Energy and Economic Growth
Applied Research Programme

Electricity in Ethiopia

EEG Energy Insight

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June 2018

Oxford Policy Management

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Introduction

Ethiopia's latest Growth and Transformation Plan II focuses on infrastructural improvements which could encourage urbanisation, job creation, industrialisation, and export promotion. Achieving these goals will require overcoming major challenges in Ethiopia's electricity sector – particularly around greater and more reliable electricity access. This paper highlights the major challenges currently facing Ethiopia's electricity sector and outlines opportunities which may help to overcome them.

The Applied Research Programme on Energy and Economic Growth (EEG) is planning a programme of work to help Ethiopia address some of the key challenges in its electricity sector. To date, we have engaged widely with key government officials, donors, and other energy stakeholders to develop a research agenda. This has comprised two scoping visits in October/November 2017 and in February 2018. These visits aimed to identify priority research areas in the country, key in-country research institutions, and opportunities to coordinate, support, and inform local energy programming. EEG also recently held a policy workshop in Addis Ababa, Ethiopia, from 13 to 14 June, to set research priorities for Ethiopia's energy and capacity development strategy. The workshop mapped out key research gaps and outlined the capacity development priorities in Ethiopia's energy sector. This will help identify and build consensus around critical research challenges in various aspects of the energy (electricity) system.

Institutional structure of Ethiopia's electricity sector

Until 2013, the Ethiopian electricity market structure was vertically integrated and functioned as the state utility Ethiopian Electric Power Corporation (EEPCo). As part of reforms to the sector, in 2013, the Ministry of Water, Irrigation and Electricity (MOWIE) separated EEPCo into two separate publicly-owned enterprises: Ethiopian Electric Power (EEP) and Ethiopian Electric Utility (EEU). The details of those entities, as well as other institutions with mandates that affect the electricity sector, are summarised below in Table 1.

Table 1. Main bodies involved in governing Ethiopia's electricity sector[1]

Institution	Acronym	Responsibilities
Ministry of Water, Irrigation and Electricity	MOWIE	• Oversees the Ethiopian electricity sector
Department of Electrification	DoE	• Will sit within MOWIE and coordinate and oversee execution of grid and off-grid components of the National Electrification Programme
Ethiopian Electric Power	EEP	• State-owned entity established in 2013 following the unbundling of the vertically integrated utility, EEPCo • Responsible for electricity generation and transmission sub-sectors
Ethiopian Electric Utility	EEU	• State-owned entity established in 2013 following the unbundling of the vertically integrated utility, EEPCo • Responsible for power and distribution sales
Ethiopian Energy Authority	EEA	• Independent regulatory agency • Responsible for developing rules, directives and standards for governing the electricity sector
Regional Energy Bureaus	REBs	• Represent regional power priorities and facilitate grid and off-grid expansion

[1] http://documents.worldbank.org/curated/en/347061503651051401/pdf/Ethiopia-ELEAP-Concept-Stage-PID.pdf

Almost 60 million Ethiopians lack access to electricity

Universal electrification will be fundamental to ensuring that Ethiopia achieves sustainable development and poverty reduction, and that it meets its goal of achieving middle-income country status by 2025. According to data from *Tracking SDG7: The Energy Progress Report*, approximately 58 million Ethiopians live without access to electricity and the overall electrification rate as a percentage of the total population is 43% (see Figure 1).

