts as zero and “always” counts as four, to arrive at a deprivation score that ranges from zero to twenty.<sup>26</sup>

We first examine the pooled, bivariate relationship between the deprivation score and electricity availability for those on the grid. This pooled relationship takes the form of a cross-tab, which we show graphically using a mosaic plot in Figure 3. The size of each cell shows the number of respondents at each intersection of the electricity and deprivation variables. In total, the figure summarizes the relationship between deprivation and electricity availability across 31,098 people. The figure reveals that the single largest deprivation score category is zero, and a little under half of the people that have this score report electricity being available “all of the time.” As one moves up the deprivation score the share of people reporting consistent electricity availability decreases approximately linearly and the share of people reporting receiving electricity “never” or “occasionally” grows. We can strongly reject the null hypothesis that there is no relationship between deprivation and electricity availability.<sup>27</sup>

The mosaic plot shows that, of people with access to the electricity grid, those with higher deprivation scores experience less consistent electricity. However, this result comes from an unweighted and pooled analysis across all respondents, and so it could be driven by over-representing countries with more respondents, or by country-specific factors that influence both electricity availability and poverty at a country level. To correct for these issues, we estimate a series of linear models with survey weights and fixed effects at different levels.<sup>28</sup> The results are reported in Table 2, where the dependent variable ranges from zero to four (inclusive), and higher numbers mean more consistent electricity.

Column one reports pooled results. The relationship between the deprivation score and electricity availability is strong. However, it is plausibly driven by country-level omitted variables. For example, it could be the case

**Figure 3. Deprivation and electricity availability, pooled data.**



that countries that are poorer on average also have less reliable electricity on average, and so what appears to be a cross-respondent result is being driven by country-level features.

Columns two, three, and four address this issue by adding fixed effects at the level of the country, first-level region, and location, respectively. Locations are intermediate regions, such as districts, that fall between first-level administrative regions and the enumeration areas.<sup>29</sup> Locations are nested within regions, which themselves are nested within countries. There are thirty-six countries, 423 subnational regions, and 1906 locations in the sample under study. Including the fixed effects allows us to see if the pooled relationship shown in Figure 3 and reported in column one holds up when we compare respondents within progressively smaller spatial units.

The fixed-effects analysis produces two noteworthy results. First, the relationship between deprivation and electricity availability weakens as fixed

**Table 2. Results from Across Africa**

	1	2	3	4	5
Deprivation	-0.069* (0.002)	-0.045* (0.006)	-0.039* (0.004)	-0.031* (0.003)	-0.042* (0.011)
Fixed Effects	No	Country	Region	Location	No
Weights	Yes	Yes	Yes	Yes	No
Subsample	On Grid	On Grid	On Grid	On Grid	On Grid + Accra
Observations	31,098	31,098	31,098	31,098	429

Models 1 and 5 have robust standard errors in parentheses.

Models 2–4 have robust standard errors clustered at the fixed effect level in parentheses.

\*  $p < 0.01$ .

effects at progressively smaller administrative units are added to the analysis. This reveals that some of the relationship between deprivation and electricity availability is indeed driven by factors that exist at the level of the country, region, or location. Second, across the specifications, the relationship between deprivation and electricity availability is consistently signed and statistically significant. The magnitude of the relationship also remains meaningful. In the weakest case, reported in column 4, a shift of ten points on the deprivation scale leads to a drop of about a third of a point (on a 0–4 scale) on electricity access.

People with access to the electricity grid and higher deprivation scores report lower electricity availability than those with lower scores, and this relationship exists within countries, regions, and locations. Some of this relationship is due to factors at high levels of aggregation. These might include, for example, the state of the national economy at the country level, or local institutions at the regional level, or quality of infrastructure at the location level. However, even when comparing within locations, it remains the case that poorer people experience worse access to electricity than richer people.

Finally, column five in Table 2 narrows the sample to only look at Accra, and in doing so provides a check on the neighborhood-level results reported earlier. Of the 440 people interviewed in Greater Accra during Afrobarometer round six, only five said that they did not have a connection from the grid to their house.<sup>30</sup> This reinforces our earlier claim that in some cities access to the electricity grid is near 100 percent. Of course, universal access to the grid does not imply universal availability of electricity. The results in column five support our earlier neighborhood-level results from Accra, as people with higher deprivation scores are more likely to report worse electricity availability.

