British International Investment

Evidence review

Insight

How does investing in electricity support inclusion?

Practical thinking on investing for development

Insight is a series of practical and digestible lessons on the issues of private sector investment and development. They're based on our experiences, knowledge and research and are aimed at investors, businesses, development professionals, and anyone with an interest in private sector development.

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Report authors
Greencroft Economics

BII Lead
Hayat Abdulahi

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Foreword

Globally, an estimated 1-3 billion people live with unreliable or poor-quality electricity. In sub-Saharan Africa, 600 million people do not have access to power. Access to reliable, affordable, and quality electricity is not only a key enabler of economic growth but also a cornerstone in lifting millions from poverty, enhancing livelihoods, and empowering marginalised groups, including women. It enables more efficient business operations and enhances productivity, as well as better access to healthcare, education and much more.

At BII, power infrastructure is one of the key sectors we invest in. In 2023, our portfolio generated 59 terawatt hours of electricity, equivalent to 18 per cent of the total electricity generated in the UK in 2022.

Our investments span various types of power infrastructure, from large-scale projects like the Benban Solar Park in Egypt – one of the world's largest solar parks, visible from space – to off-grid solar energy companies like Lumos in Nigeria, which provides solar home systems to families and businesses, often granting them access to power for the first time.

Inclusion is a priority for us. We aim to ensure our investment reaches those most in need. Our latest study explores the complex relationship between large-scale power sector investments and improved inclusion in the countries where we invest. It examines the potential to enhance poverty alleviation and living standards for women, and people living on less than $6.85 per day, (based on 2017 purchasing power parity) through utility-scale generation, commercial and industrial embedded generation, transmission and distribution, and smart metering.

The findings presented in this report offer critical insights into how different dimensions of power access—whether in terms of availability, reliability, or affordability—affect the financial and social well-being of individuals, households, and firms in low-income and emerging economies. With over 675 million people lacking access to electricity and over three billion living below $6.85 per day, much of the evidence gathered here underscores the importance of both improving access to power and enhancing the quality of existing electricity supply, especially in rural and underserved regions.

We hope that this study will contribute towards the ongoing dialogue on energy access, poverty reduction, and sustainable development. It not only reinforces the need for increased investment in energy infrastructure but also serves as a guide for policymakers and impact investors committed to driving inclusive, long-term growth in some of the world's most vulnerable regions.

Hayat Abdulahi

Head of Impact for Infrastructure and Climate Investments
British International Investment

Contents

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Disclaimer

Contacts

For questions, please contact Hayat Abdulahi, Head of Impact for Infrastructure and Climate Investments, at habdulahi@bii.co.uk

Abbreviations

BII	British International Investment
DFI	Development finance institution
ESMAP	Energy Sector Management Assistance Programme
GDP	Gross domestic product
GW	Gigawatt
ICT	Information and communication technologies
MTF	Multi-tier framework
PPP	Purchasing power parity
PV	Photovoltaics
REP	Rural Electrification Programme
SAIDI	System average interruptions duration index
SAIFI	System average interruptions frequency index
SDG	Sustainable Development Goal
SHS	Solar home system
SME	Small and medium enterprises
T&D	Transmission and distribution
WTP	Willingness to pay

Executive summary

Objectives and scope

This study explores the relationship between large-scale power sector investments and inclusive outcomes in BII investment countries. It looks at the potential to improve poverty and standard of living outcomes for women and people living on less than $6.85 per day, based on 2017 purchasing power parity (PPP), through utility-scale generation, commercial and industrial embedded generation, transmission and distribution, and smart metering. While it focuses on large-scale power, much of the evidence on inclusive outcomes comes from small-scale distributed energy projects.

It considers three key impact mechanisms: power access, reliability, and affordability. Improving access is a priority for the 675 million people without electricity worldwide, with most living in rural areas in sub-Saharan Africa. Improving power reliability could improve the outcomes for between 1-3 billion people with low-quality power supply, most living in emerging economies in both urban and rural communities. The affordability of power is also important, given energy often makes up a significant share of the budget for people living in poverty, and for women.