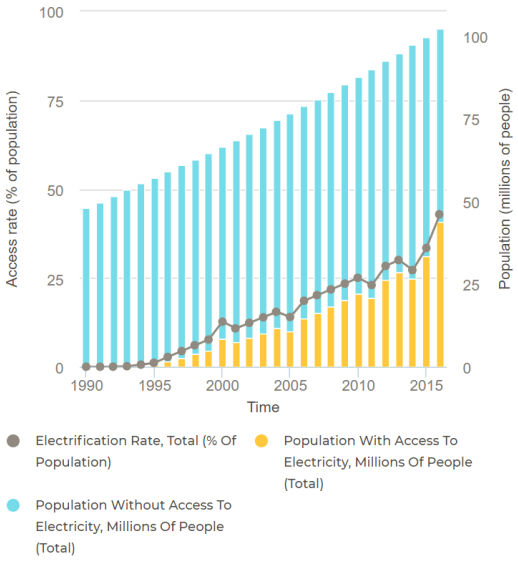
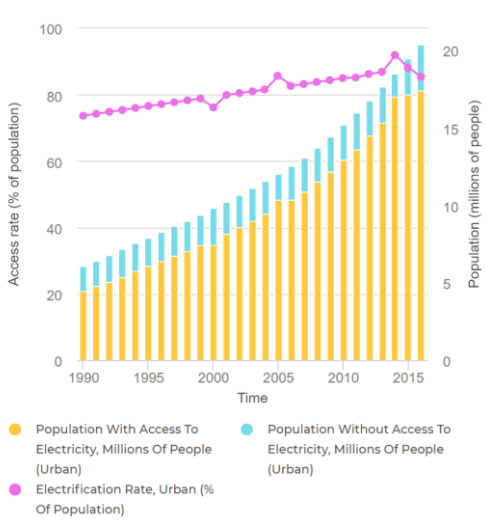
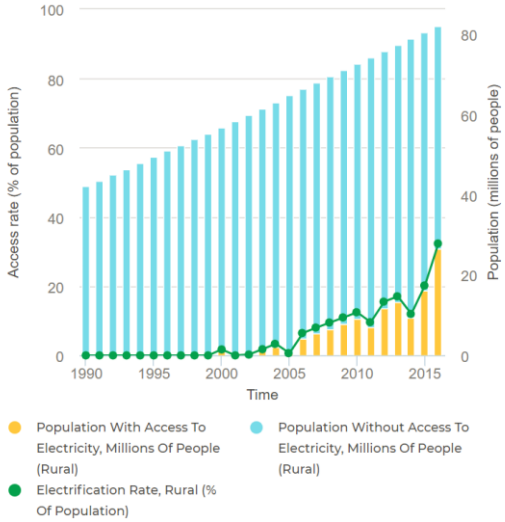


Figure 1. Access to electricity, 1990–2016 (total population)[2]

The rural/urban disparity in access to electricity remains stark: despite electricity access in urban areas having grown steadily over the period 1990–2016, access in rural areas has only really picked up since the early 2000s. The rural/urban gap is such that, at present, 55 million people living in rural areas do not have access to electricity, compared to 3 million people in urban areas (see Figures 2 and 3).





Figures 2 and 3. Urban and rural access to electricity, 1990–2016 (respective populations)[3]

[2] Figure taken from https://trackingsdg7.esmap.org/country/ethiopia
[3] Figures taken from https://trackingsdg7.esmap.org/country/ethiopia

To address the access challenge, Ethiopia's National Electricity Programme-Implementation Roadmap (NEP-IRM)[4] was launched in 2017 and reflects the National Electricity Strategy's (2016) aim of 'achieving universal electricity access nationwide by 2025'. The NEP-IRM is focused on serving the under-served rural and deep rural areas where most of the population lives, and where the living standard is $2 a day. Achieving universal access through the NEP-IRM will include combined on-grid and off-grid solutions, as well as sector capacity and institutional reform. There will be a particular focus on social services delivery (schools, clinics, water points), as well as for productive uses such as for industrial parks and small and medium-sized enterprises.

Approximately 96% of the Ethiopian population is within the service area network footprint of the EEU (the national utility) and is expected to be connected to the grid at least-cost over the medium term (NEP-IRM, 2017). The first stage of implementation of the National Electrification Programme (NEP) (2018–2022) is focused on grid densification. This involves connecting 4.5 million families which are in the closest proximity to the existing EEU network infrastructure.

The on-grid component of the NEP-IRM will be complemented by the off-grid pre-electrification component, which will include a focus on the provision of individual solar systems and isolated micro/mini-grids. The transitional off-grid pre-electrification plan would target towns, villages, and settlements where grid connectivity is the least-cost solution. To achieve universal access by 2025, it is estimated that 35% of the population (or 5.7 million families) will be served by off-grid access (NEP-IRM, 2017).

The total capital expenditure (capex) needed to achieve grid connectivity through densification and expansion is an estimated $19 billion. This equates to an average $820 per family across an estimated population of 22.6 million families by 2030 (NEP-IRM, 2017). The estimated capex required for the first phase of the NEP (2018–2022) is $1.5 billion, comprising approximately $1 billion expenditure on on-grid electrification and $0.5bn on off-grid pre-electrification. In March 2018 the World Bank approved an International Development Association loan of $375 million to support Ethiopia's electrification goals.[5] Further grid capital expenditure plans are detailed in Table 2 below.