This section has shown that across Africa, poorer people with a connection to the electricity grid report lower levels of electricity availability than richer people. It is important to note that our analyses do not identify the causal effect of being poor on electricity availability. Regardless, they show that electricity cuts fall most heavily on the poorest. While the Afrobarometer analysis suggests that our neighborhood-level results from Accra may generalize, an important caveat is in order. The data from the neighborhood-level analysis in Accra tracked the actual availability of electricity in close-to-real time, while the Afrobarometer data only record the respondent's retrospective, self-reported assessment of how often electricity is available. Aside from this leading to reliability issues, it is possible that the relationship between deprivation and electricity availability in the Afrobarometer analysis is due to poorer people being able to afford lower availability rather than it being the result of the choices of governments or electricity utilities. The question is worded in a way that should minimize this concern, as it asks how often electricity is available rather than how often a respondent can afford electricity, but question wording can be tricky, and so this issue is worth flagging. Thus, while the analysis of the Afrobarometer data is

consistent with the earlier evidence drawn from Accra, it should be considered a weaker test of the claim that electricity cuts are targeted in ways that protect the relatively rich and concentrate cuts on the relatively poor.

## Discussion and Conclusion

Rolling blackouts are a common occurrence in much of SSA, but we know little about the political economy of their causes or consequences. Our study focused on the consequences of rolling blackouts. We have provided theory and evidence suggesting that poorer people are more likely to experience electricity outages during rolling blackouts and that richer people are likely to be uniquely sheltered.

Our theory posited that interlocking economic and political factors push electricity utilities to concentrate blackouts on poorer parts of countries while providing more electricity to richer areas. The main economic factor is simply that poorer areas often generate less profit for the utility than richer neighborhoods. If a utility has a shortage of electricity and is focused heavily on recouping its costs, then it may choose to focus its limited electricity on the richer parts of a country. While this may be a reasonable choice given the goals of the utility, this strategy will lead to blackouts concentrated on the people who are least able to keep the lights on through other means (e.g., generators, batteries, solar power).<sup>31</sup>

Political factors also push blackouts to concentrate more in poorer neighborhoods and to spare richer ones. This is because key decision-makers are more likely to live in wealthier neighborhoods, because politicians may be more sensitive to the opinions of their richer citizens, and because wealth is likely to be translatable into political power. Finally, these political and economic factors imply not only that power cuts may be directed to poorer places but also that poorer places may see lower rates of investment in infrastructure, which itself makes power outages more likely. These factors interact to produce a strong prediction that the poor will suffer most during rolling blackouts.

We subjected our prediction to an intensive and an extensive test. The intensive test involved collecting and combining original, daily, neighborhood-level data on access to electricity in Accra with two different measures of neighborhood-level wealth. Regardless of whether we measured wealth using housing quality or municipal tax brackets, poorer neighborhoods received the least power and richer ones received the most. This shows that the cost of dumsor is falling on the relatively poor, and that on average the richest neighborhoods experience very few hours without electricity per day. The gap between the richest and poorest neighborhoods is large, with the richest receiving about ten hours more electricity per day.

Our extensive test compared access to electricity and poverty across people with a connection to their country's national electricity grid. This test traded the spatial detail of the analysis in Accra for breadth, as it covered more than 30,000 people spread over thirty-six countries. Poorer people

on the grid consistently reported lower electricity availability than richer people. This result holds whether we make our comparisons across all people or whether people were examined within the same country, region, or location.

In sum, our analyses show that there is a durable relationship between poverty and electricity availability *for those who already have a grid connection*. The presence of a grid connection is important, as our findings are not due to poorer people living in places without access to the national grid. Rather, we have demonstrated that even when the poor live in houses with a connection to the grid, they are still likely to have less reliable access to electricity than richer people.

Our results have implications for theory, measurement, and policy. First, our analyses show that the effects of rolling blackouts vary over space and can be targeted. This means that these outages create an opportunity for distributive politics. The present study focused on understanding the relationship between electricity and wealth. However, there may also be relationships between electoral politics and access to electricity. Future work could examine, for example, the electoral politics of access to electricity, or the effects of rolling blackouts on voter turnout or incumbent-party support.

