Yael Borofsky
ETH Zurich
February 2021

The Love-Hate Relationship with Self-Generation

Demand for reliable, affordable electricity is growing fast in sub-Saharan Africa (SSA), but the power grids aren't keeping up.[1] Roughly one billion people globally with a grid connection experience over 1,000 hours of power outages per year (about 40 days), many of them in SSA. Unreliability drives individuals and businesses to back-up generators — usually diesel or gas-powered — to meet their electricity needs. Back-up generation comes with daunting costs like fuel purchasing and atmospheric pollution from greenhouse-gas emissions. But generators also fill a critical gap in electricity service.

Back-up generators are highly distributed and largely consumer-facing, so reliable data is scarce, and analysis relies on models (and assumptions) to develop market estimates. The latest findings indicate that the energy poverty problem in SSA may be even bigger than we think—some countries have almost as much back-up capacity as on-grid generation.

The economic cost

> IN SUB-SAHARAN AFRICA, THE BACKUP CAPACITY IS ROUGHLY EQUAL TO THAT OF POWER PLANTS ON THE GRID.

- Sub-Saharan Africa accounts for roughly **25 percent** of the total installed capacity of back-up generation in low- and middle-income countries worldwide—more than any other region.[2]
- Back-up generators provide **9 percent** of all electricity consumed in sub-Saharan Africa and **40 percent** in Western Africa.
- Nigeria alone spends **$12-17 billion** per year on backup generation.[3] This represents up to **22 million small gasoline generators** used by households and small businesses, totaling **eight times the peak capacity** of the Nigerian electric grid (about 5.3 GW).[4]

The environmental and health costs

The use of back-up generators at this scale has substantial environmental and health consequences that we can't fully quantify. Two reports, one from the Access to Energy Institute (A2EI) and the other from the International Finance Corporation (IFC), attempt to address this gap.[2,4] They find:

- Generators emit pollutants harmful to human health and climate, including nitrogen oxides (NOx), fine particulate matter (PM2.5), local black carbon, ozone (O3), and sulfur dioxide (SO2).
- The negative health impact is especially concentrated in urban environments.
- Emissions of NOx and PM2.5 account for most of the power sector emissions.[2]
- Back-up generators are responsible for 15 percent of total NOx emissions every year in SSA.
- CO2 emissions from back-up generators in SSA are equivalent to 20 percent of all CO2 emissions coming from vehicles in those countries.

Reliability needs cleaner options

- **Invest in grid reliability.** Back-up generation is often vastly more expensive than grid tariffs, so if the grid offered similar reliability switching would occur naturally. The most straightforward solution is to create a more reliable grid alternative.
- **Solar-powered back-up generators.** With advances in tech, solar-power back-up generation could provide a future alternative to diesel in some scenarios. A2EI is trying to bring solar to the back-up generation market with calls to reduce costs, improve financing options for larger-scale systems, and alter the regulatory environment, with a specific (controversial) proposal to ban the import of low-cost generators. But without an affordable, improved alternative, such a ban would force low-income consumers to turn to even dirtier and costlier sources.
- **Redirect fossil-fuel subsidies.** Both reports suggest that current fossil fuel subsidies could be reallocated to clean alternatives, such as solar-powered generators with storage. However, countries like Nigeria have struggled with adjusting diesel subsidies, partly due to generators, but mostly due to the impact on transportation costs and public backlash.[5]
- **More research.** Ultimately, there is still relatively little research on back-up generation throughout SSA. More information would help understand the scale of the market, and enable better assessment of economic and health trade-offs. Focusing attention on the range of responses to grid unreliability may shift our understanding of reliable, affordable access to electricity, especially in rapidly growing cities.[6]

Endnotes

1. Catherine Wolfram, Orie Shelef, Paul J. Gertler. How Will Energy Demand Develop in the Developing World? Working Paper 17747, National Bureau of Economic Research, January 2012.
2. The Dirty Footprint of the Broken Grid: The Impacts of Fossil Fuel Back-up Generators in Developing Countries. IFC and the Schatz Energy Research Center, September 2019.
3. Bassey Udo. Nigerian manufacturers spend N3.5trn yearly on generators — NLC. *Premium Times Nigeria,* June 25, 2015.
4. Putting an End to Nigeria's Generator Crisis: The Path Forward. Access to Energy Institute and Dalberg, June 2019.
5. Priscilla Atansah, Masoomeh Khandan, Todd Moss, Anit Mukherjee and Jennifer Richmond. When Do Subsidy Reforms Stick? Lessons from Iran, Nigeria, and India. Center for Global Development, November 17, 2017.
6. Steven Davis & Jay Taneja. Without a back-up plan. *Nature Sustainability,* October 15, 2018.