Table 2. Grid capital expenditure – least-cost staged programme (taken from table ES.2 in NEP-IRM, 2017)

(order of magnitude estimates)

HHs Segments	Spatial Proximity Segmentation	US$/Connection	Estimated Capex (US$ billion)
A. Existing—"Proximate" *(mostly LV investment—of which first stage "densification program" targets approx. 4.5m cheapest connections)*	(First) 2.5m	US$150	0.375
	(Next) 2.0m	US$300	0.6
	Average US$/conn. for 4.5 million	US$222	US$0.975m
	(Next) 3.1m	US$600*	1.86b
	(Subtotal) 7.6m		~US$2.9b
B. Existing—"Not Proximate" (LV + some MV)	8m	US$900	US$7.2b
C. Population Growth (2016–2030)[a] MV + LV	7m	US$1,200	US$8.4b
Total A + B + C	22.6m	Average US$820/connection	US$18.5[b]

Note: Order of magnitude estimate, not including: (i) capex for MV network strengthening and reinforcements in all 15 regions necessary to enable densification of customer connections; (ii) capex required for the off-grid program rollout, and (iii) the cost of Technical Assistance necessary for strengthening institutional capacity directly linked to facilitate and support the achievement NEP implementation targets (DoE, EEU as well as off-grid program implementing agents and key intermediaries).

[a] Population estimates: UN Statistical Office, Ethiopia. Assumes 5.5 people per HH (Source: Central Statistical Agency, CSA). 2016 population (est.): 100m (18 million HH); 2020 population (est.): 110m (20 million HH); 2025 population (est.): 120m (22 million HH); 2030 population (est.): 140m (25 million HH).

[b] Comparable estimates for the program through 2025: estimated cumulative capex = US$15 billion at the average unit connection cost of US$765.

*Average based on the US$450 cost for three poles.

[4] MOWIE (2017) 'Light to All: National Electrification Program, Implementation Road Map and Financing Prospectus'.
[5] www.worldbank.org/en/news/press-release/2018/03/01/world-bank-supports-ethiopias-endeavors-to-provide-all-citizens-with-access-to-electricity

Box 1: Ethiopia's nationwide GIS least-cost rollout plan

As part of the least-cost NEP-IRM, a nationwide GIS least-cost rollout plan is being launched to accurately map demographic and economic load centres and the existing distribution network. This will help to inform the sequencing of on-grid and off-grid connections (NEP-IRM, 2017). The findings from this GIS plan, together with further studies on adopting a connection policy, reducing network design and construction standards, and producing a distribution technical design investment programme, will help update the NEP-IRM (NEP-IRM, 2017).

The NEP Steering Committee, comprising cross-ministerial members and experts, will provide strategic direction and policy guidance, and will facilitate coordination among ministries, departments, and agencies. The Directorate of Electrification will be established and will have close oversight of the NEP-IRM. It is envisaged to coordinate a sector-wide geo-spatial data, network and connections planning platform; and will coordinate between agencies, with the aim of preparing updated geo-spatial plans and a rollout construction programme to align with the national least-cost geo-spatial plan (NEP-IRM, 2017).

Lack of electricity access has consequences for productive uses and job creation

As part of its Growth and Transformation Plans I and II, Ethiopia intends to drive strong agro-industrial growth. The top three electricity consumption categories are residential, industrial, and commercial consumption (see Figure 4). The current lack of reliable electricity has consequences across the different sectors of the economy. For agriculture, lack of reliable electricity for productive uses poses challenges for supplementary irrigation and post-harvest storage (Mulugetta *et al.* 2018).[6] This has serious consequences as Ethiopia is still a largely agriculture-oriented economy where livelihoods rely on agriculture and livestock, and where farm incomes are already low (Mulugetta *et al.* 2018).[7]

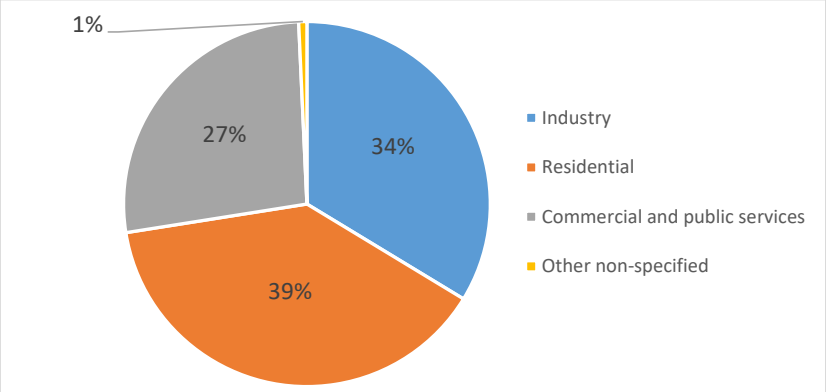


Figure 4. Sectoral breakdown of Ethiopia's electricity consumption, 2015. The volume of the pie slices indicates the relative quantity consumed in gigawatt hours (GWh) (data from International Energy Agency (IEA), 2015)[8]