Aside from the distribution of blackouts, our study speaks more broadly to research on the relationship between electrification and poverty. Our research has close affinities to the work of Brian Min (2015), which showed that democracies provide more electricity to the poor than do autocracies.<sup>32</sup> While we do not speak to the effects of country-level factors on electrification, we show that within Accra and across Africa the relatively poor receive a lower supply of electricity than the relatively rich.<sup>33</sup> While country-level factors such as democracy likely influence how much the poor receive electricity, even within a democratic country such as Ghana we find a strong pro-rich bias in who receives power.

Our work also speaks to broader debates in urban politics on the role of infrastructure in fragmenting or integrating urban spaces. For example, our findings are in line with the research of Steve Graham and Simon Marvin (2001), who challenge the notion that infrastructure necessarily integrates cities, and who show how technologies and infrastructure systems can splinter urban environments and create separate spaces for the “haves” and “have-nots.” Our work also resonates with that of Colin McFarlane and Jonathan Rutherford (2008:366–69), who claim that “the development of urban infrastructure is always a highly political process” and that this extends past the issue of construction to include “maintenance and breakdown” as well as “conflict over access and distribution.” Our finding that the poor disproportionately suffer the costs of electricity failures also reinforces the claim that infrastructural crises are “mediated by and often exacerbate existing forms of inequality” (McFarlane 2010:132). Reaching only a bit further, if one accepts the argument that “infrastructure [...] has constitutive power” (Kesselring 2017:95), then our findings show how government

action exacerbates inequality by layering a new kind of social stratification on top of existing income or wealth inequalities.

Second, in terms of measurement, our research reinforces prior work suggesting the potential for a wide gap between the presence of infrastructure and the presence of outcomes that are hoped to follow from such infrastructure (Thurlow et al. 2015). For example, Naaborle Sackeyfio (2017:60) notes that “The notion of electricity access conceals what are essentially stark differences between actual connectivity, quantity and supply.” The distinction between infrastructure and outcomes is also made by Lant Pritchett (2013), who shows that there is often a wide gap between the presence of schools and actual learning. Aside from empirically supporting the claim that grid access is not equivalent to electricity access, we also show that using an indicator for grid access when one really wants to measure electricity availability will not only overstate electricity availability, but it will also introduce bias by overstating the extent to which poorer people have electricity available. The correlation between grid access and electricity availability weakens as poverty increases, implying that development strategies aimed at increasing the availability of electricity for the poor cannot safely assume that grid extensions lead to increases in electricity availability. These results support existing work in organizations such as the World Bank to create multi-tiered variables measuring access to electricity instead of binary variables measuring grid access (Bhatia & Angelou 2015).

Third, and relatedly, we demonstrate that universal access to the grid is insufficient to guarantee an equitable or reliable supply of electricity to all people.<sup>34</sup> Increasing generation capacity, and increasing efficiency throughout the network, is an important component of meeting this challenge, but it probably will not be sufficient in the medium term, as electricity supply is unlikely to meet demand for some time. In this case, it is likely the marginalized position of the poor that leads them to bear a disproportionate share of outages. To the extent that political factors are driving pro-rich and anti-poor targeting of electricity, it may be useful to push for the institutional insulation of utilities from political pressure. There are not clear, context-free blueprints for empowering the poor or insulating utilities from political pressure. However, it is worth at least noticing that these are critical problems standing in the way of universal access to electricity even if simple, technical solutions are in short supply.

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## Notes

1. For clarity, this article makes a distinction between *access* to electricity and electricity *availability*. Access refers to the state of being physically connected to the electricity grid. Availability refers to the state of receiving electricity supply from the grid. Thus, we use *availability* and *supply* interchangeably in context.
2. Kemausuor and Ackom (2017) report electricity rationing from 2011 until December of 2015. We can confirm that it still exists through December 2016. Ghana has a history of load shedding. As noted in Kumi (2017:8), "Ghana suffered severe power rationing/load shedding in the years 1983–1984, 1997–1998, 2003, 2006–2007, 2011–date."
3. In Ghana in 2013, firms reported about eight outages in a typical month (World Bank 2017b).
4. About 620 million people in SSA still await a grid connection (International Energy Agency 2014:30). The number of people gaining access to the grid is generally only a small part of growth in demand, which typically is driven by the commercial and especially industrial sectors.
5. One partial exception is the insightful analysis of the politics of electricity supply in Nigeria in Ayodeji Olukoju (2004). Another exception, using American data, is Raoul S. Liévanos and Christine Horne (2017:208), who show that "neighborhoods with a higher proportion of disadvantaged residents [...] experienced

