Energy and Economic Growth
Applied Research Programme

EEG Energy Insight

Developing a Programme of Research on the Electricity Sector in Sierra Leone

Written by Simon Trace

The goal of the UK Department for International Development- (DFID-) funded Energy and Economic Growth programme (EEG) is to build a body of evidence around how sector reforms, innovative technologies, and practicable actions can be used to help maximise the economic impacts of larger-scale energy projects to bring the benefits of modern energy services to poorer people. As part of that effort, EEG is developing a programme of research activity focused specifically on the energy sector needs of Sierra Leone, a country with one of the lowest rates of access to electricity in the world.

This paper sets out some of the main energy challenges faced in Sierra Leone and describes a process by which opinions were gathered across the sector as to where further research might elicit valuable insights for planning and further policy development.

Based on the work outlined, a call for research proposals was issued in April 2018.

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Introduction

The overall purpose of DFID's EEG is to build a body of evidence around how sector reforms, innovative technologies, and practicable actions can be used to help maximise the economic impacts of larger-scale energy projects in sub-Saharan Africa and south Asia, and bring the benefits of modern energy services to poorer people. EEG aims to fill an important niche by focusing on larger-scale energy infrastructure, particularly renewable generation and urban infrastructure.

It has been determined that EEG will be delivered, at least in part, through a collection of geographically-confined sets of research initiatives. Sierra Leone has been identified as the location for one such programme, based on its low access rates and the wide range of challenges faced by the sector.

The purpose of this Energy Insight paper is to describe some of the challenges faced in delivering universal access to electricity in Sierra Leone and to describe how EEG has gone about designing a programme of research aimed at helping to address some of those challenges. The Sierra Leone programme is EEG's first attempt to deliver a programme of research that is specifically tied to potential research problems identified by sector stakeholders themselves, as a means of developing a body of research that will be of direct use to policymakers.

The electricity sector in Sierra Leone

A series of significant challenges exist in the electricity sector in Sierra Leone. These include the following:

1. Low overall access rates: Estimates of coverage vary – Power Africa puts the national access rate at just 5% (11% of the country's 400,000 urban households and 1% of its 600,000 rural households), while the Global Tracking Framework of the UN's Sustainable Energy for All (SE4ALL) initiative puts the national figure slightly higher at 13% (with 30% of urban households connected and 1% of rural).
2. A supply-demand imbalance: The unconstrained demand for electricity (including mining sector demand) is estimated at 256 megawatts (MW) (with around 50MW from the mining sector), and the constrained demand at around 100 MW. Significant construction activity in Freetown (especially hotels) is likely to add to demand. In comparison, the national generation capacity is, at its peak, at around only 80MW. The scale of the imbalance is highly seasonal, being far less in wet season (as hydro power provides 40MW in the west season, compared to 10MW in dry season).
3. An inadequate energy mix: Heavy fuel oil-(HFO-) generating plants are required to maintain generating capacity given seasonal fluctuations of hydropower. For example: Bumbuna has 50 MW seasonal hydro capacity, backed up by around 25MW of HFO capacity, while the smaller integrated Bo-Kenema grids have seasonal 4.5MW hydro, backed by 3MW of HFO.
4. Low capacity of the network and high system losses: There is generation capacity to supply Freetown at 42MW but the distribution network is subject to major issues (thus even new generation projects are limited in reach). So, although reliability is a major issue in the dry season because of limitations on power availability, problems persist into the wet season, when generating capacity is higher but network limitations lead to around 15 hours of outages per month in Freetown. In addition, there are an estimated 35% commercial and technical losses in distribution.
5. Financial unsustainability of the formal electricity sector. In response to these issues, 2016 saw the unbundling of the National Power Authority into two utilities – the Electricity Generation and Transmission Company (EGTC) and the Electricity Distribution and Supply Authority (EDSA), while a new sector regulator is still in the process of being set up. At the moment, however, there is continued reliance on emergency fuel, sub-optimal PPAs, poor planning, and a non-cost-reflective tariff.