Electricity access is also an issue for the industrial sector. The Government of Ethiopia has prioritised the development of micro, small and medium-sized enterprises, which it anticipates will contribute more than 3 million jobs over the duration of the current Growth and Transformation Plan II (NEP-IRM, 2017). Nevertheless, bottlenecks persist: 10% of Ethiopian firms surveyed in the World Bank Enterprise Survey (WBES) (2015) identified constraints around electricity as the next most significant obstacle to their business operations, after access to finance.[9] Disaggregating between small, medium, and large enterprises (5–19, 20–99, and 100+

[6] Mulugetta, Y, Modi, V, Hogarth, JR. (2018) 'Proposed EEG Country Programme in Ethiopia', EEG programme. Oxford Policy Management.
[7] Ibid.
[8] www.iea.org/statistics/statisticssearch/report/?country=Ethiopia&product=electricityandheat
[9] www.enterprisesurveys.org/data/exploreeconomies/2015/ethiopia

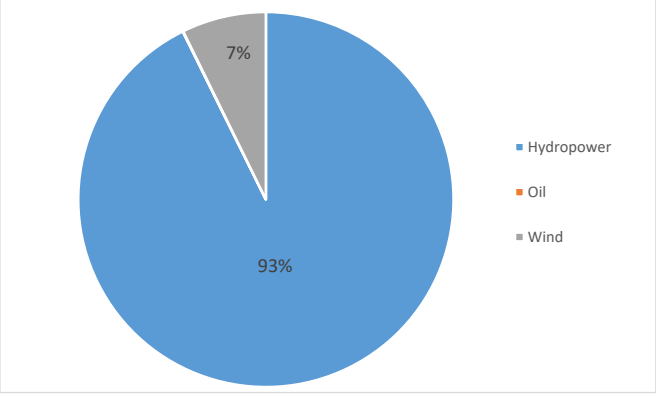
employees, respectively), shows that medium and large enterprises rate electricity constraint as their second most significant business constraint, again after access to finance. For example, results from the WBES (2015) show that it takes an estimated 194 days to obtain an electricity connection in Ethiopia, compared to approximately 37 days elsewhere in sub-Saharan Africa.[10]

To help overcome the challenges around productive uses, the NEP-IRM (2017) highlights that a rapid appraisal of entrepreneurship and challenges with grid adoption will be conducted in 2018, and a programme on productive uses will be implemented in 2019. However, in the scoping study for EEG, Mulugetta *et al.* (2018)[11] identified other factors that must also be considered in the promotion of productive uses in electricity: driving strong growth and overcoming challenges to productive uses will also require EEU to work to increase electricity uptake so as to ensure adequate revenues to fund further investments. EEU will need to be strategic in its investment decisions so that Ethiopia is able to reap the economic rewards from grid expansion, while ensuring the needs of households, public service delivery, and local government are met. Furthermore, the national utility will need to consider that electricity demand for productive uses is unequally distributed across Ethiopia (Mulugetta *et al.* 2018).[12]

Overcoming the challenge of weak industrial access to electricity will require grid densification targeted around industrial parks and agro-industrial parks (NEP-IRM, 2017). The NEP-IRM details the need to realise synergies between the EEU and the Industrial Parks Development Corporation (IPDC). The IPDC was established in 2014 and its mandate is to develop, operate, and administer industrial parks. It is also responsible for connecting parks with transmission lines. There are currently 12 industrial parks throughout the country and 17 potential areas for agro-industrial growth corridors have been identified. Agro-industrial parks are expected to be worth £1.5 billion in investments and to generate 400 business opportunities and 400,000 jobs (NEP-IRM, 2017).