- longer outage duration.” Finally, Christopher Gore (2017) examines the political economy of energy reforms in Uganda.
6. The current state of the art has moved from country or region-level data to understanding the relationship between electricity use and covariates across a spatial grid. Min (2015), for example, uses a one-degree latitude by one-degree longitude grid of annual light at night tiled across the low-income world. This grid is extensive, and is a large improvement over prior research. However, the area of each cell in the grid is approximately 10,000 km<sup>2</sup>, which is over ten times larger than the entire Accra metropolitan area in which our neighborhoods are nested. Further, the light measure within each cell is taken over a year while we capture variation over days.
  7. Brian Min and Miriam Golden (2014) show that elections influence where and when line losses spike.
  8. The idea that blackouts can be aimed and that this creates an opportunity for distributive politics was also proposed in Min (2015:46), who writes “Blackouts are technical failures but also politics opportunities.” How exactly electoral politics influences electricity rationing will depend on local institutions and electoral geography. On institutions and electoral politics in Ghana, see Ryan C. Briggs (2012), Barak Hoffman and James D. Long (2013), and Abdul-Gafaru Abdulai and Sam Hickey (2016). On the electoral geography of Ghana, see Kevin Fridy (2007; 2012) and Staffan I. Lindberg (2013).
  9. Concern about repayment will be smaller in Accra than in many other parts of Ghana, as most meters in Accra are now pre-paid. It should also be noted that while Accra largely has pre-paid meters, the pre-paid vending system can itself experience outages (Brakopowers 2017). Additionally, theft remains an issue regardless of the type of meter. Line losses in Ghana have increased since 2000 and are now at around 25 percent (World Bank 2017a). While not all line losses are due to theft, theft (often in the form of tapping electricity lines) is one plausible explanation for losses of this magnitude.
  10. While this logic explains why the ECG might target electricity to richer areas, it leaves open the puzzle of why the ECG is so often ineffectual at actually collecting on-time payment from those with post-paid meters.
  11. Our conceptualization of power (in the political sense of the term) comes from Robert Dahl (1957) and is simply the ability to influence an actor (violently or otherwise) so that it does something that it would not otherwise do.
  12. A related possibility is that the ECG is attempting to maintain consistent electricity in areas with foreign embassies or their staff. This could explain higher electricity levels in the neighborhoods of Cantonments and Ridge.
  13. In the words of Nic van de Walle (2009:308), “the recent political science literature on domestic inequality in the developing world is sparse, and on SSA, it is virtually nonexistent.” This implies that there is also very little written on the effect of domestic inequality on politics, as the literature on the effect of domestic inequality on politics is a subset of the broader literature on domestic inequality.
  14. We would like to thank a participant at a presentation at the Center for Global Development for this explanation.
  15. While we use Accra for brevity, our neighborhoods technically fall within Greater Accra.
  16. More than 85 percent of the population of Accra had access to electricity in 2010 (Kemausuor & Ackom 2017). Only 1 percent of the surveyed population of

Accra reported not having a connection to the grid in Afrobarometer round six (Afrobarometer 2016).