Table 1: Public vs private generation capacity in Sierra Leone[1]

Types of power plant	Installed capacity in MW	Number of plants	State owned, private, mixed	Grid connected or decentralized
Thermal Oil plant	37	7	State owned	grid connected
Large Hydropower plants (>10MW)	50	2	State owned	Grid connected
Small Hydropower plants (<10MW)	6.75	4	State owned	Grid connected
Auto-generators (135MW) plus two years imports (39MW)	135+39 = 174	33,000	Private	Isolated
Mining company generators	88.5	Unknown	Private	Isolated
Photovoltaic	0.025	Unknown	Mixed	Isolated
Total MW	**356.3**			

The problem of low and unreliable supply of power in the economy is such that companies, and households that can afford to, often turn to generating their own power instead. Table 1 shows that over 70% of current generating capacity in the country is in fact in private hands, with more than two-thirds of that (174MW) owned by non-mining businesses and private households. The total capital costs being borne by households and private firms (excluding mining companies) to provide generating capacity to address the limitations of grid power supply is estimated at over US$100 million[2].

As a consequence of the difficult financial situation in the sector and the availability of potential donor funding (for example, the Millennium Challenge Corporation (MCC) Threshold Programme, which provides US$20 million of technical assistance) there has been significant interest in reforms. This has included the DFID Energy Africa Compact with the Sierra Leonean Government (focusing on off-grid smaller-scale solar technology) and MCC support for the drafting of a new Electricity Road Map.

Current planned investments include the following:

1. A 57MW thermal plant (with plans to expand to 100+MW) that would be financed by the World Bank, CDC and the African Development Bank (AfDB). This power plant would be aimed at supplying Freetown and an agreement is at the final stage, although its implementation rides on governance reforms which have not yet materialised.
2. The upgrading of the isolated grid network of the second and fourth largest cities (Bo and Kenema respectively), including a new transmission line and construction of distribution networks. Funding for this initiative will come from DFID and AfDB (£80 million).
3. Connection to the West African Regional Power Pool through a new transmission line, with a possible deal with Cote D'Ivoire to supply a guaranteed minimum of 27MW to Sierra Leone at a rate of USD 13 cents per kWh (compared to a USD 23-cent tariff currently). A new substation would also allow for a connection to Bo-Kenema.
4. Significant expansion in renewable energy, including a DIFD/UN Office for Project Services (UNOPS) £35 million project to establish 90 mini-grids (c.30–40 kilowatts (kW) each) in rural areas (which, for the most part, will be the first of their kind in

[1] Millennium Challenge Corporation (2013) 'Sierra Leone Constraints Analysis Report: A Diagnostic Study of the Sierra Leone Economy: Identifying Binding Constraints to Private Investments and Broad-based Growth'.

[2] ibid

Sierra Leone) and new investments in Hydropower (50+MW).

Reforms and investments to date have tended to be supply-side in nature, as opposed to a response to an understanding of demand. Basic data on outages, consumption, and connections are weak, and are housed in different places with sometimes competing institutional mandates. Coordination of energy policy with industrial policy seems to have been limited to some discussions with mining companies. In addition, the focus has tended to be on generation and transmission, at the expense of distribution.

There is significant interest in off-grid solutions as a means of bypassing current challenges with the expansion of on-grid supplies, but again the supply-side nature of some of these investments raises questions about their sustainability. Productive use will be critical to ensuring adequate load factors are achieved that allow mini-grids to create sufficient revenue to cover operation and maintenance costs. Although some of the currently planned 90 mini-girds are to be built near agro-processing centres, many are not, and focus instead on powering rural health centres.

Defining a research programme

To elicit potential research questions that will be of interest to policymakers in Sierra Leone, a two-stage exercise was held in October and November 2017. Interviews were initially carried out with key stakeholders in, or engaged with, the electricity sector in Sierra Leone. Some were conducted remotely by telephone/Skype, but the majority were face-to-face discussions that took place in Freetown. The purpose of each interview was to introduce the aims and objectives of the EEG programme and then to ascertain the interviewee's view of the most pressing issues in the nation's energy sector that would benefit from further research. A long list of 40 questions was then recirculated amongst stakeholders, with a request for their prioritisation.

