ACCESS TO ELECTRICITY

The dirty footprint of backup generators in the developing world

round the world, nearly one billion people are still living without any access to electricity – and of those with access, an additional 840mn have unreliable and intermittent service from grids that are essentially broken. For decades, energy sector issues have prevented utilities from delivering reliable and steady service to many cities, townships, and villages, resulting in a seemingly intractable grid reliability deficit across much of Asia and Africa.

Frequent blackouts can stretch for hours, sometimes days, on end, leaving homes and businesses in the dark. The structural challenges underlying these conditions are varied, including low population density, underinvestment in infrastructure to meet demand, mismatch between costs and customers' ability to pay, financial pressures on utilities, and general mismanagement. Communities are left to cope with the outcomes.

A failed solution

Responding to decades of unrealised

Small fossil fuel generators were mainly meant to serve as temporary fixes to the problem of intermittent energy access in developing countries. Reliance on them has serious climate and public health implications, but renewables offer a ray of hope, writes *Russell Sturm*.

promises, tens of millions of people have turned to fossil fuel backup generators as a stopgap measure for their unreliable grid connections. Many of these generators were originally designed to deliver only emergency and temporary relief from grid failure but have come to serve as primary and often exclusive sources of power.

While generators are a pathway to accessing electricity, they offer only a problematic, intermediate solution – the cost of operations is often double or more than that of grid electricity. The rumble of engines fills neighbourhoods and cities with noise pollution. The exhaust is foul smelling and

Figure 1. Backup generator fleet count estimates for 2016 across all modelled countries *Source: IFC* hazardous to health and the environment. Not to mention the time and effort required to install, fuel, and maintain generators imposes significant additional costs to those that depend on them.

Despite these drawbacks, generators have become commonplace and are used for thousands of hours per year in places with the worst grid reliability. Until now, they have been the best bad option available.

This autumn, the International Finance Corporation (IFC), part of the World Bank Group, partnered with the Schatz Energy Research Center at California's Humboldt State University to release a new study: *The Dirty Footprint of the Broken Grid*, surveying for the first time the economic, environmental, and health effects of the fleet of fossil fuel generators operating in the developing world.

The results are alarming: Across the developing world, there are 20–30mn sites using backup generators, consuming 40–70bn litres of fossil fuel annually at a cost of nearly \$50bn – a toll that is perversely enabled by an estimated \$1–\$2bn in government subsidies for the fuel burned in these generators.

While the study paints a troubling picture of the global reliance on dirty, dangerous, polluting backup generators, our analyses show market readiness for widescale commercialisation of solar and battery storage-based solutions. In response, IFC is working across a range of advisory and investment platforms to



support first-mover companies in rapidly building the market for safe and clean alternatives.

Nigeria's footprint

In Nigeria, one of the largest markets for backup generators, the grid is grossly insufficient to serve the needs of the country. With the largest population and economy in Africa, Nigeria has only 5.3 GW of power generation reliably connected to a national grid. Nigeria's installed power capacity amounts to about 30 W per person, compared to a global average of about 900 W per person. Stunningly, the generating capacity of the installed fleet of backup generators is estimated to be four times larger than that of the grid.

The population and economy of Nigeria are largely powered by small-scale generators, including both diesel units and smaller gasoline-powered generators. Large diesel generators power offices, industry, and large homes and businesses (as is common in many parts of the world with poor or no electricity access). The cost to operate these generators is significant. A recent estimate by the Nigeria Labor Congress shows that approximately \$17bn is spent each year by industrial generator users alone.

Despite being banned by the

Nigerian government, there is also a widespread use of extraordinarily dangerous and inefficient small gasoline-burning generators in homes and small businesses. Many utilise two-stroke engines that burn a mixture of gasoline and lubricating oil – as opposed to quieter and typically less polluting four-stroke engines like those used in cars.

Our research found that the annual emissions of carbon dioxide (25 Mt) and nitrogen dioxide (170 kt) from backup generators are comparable to that of the entire vehicle fleet in the country. In Nigeria, backup generators account for over 90% of the emissions of fine particulate matter (PM2.5), black carbon, sulfur dioxide and nitrogen dioxide from power generation.

All considered, backup generators are a major source of pollutant emissions in Nigeria. Their timely replacement presents a significant opportunity for improving air quality, reducing the national burden of disease, and cutting greenhouse gas emissions.

The opportunity

The Nigerian story can be told in many of the markets that we have uncovered in this new picture of the global footprint of backup generators. With rapid improvements in efficiency, performance, and pricing, distributed solar and storage technologies now offer a superior and effective alternative to the generators that have proliferated across much of the developing world. We believe that the moment for wide-scale commercialisation is at hand – and with it, the opportunity to clean up the dirty footprint of the broken grid.

This is an opportunity for the private sector to catalyse new markets for modern energy access – and vastly improve economic conditions in parts of the world still tethered to broken electrical grids. However, transitioning to distributed solar and storage solutions will require innovative efforts to address market barriers and catalytic finance to enable commercial scale.

IFC has worked with industry pioneers to build today's \$1bn market for off-grid solar technologies, which have broadly displaced rural populations' reliance on kerosene lighting. Now, a similar revolution is possible to displace backup generators at scale and to improve the livelihood, health and environment for millions around the world. •

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energy

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