17. At various points in time this was changed to twelve hours on and twenty-four off. The essential point is that the outages were to be shared equally across neighborhoods.
18. Almost no updates were submitted during the first two-week period. In the second two-week period updates were much more consistent over neighborhoods and over time.
19. The neighborhoods with wealth quintile data are: Abelenpke, Baatsona Spintex 1, Baatsona Spintex 2, Banana Inn, Cantonments, Chorkor, Dansoman, Dome pillar 2, East Legon, Kwabenya, Kwashieman, Labadi, Lapaz (Abeka), Lapaz (Nyamekye), Laterbiokoshie, Legon Campus, Madina, Mamprobi, Ministries, Pokuase ACP, Ridge, Santa Maria (Auntie Aku), Santa Maria (School Junction), Taifa, and Trade Fair.
20. The tax residential tax classes run, in descending order: 1A, 1B, 2A, 2B, 3A, 3B, 3C. We do not include 3B because we do not have a neighborhood in that tax class. We also include a commercial tax class (which has the highest tax rate), as we have one neighborhood that falls into a commercial class.
21. The neighborhoods with tax class data are: Abelenpke, Baatsona Spintex 1, Baatsona Spintex 2, Banana Inn, Cantonments, Chorkor, Dansoman, East Legon, Kwashieman, Lapaz (Abeka), Lapaz (Nyamekye), Laterbiokoshie, Legon Campus, Mamprobi, Ministries, Ridge, Santa Maria (Auntie Aku), Santa Maria (School Junction).
22. The most common cause of missing data on the wealth variables was that the neighborhood from the Dumsor Project was technically outside of Accra. The neighborhoods with missing wealth data do not have significantly different levels of daily electricity than those without, and the direction of relationship between having missing data and electricity availability is differently signed (and always statistically insignificant) across the wealth measures.
23. The left panel has 350 observations and the right panel has 252 observations. The scheduled electricity variable is never statistically significant and always has a very small coefficient (suggesting that a one-hour increase in scheduled electricity leads to fewer than six minutes of actual electricity). Dropping the scheduled electricity variable has essentially no effect on the results. The analyses use robust standard errors instead of cluster robust standard errors (clustering on neighborhoods), as the latter leads to implausibly small standard errors in the clusters that have only one neighborhood per level of the wealth variable. This occurs most problematically in the poorest neighborhood in either panel (Chorkor). The differences in levels of electricity across the low, middle, and high neighborhood wealth groups remain significant when we cluster on neighborhoods and use bootstrap standard errors.
24. Note that population density is very likely higher in the poorer neighborhoods, so per person these effects are likely to be even more extreme.
25. A small number (229) also either reported missing data or said that they did not know the answer to the question. Those respondents are dropped from the analysis.
26. We experimented with using subsets of the questions, such as only focusing on deprivations of food, water, and medicine, and the results were very similar.
27. The  $\chi^2$  statistic for no relationship between electricity availability and deprivation is 2258.8,  $df = 80$ ,  $p < 0.01$ .

28. The survey weights correct for non-random sampling within countries and for the fact that some countries had larger sample sizes than others. The weights do not correct for the fact that we are limiting our sample to people whose house is connected to the grid. This implies that our results weight more heavily countries with more people on the grid, which seems appropriate given our research goals. We use OLS, thus treating our ordinal dependent variable as if it is cardinal. To ensure that this does not influence sign or significance, we also estimate ordered logistic models for the pooled and Accra-only columns and attempt to use the “blow up and cluster” method to estimate ordered logistic models for the columns with country, region, and location fixed effects (results not shown). We are not able to estimate the model with country fixed effects due to a numeric overflow, but the remaining models run without issue. The coefficient for deprivation was similarly signed and statistically significant ( $p < 0.01$ ) across all of the models. We report OLS results for ease of interpretation. On the blow up and cluster estimator, see Gregori Baetschmann et al. (2015). We implement the estimator using code from Andy Dickerson et al. (2014).
29. Locations are much larger than the neighborhoods used in the Accra analysis, so we can still expect a good deal of neighborhood-level variation within locations.
30. There is also one missing value on the dependent variable, and five people had a missing value on the deprivation score.
31. For a discussion of how wealthier Ghanaians are more able to afford technology to mitigate electricity failures, see Jonathan Silver (2015).
32. This reinforces earlier work by David S. Brown and Ahmed M. Mobarak (2009), who showed that democratization in poor countries increases the share of electricity that is used by the residential sector.
33. This possibility is noted in Min (2015:9), who writes “There is no doubt that the benefits of many public services and goods seem to pass over the poor, even in countries with elections.”
34. Sustainable Development Goal 7 is to “ensure access to affordable, reliable, sustainable, and modern energy for all” (United Nations Global Compact 2017).