Almost 100% of Ethiopia's electricity comes from renewable resources

Energy Sector Management Assistance Program (ESMAP) figures suggest that approximately 99.96% of the electricity consumed in Ethiopia is from renewable resources.[13] IEA (2015) figures show that 93% of electricity is generated from hydropower, with the remainder being generated by wind energy and less than 1% by diesel (see Figure 5).[14] Given the country's significant renewable energy resources, the Government aims to take advantage of its cost-competitive generation capacity to provide exports to power markets in Sudan, Kenya, and Djibouti, with projections of potential export revenues in the region of $600 million per year by 2020 (NEP-IRM, 2017).



[10] Ibid.
[11] Mulugetta, Y, Modi, V, Hogarth, JR. (2018) 'Proposed EEG Country Programme in Ethiopia'. EEG. Oxford Policy Management.
[12] Ibid.
[13] https://trackingsdg7.esmap.org/country/ethiopia
[14] https://www.iea.org/statistics/statisticssearch/report/?country=Ethiopia&product=electricityandheat

Figure 5. Breakdown of Ethiopia's electricity generation by energy source, 2015. The volume of the pie slices indicates the relative quantity produced in GWh. Data from IEA (2015)[15]

The country has the potential to generate about 60,000 megawatts (MW) of electricity from hydroelectric, wind, solar, and geothermal sources (Power Africa, 2016)[16], and so the currently installed generation capacity of 4,206MW is still very low (Power Africa, 2018)[17]. The NEP-IRM (2017) highlights Ethiopia's engagement with several development partners, with the aim of maximising its installed capacity: the Adama 1 and 2 and Ashegoda wind power projects are in operation and have a total capacity of 324MW. The International Financial Corporation has agreed to develop up to 500MW of solar. The US Agency for International Development (USAID) is supporting projects equivalent to the generation of 300MW of solar (Metehara, Mekele, and Humera), 1,700MW of hydro (Tams), and 1000MW of geothermal (Corbetti and Tulu Moye/Abaya).

The Government is also pursuing public–private partnerships (PPPs) and encouraging private sector participation in the electricity sector. A significant step towards achieving this was the ratification by the Ethiopian Parliament of a comprehensive PPP Proclamation on 25 January 2018. This will provide a framework for the private sector to engage in providing finance for the country's infrastructure systems.[18] PPPs in the sector are typically represented by independent power producers (IPPs). Mulugetta *et al.* (2018) note that Ethiopia will be able to draw on international experience in developing IPP projects in deregulated electricity markets, as well as vertically integrated state-owned utilities. The focus on broadening out its avenues for funding through PPPs will be especially relevant as Ethiopia seeks to position itself as the power hub in the East Africa Power Pool.

Ethiopia's businesses remain hamstrung by the poor reliability of the electricity system

The reliability of Ethiopia's electricity supply remains a major problem. WBES (2015) reports on the business operating environment of 848 Ethiopian firms (which include those in manufacturing, retail, wholesale, IT, hotels, and restaurants). The survey shows that 80% of Ethiopian manufacturing and retail firms experience electrical outages, which is above the regional average of 78.7%. There are 8.2 electrical outages in a typical month, with an average outage duration lasting 5.8 hours.

Almost half of Ethiopian firms surveyed in WBES (2015) own or share a generator. Of the firms who own or share a generator, almost half (48.9%) of their electricity supply comes from a generator, compared to the sub-Saharan average of 28.2% reliance on generator electricity. The effect is disproportionately felt by small Ethiopian firms, who rely on 62.4% of their electricity supply coming from generators. A high degree of reliance on generators is challenging for firms due to the electricity produced from generators being significantly more expensive than grid electricity.

Results from WBES (2015) suggest average losses due to electrical outages equate to 6.9% of annual sales among large firms, which, although below the sub-Saharan African average (8.3%), is significant. The private sector therefore requires a reliable electricity supply; if it does not have such a supply this will result in increased costs, reduced profitability, and further disruptions to production. Moving forward, tackling this challenge will require rehabilitating the transmission and distribution system. Efficient planning and operation/maintenance of the grid must be undertaken as it is expanded and new connections are added to keep up with new generation (Power Africa, 2018)[19] [20].