Table 2 lists the institutions that were interviewed during the course of this exercise. It also shows who responded to the request to provide their top-priority research questions from the long list of questions developed from the interviews[3]. In addition to interviews, the following key sector documents were consulted to identify additional potential research questions:

- Electricity Sector Reform Roadmap 2017–2030 (supported by the MCC and carried out by Adam Smith International);
- Energy Efficiency Policy of Sierra Leone 2016 (supported by Economic Community of West African States (ECOWAS) Centre for Renewable Energy and Energy Efficiency (ECREEE));
- Renewable Energy Policy of Sierra Leone 2016 (supported by ECREEE); and
- UN SE4ALL Investment Prospectus for Sierra Leone 2017 (supported by the EU).

[3] In two cases (Adam Smith Institute and UNOPS), although availability issues prevented interviews from being carried out, the institutions still responded to the request to provide a prioritised list from the long list of questions.

Table 2: Institutions engaged in scoping study

EEG issues (columns) and cross-cutting themes (rows)		
Institution	**Interviewed**	**Prioritised shortlist of questions**
Government / quasi-governmental Institutions:		
ECREEE – Sierra Leone focal point	✓	✓
EDSA	✓	✓
Ministry of Energy	✓	
Office of the Water and Electricity Regulatory Commission	✓	✓
International finance / donors:		
AfDB	✓	✓
DFID	✓	✓
Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)/EnDev	✓	✓
MCC	✓	✓
UNOPS		✓
World Bank	✓	
Consultants / contractors / research institutions:		
Adam Smith International		✓
Centre for Economic Research and Capacity Building in Sierra Leone	✓	✓
International Growth Centre	✓	✓
INENSUS	✓	✓
Rocky Mountain Institute	✓	✓
Tony Blair Institute	✓	✓

Using the prioritisations by stakeholders, three different methods of creating a final shortlist of potential research areas were explored. The method eventually selected led to 16 research areas being identified. These are shown in Table 3, grouped under EEG's four priority research areas and four cross-cutting themes. Potential key users of research outputs have also been shown for each issue. The 'researchability' of potential questions (whether they are likely to lead to a clear answer) and the level of interest of key stakeholders (such as the Ministry of Energy and key donors) was also taken into consideration when doing the final ranking. A call for research proposals to answer these questions was released in April 2018.

Table 3: Final list of research areas for a research programme in Sierra Leone

List of energy policy issues identified for further research in Sierra Leone		
EEG four priority research areas	**Cross-cutting themes**	**Key potential research users**
Efficient and productive use		
(a) What factors / services have to be in place to ensure increased access to power leads to productive use and growth in economic activity? What added value do business development services offer when provided alongside improved access to energy, in terms of stimulating productive use?	Economic and social impact	DFID / AfDB / Ministry of Finance
(b) What financial incentives / instruments are most likely to lead to the adoption of more energy-efficient appliances / measures by consumers and industry, and which are most cost effective?	Policy	Ministry of Energy / ECREE focal point
(c) What are the most effective energy efficiency measures for the country in terms of return (savings) on investment?	Policy	Ministry of Energy / ECREE focal point
(d) What are the main appliance determinants of demand (and load shedding) on the grid in Freetown? What is the potential scale of the impact of a shift to more efficient appliances on reliability?	Technology	Ministry of Energy / ECREE focal point
Grid access		
(a) What is the optimum arrangement of cross subsidy to align cost of service and affordability in rural areas and what is the political economy of that being achieved in practice?	Decision support	EDSA
(b) What is the willingness and ability to pay in different socio-economic groups and the implications for technology choice and management models (could include grid and off-grid)?	Decision support	EDSA
(c) Does the extension of the Bo-Kenema grid to new communities result in small business and new job creation or the expansion of existing small businesses and business opportunities?	Economic and social impact	DFID / AfDB / Ministry of Finance
(d) Do improvements in the reliability and extension of the Bo-Kenema grid to new communities increase employment opportunities to the extent that it slows or reverses migration flow from this area to Freetown?	Economic and social impact	DFID / AfDB / Ministry of Finance
(e) What is the impact of improvements in electricity access or reliability on women's empowerment?	Economic and social impact	DFID / AfDB / Ministry of Finance
(f) How can tariffs be constructed for EDSA and EGTC that promote and achieve high efficiency within their respective customer bases?	Policy	EDSA / EGTC

