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Review

Benefits and challenges of expanding grid electricity in Africa: A review of rigorous evidence on household impacts in developing countries

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ABSTRACT

Electrification rates have risen dramatically in many developing countries, but most low-income African countries lag far behind. A growing number of donors are now targeting this issue, notably the United States–sponsored Power Africa initiative. In this paper we summarize research that can inform donors and governments working in this area. We cover challenges to and benefits of expanding grid electricity, prioritizing rigorous impact research in Africa when possible. The evidence we review suggests that potential benefits are large and spread across a variety of economic and noneconomic domains. However, expanding access cost-effectively and sustainably may pose a serious challenge. In particular, relative to the benefits, grid electrification involves substantial costs from building lines, improving capacity, and connecting households—costs that may be higher in Africa than in more densely populated regions of the world. Reducing customer connection costs would increase connection rates and could thus reduce the cost of building new lines per connection but might still not be cost-effective, especially in low-density rural areas.

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Introduction

Although many developing countries have made great strides in bolstering access to electricity, it is well-established that most low-income African countries lag far behind, especially in rural areas. Much of the progress in developing countries in recent years has been driven by the rapid expansion of grid electricity in India; in Africa, the pace of electricity growth has barely exceeded population growth (IEA and World Bank, 2015). In Sub-Saharan Africa as a whole, only 38% of the population had access to electricity in 2014, a modest increase from 25% in 1990 (World Bank, 2017a). Electrification rates vary widely across sub-Saharan Africa: while most households in Ghana, Nigeria, Senegal, and South Africa had access by 2014, less than 12% had access in Burundi, Chad, Liberia, Malawi, and South Sudan (World Bank, 2017a).

Challenges to improving Africa's electricity rates abound. Access rates are lowest in rural areas in part because low-density areas are more expensive to electrify. Even where lines are built, household connection rates are often low, largely because of high connection costs. In both rural and urban areas, poor households connected to the grid exhibit low usage (IEA, 2014; Louw, Conradie, Howells, and Dekenah, 2008). In addition, although connection costs are too high for many low-income customers, usage tariffs are often low enough to make the total revenues of utilities fall well below their costs. All these factors provide a disincentive for private companies and electric utilities to expand into unreached areas.

At the same time, both policy and research have undergone a dramatic shift regarding electricity access in Africa. A growing number of donors are now funding electricity projects in Africa, notably the United States–sponsored Power Africa initiative, announced in 2013. Energy is one of the 17 Sustainable Development Goals for 2030, with the aim of universal access to affordable, reliable, and modern energy services by 2030 (United Nations, 2016). In 2016, the African Development Bank (AfDB) adopted a plan called "The New Deal on Energy in Africa" with the goal of achieving universal access by 2025 (AfDB, 2016). Perhaps in part because of these initiatives, research on electricity in developing countries has shifted in the last decade toward a much greater emphasis on estimating impacts of improving electricity access and connection rates on outcomes related to energy and time use, education, health, and income.

This literature review provides context and evidence relevant for donors and governments aiming to increase both access to electricity and connection rates in Africa. The review focuses on the challenges and benefits of expanding grid electricity to households in Africa, prioritizing rigorous household-level research on impacts when possible. Thus we summarize research that estimates impacts of specific interventions using a design in which one group of households receives the intervention and another group does not. In most cases the number of rigorous impact studies and the amount of data available are not sufficient to estimate interaction effects between these interventions and key policy variables. This means that we cannot directly address a large number of potentially important issues such as identifying which policies are most effective and/or the potential importance of combining electrification interventions with other interventions related to infrastructure and economic development. However, our work will help inform other research that does address these type of issues (see, for example, Barnes, Peskin, and Fitzgerald, 2002; Bastakoti, 2003; Jamasb, Nepal, and Timilsina, 2017, Mapako and Prasad, 2008; Peters, Harsdorff, and Ziegler, 2009; UNDP, 2014). In addition, when more rigorous impact research at the household-level becomes available we believe that it will be possible to address some of these other issues more directly.

The article is organized as follows. In the section, History of electricity investments in Africa, we provide a brief history of electricity investments in Africa, a topic covered in greater detail in Bernard (2012). In the section, Challenges with expanding access, we review challenges faced by governments and policy-makers. Next, in the section, Challenges to connecting, we focus on challenges faced by households. We first discuss evidence on how long it takes households to connect once electricity is available. We then describe household barriers to connecting to electricity. In the section, Interventions to reduce consumer costs of electrification, we review the various interventions that have been implemented to reduce the cost of connecting to the grid. In the section, Impacts of connecting, we draw on evidence from developing countries around the world to explore the potential benefits of electricity and how long it takes for those benefits to be realized. When possible we focus on more rigorous impact studies that attempt to establish causal links between interventions and household-level outcomes and those that focus on Africa. This discussion is organized by the domains frequently covered in the literature: fuel and energy use, education, health and safety, time use, economic activity and well-being, and household composition and mobility. Finally, in the section, Conclusion, we discuss key policy implications of the evidence summarized in this review.

History of electricity investments in Africa

Efforts to increase electricity access in Africa, particularly in rural areas, have been ongoing for decades. During colonial times, electricity lines were installed primarily to support industrial projects of colonial powers (Cook, Campbell, Brown, and Ratner, 2015). Rarely was electricity installed with the goal of improving household access. As a result, the majority of African households lacked electricity, a condition seen as a barrier to economic growth during what Bernard (2012) describes as the first of three distinct periods in the recent history of rural electrification in developing countries. In the first period, lasting from decolonization until the early 1980s, infrastructure was viewed as a key to economic growth. Electricity in particular was deemed crucial for improving conditions in rural areas and thereby slowing the rate of deforestation and the rate of migration to urban areas. Large-scale state-led energy projects, including the construction of hydroelectric dams, were popular during this period, and electricity was highly subsidized (Cook et al., 2015; Williams and Ghanadan, 2006).

During the 1980s and early 1990s, the focus switched from government and donor-funded rural electrification projects to structural adjustment policies, through which the World Bank pushed for the unbundling and privatization of state-owned utilities. Donors and governments realized that large-scale investment in infrastructure had led to substantial debt burdens in developing countries, a situation compounded by the oil shocks of the 1970s. Artificially low electricity prices meant that many utilities could not cover their costs, and systems were plagued by electricity shortages, poor quality equipment, and inability to expand the grid (Williams and Ghanadan, 2006). Even where rural electrification access had expanded, connection rates were low (typically between 25 and 50%), and few households used electricity for anything beyond lighting (Bernard, 2012). Households did not change their cooking practices and thus did not reduce their reliance on wood, and there was no evident slowing of rural-to-urban migration. This second period of rural electrification described by Bernard was characterized by international donors' unwillingness to invest in electricity because of government corruption and a related lack of success (Bernard, 2012; Cook et al., 2015). Rather, at the behest of the World Bank and International Monetary Fund, governments in developing countries implemented structural adjustment programs that promoted market competition and reduced government control over the economy, encouraged privatization of state-run industries, and facilitated foreign private investment. In general, these reforms failed to increase private investment in the power sector in Sub-Saharan Africa (Jamasb et al., 2017).

Finally, the third period described by Bernard (2012) started in the 1990s and continues today. This is the period during which electrification came to be seen as a means of poverty reduction and, specifically, as a key input to achieving the Millennium Development Goals. In