[15] www.iea.org/statistics/statisticssearch/report/?country=Ethiopia&product=electricityandheat
[16] www.usaid.gov/sites/default/files/documents/1860/EthiopiaCountryFactSheet_2016.09%20FINAL_0.pdf
[17] www.usaid.gov/sites/default/files/documents/1860/EthiopiaPACFS_3-13-2018_1.pdf
[18] www.mofed.gov.et/documents/20182/46908/PPP+Proclamation+English++final.pdf/bb25bdd6-22f8-415d-9438-f4c403d8032e
[19] www.usaid.gov/sites/default/files/documents/1860/EthiopiaPACFS_3-13-2018_1.pdf
[20] Power Africa is a USAID program working with partners to increase access to power in sub-Saharan Africa. https://www.usaid.gov/powerafrica

Ethiopia's electricity tariffs are amongst the lowest in the world, but are not cost-reflective

The current average flat rate of electricity tariff charged to consumers is around 0.5203 birr/kwh (equivalent to about 0.02 $/kWh) and was last revised in 2006. This is far lower than the cost of service provision and does not enable the national utility to engage in full cost recovery of operating expenditures (Mulugetta *et al.*, 2018). While the Government of Ethiopia justifies the flat tariff levels on the grounds of fairness across customers and affordability, these low levels pose challenges. The lack of full-cost recovery results in reduced maintenance of existing systems and leads to poor electricity service delivery, which in turn makes it difficult for the sector to keep up with rising levels of electricity consumption across all sectors (see Figure 6). A draft tariff framework has been proposed by the electricity utilities which suggests a tariff of 0.06–0.07$/kWh to reflect the full cost recovery.[21] The framework proposes the option of adjustments every four years to reflect market conditions. The framework is being reviewed by EEU and EEP management as well as the regulator (the Ethiopian Energy Authority (EEA)).

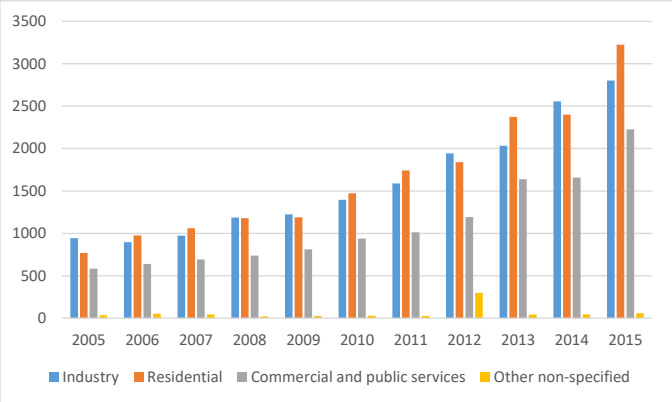


Figure 6. Sectoral breakdown of Ethiopia's electricity consumption in GWh, 2005–2015. Data from IEA (2015) [22]

Looking forward – EEG's country programme of work in Ethiopia

EEG is engaging with a wide range of stakeholders, including government officials, donors, academics, and other entities overseeing and operating in Ethiopia's electricity sector. In so doing, the following priority areas have been identified: enabling agro-linked and industrial uses of electricity; linking electricity tariff structures with user behaviour; strengthening the utility's capacity to link commercial data to electricity planning; and exploring the barriers to and opportunities for increased private sector participation in the Ethiopian electricity sector. EEG intends to develop a country programme of work which will foster research in these priority areas to ultimately enable the sector to tackle some of the major challenges discussed in this report.

[21] http://documents.worldbank.org/curated/en/347061503651051401/pdf/Ethiopia-ELEAP-Concept-Stage-PID.pdf
[22] www.iea.org/statistics/statisticssearch/report/?country=Ethiopia&product=electricityandheat

About the author

Ashira Perera was awarded her PhD in Development Economics from the University of Nottingham, U.K., in 2016. Her doctoral research focused on exploring the rural collective coping strategies used to mitigate environmental risk in Sri Lanka. This involved using quantitative, qualitative and behavioural experimental research methods.

Ashira joined Oxford Policy Management (OPM) in September 2016 and her professional experience there has included providing analytical and research expertise on EEG relating to the institutional mechanisms around energy planning, designing energy planning stakeholder surveys, and contributing to EEG's Energy Insight Series. Ashira has also contributed technically to extractives governance projects and reviews in Kenya, Tanzania and Uganda. She is currently Programme Manager on the £15 million DFID-funded Ghana Oil and Gas for Inclusive Growth (GOGIG) programme which engages in regulatory reforms that also encompass the energy sector. She has also worked as Emerging Asia Economist at Capital Economics (U.K.), and in the Sri Lankan NGO sector.

Front cover image: ERIC LAFFORGUE / Alamy