(g) What options does the regulator have in Sierra Leone for tariff setting that encourages private sector investment while protecting poor consumers' interests?	Policy	EDSA / Regulator
(h) Illegal connections – what drives them and what is the most effective way of converting them into legal paying connections?	Policy	EDSA
Reliability		
(a) What method could be used to quantify improvements to grid / distribution reliability, their economic and social impact and the associated returns on investment?	Decision support	Ministry of Energy
(b) Do reliability improvements to the Bo-Kenema isolated grid result in small business creation and new jobs?	Economic and social impact	DFID / AfDB / Ministry of Finance
Renewable energy		
(a) Can a comparative cost–benefit analysis of grid vs mini-grid provision in rural Sierra Leone (from both a productive use and access perspective) be produced?	Decision support	Ministry of Energy
(b) Could mini-grids that are built to standards that allow for ultimate incorporation into the grid be economically viable in Sierra Leone prior to incorporation?	Technology	Ministry of Energy

Translating research into impact

The aim of co-creating a research agenda for Sierra Leone with energy sector stakeholders has been to develop a research programme that will be capable of delivering findings that are of practical relevance to policymakers and practitioners in the country. Broad categories of potential users of research results for each research area have been identified and, as part of the proposal development process, applicants for research grants are required to:

- describe the anticipated impact of the research project (e.g. technological innovation, improved evidence for policymaking, etc.); and
- further identify the specific end-users of the knowledge generated by the research and any additional stakeholders whose participation is required to carry out the research, demonstrating the engagement with these end-users and key stakeholders thus far; and
- describe a research uptake plan, i.e. the steps that should be taken before, during, and after the research to ensure that the knowledge generated will lead to impact.

Whatever the research uptake strategy, all projects are expected to allocate sufficient resources to ensure stakeholder engagement and inclusion throughout the project and to create outputs that are suitable for the intended audiences in form and content (open access academic papers, conference presentations, capacity development workshops, or training programmes; etc.). Where appropriate, it is expected that research programmes will also include activity to build local research capacity, build the capacity of the users of the research to interpret the evidence and apply it in practice, and identify and overcome the political economy challenges associated with achieving the desired impacts.

References and further reading

Ministry of Energy, Sierra Leone, Millennium Challenge Corporation (2017) Electricity Sector Reform Roadmap 2017–2030

Ministry of Energy, Sierra Leone (2016) Energy Efficiency Policy of Sierra Leone

Ministry of Energy, Sierra Leone (2016) Renewable Energy Policy of Sierra Leone

UN SE4ALL (2017) Investment Prospectus for Sierra Leone (supported by the EU)

About the author

Simon Trace has 35 years' experience working in international development, with a focus on access to basic services (energy, water, and sanitation), natural resource management, and technology.

Simon joined Oxford Policy Management in 2017 and is currently the Programme Director for the Facility for Oil Sector Transformation (FOSTER) programme in Nigeria, a £19 million project that aims to achieve more effective use of Nigeria's extractive industries to support national development. He is also leading the work on EEG's Sierra Leone country programme.

Simon has 16 years' experience in senior executive positions in international NGOs, including time as International Director of WaterAid and 10 years as CEO of Practical Action. During his time at Practical Action he provided oversight and technical input for several high-profile energy sector publications, frameworks and strategies, including the UN SE4ALL Global Tracking Framework, the World Bank's Regulatory Indicators for Sustainable Energy (RISE), the World Energy Outlook, and the Poor People's Energy Outlook (PPEO).

A chartered engineer with an MA in the Anthropology of Development, Simon has lived and worked in Africa and Asia. He has served on a number of steering and advisory groups for prominent international initiatives related to energy, including the UN SE4ALL Tracking Framework Steering Group, and is currently a member of the Strategic Advisory Group for the UK Government's £1.5 billion Global Research Challenge Fund.