One of the key pathways to inclusive outcomes is through firms and employment. This study looks at both the impacts of improving the electricity supply to (1) individuals and households, and (2) firms and workers. Improved electricity supply to firms and workers can have substantial impacts on financial poverty – that is as measured by income per day – in the short-term. Larger transformation in outcomes can be achieved in the longer term through structural economic shifts.

Key findings

F1 While there has been substantial progress in reducing *extreme* poverty, most people in BII target countries still live in poverty. The global incidence of extreme poverty – people living on less than $2.15 per day (2017 PPP) – fell from 38 per cent in 1990 to 9 per cent by 2019. Nonetheless, in some regions extreme poverty remains high, particularly in sub-Saharan Africa (35 per cent). Many of those who have escaped extreme poverty still live under $6.85 (2017 PPP) per day. Indeed, across BII investment-eligible countries, 75 per cent of the population – three billion people – live in poverty.

F2 In countries with low access to power, extreme poverty tends to be higher. Extreme poverty is concentrated in countries highly dependent on agriculture and subsistence farming, and in rural communities which do not yet have access to power; such as Burundi, Zimbabwe and Rwanda, which all have substantial populations living under $2.15 per day.

F3 Increasing access to electricity improves living standards, but access alone has a muted impact on financial poverty. Improving access to energy technologies can improve livelihoods by improving health and safety, education, time use, and empowerment. However, these improvements are hard to monetise for people living in extreme poverty. The impact on financial poverty is dependent on contextual factors, such as proximity to roads, markets or financial services. Improving access alone is unlikely to drive changes in income or employment, particularly where ability or willingness to pay for electricity-intensive appliances is low.

F4 Many people living in poverty have access to power, but suffer frequent outages. In India and Bangladesh, more than 80 per cent of the population both have access to power and live in poverty. In Nigeria, Ethiopia, Rwanda and South Africa, between 40 per cent and 60 per cent of the population have access to power and yet remain in poverty. In these countries, more poor people will benefit from improving the quality of access than from rolling out new connections, although those currently without a connection are likely to be the poorest.

675m

people worldwide do not have access to electricity.

1-3bn

people worldwide have low-quality power supply.

75%

Across the countries where we invest, 75 per cent of the population – three billion people – live in poverty.

F5 High quality power supply is the key driver of both short- and long-term transformation of employment and incomes. Reliable power is a binding constraint for higher productivity that cannot be substituted by other factors of production. In the short term, reliable power for manufacturing delivers substantial cost reductions associated with reducing backup generation usage, or increases output, revenue, and labour productivity for firms that do not have access to a generator set (genset). In the longer term, the benefits of reliable power supply are several times larger than in the short term, as economies transform with higher rates of capital formation and a shift to higher productivity activities.

F6 While affordability matters, it is a second order priority after reliability. Firms have both high stated and revealed preference for reliable power supply that tend to exceed the cost of unit electricity tariffs. While firms react to an increase in the cost of power by reducing output and shifting to less energy-intensive production methods, this effect is small compared to the positive impacts of improving reliability. Poor households do not change consumption much in response to price changes, so while affordable tariffs improve welfare by freeing up resources that can be spent on other goods and services, they do not immediately result in substantial changes in how households use their electricity access.

F7 Over the longer term, power supply is a key enabler of economic and societal transformation that may improve outcomes for women. While the short-term impacts on female employment are constrained by sociocultural norms, over the longer term, increasing the education level of girls, reducing the reliance on physical labour, and changing societal norms and female empowerment can all be supported by improved power supply.

Recommendations

R1 Impact investors should be explicit about recognising trade-offs between improving wellbeing and reducing financial poverty. There are trade-offs in improving outcomes for those who don't have access to power – often the extreme poor, and those living on less than $6.85 per day and who have access to low quality power. Improving living standards through access for women and poor people is an important objective in its own right, but may be less transformational in terms of lifting people out of financial poverty than ensuring a high-quality and reliable power supply to less poor, but still in poverty, households and firms.

R2 To reduce financial poverty, investments should prioritise improving quality of power supply to people living on less than $6.85 per day, in higher energy access contexts. Countries with high extreme poverty rates or in fragile contexts are less likely to see large power sector projects deliver reductions in poverty in the short term. There is higher potential to deliver improvements in financial poverty outcomes where large populations live in poverty, but have the beginnings of a well-functioning power system and increasing economic opportunities which can reinforce demand for power and boost productivity. In these settings, DFI-type investments can deliver inclusive outcomes by raising reliability up to minimum service levels, thereby providing firms and households with confidence to invest in higher-productivity, capital-intensive activities.

R3 Further research should explore enabling factors to maximise the inclusive benefits of power access, with a focus on outcomes for women. Delivering improvements in financial poverty and standards of living will need a combination of both small-scale distributed energy and grid infrastructure. The conditions under which different technologies are most effective should be researched further, with a focus on synergies between power supply, road access, access to markets, and broader economic reforms. This study finds strong evidence of the impact of power sector investments on people living in poverty, but much less detail on how improved power can deliver better outcomes for women.

1

Introduction

1.1. Objectives of this study

The aim of this study is to better understand the evidence for how power sector investments can deliver inclusive outcomes. It explores how various types of power sector investments could deliver improved outcomes for people living in poverty and women, and what conditions are needed for these improved outcomes to be realised. The main purpose is to summarise the breadth and depth of evidence on the relationships between power supply and inclusive outcomes, including highlighting where evidence is relatively less strong or less available.

The focus is on countries where most of the world's poor live. The review focuses on sub-Saharan Africa and South Asia, which contain the most people still living in poverty and represent the main focus of BII investments.

Three impact mechanisms are explored: improved access, reliability, and affordability of power. Outcomes are defined at the level of households or individuals, through access to electricity in the home or through employment as workers in firms which benefit from improved electricity service provision.

A secondary focus is on short-term changes in inclusive outcomes versus the potential for longer-term structural transformation. The short-term impact pathway draws on a relatively rich microeconomic and impact evaluation evidence base, while the long-term impact pathway draws mainly on macroeconomic literature and predictive modelling.

The inputs to this study are a literature review, guided by interviews with academics and practitioners. Over 100 academic publications and grey literature were reviewed, guided by and reinforced by expert interviews and review from experts within the BII team and from external reviewers.

The aim of this study is to better understand the evidence for how power sector investments can deliver inclusive outcomes.

The study focuses on direct users of electricity; it does not explore impacts on local communities living near power project sites, nor the benefits of electrifying public institutions. The focus of this study is on the impact on those directly using electricity either through new connections or from improving service for existing customers. It does not consider impacts on communities where projects are developed, where for example the localised benefits in terms of access to power or job creation from solar PV plants may be limited.[1] It also does not explore electrification of public services such as health centres, schools, or street lighting.

Project design to maximise inclusive outcomes is also not discussed. There are ways to tailor project design and implementation to enhance inclusive outcomes. For example, including contractual clauses to target specific end user groups, or involving beneficiary communities in design and implementation. This study focuses on the broader potential for power sector investments to deliver inclusive outcomes, and on the conditions which are beyond the project developer or investor's control which may affect the extent to which inclusive outcomes can be realised. It then looks at contextual factors that might influence the potential for power sector projects to deliver inclusive outcomes in different country contexts.

1.2. Research questions

The evidence review is organised around five research questions, to test hypotheses on how people living in poverty or women benefit from improved access, reliability, or affordability of electricity.

RQ1 To what extent do people living in poverty have access to electricity networks?

RQ2 To what extent and how do people living in poverty benefit from improved reliability of electricity?

RQ3 To what extent and how do people living in poverty benefit from improved affordability of electricity services?

RQ4 Do women benefit more than men from improved access to, reliability, or affordability of electricity?

RQ5 To what extent can power sector investments deliver different types of inclusive outcomes and what are the key trade-offs?

1.3. Structure

The report is structured as follows:

- Section 2 explains the focus on inclusive outcomes of access to, reliability of and affordability of power, and proposes a framework to map the impact of power sector projects to inclusive outcomes.
- Section 3 summarises the approach to the literature review, and provides summary statistics alongside a high-level assessment of the breadth and depth of the evidence.
- Section 4 details evidence on short-term and longer-term impacts for each of the three impact mechanisms (access, reliability, affordability).
- Section 5 discusses national contextual factors to help unpick what type of markets, and what type of power sector investments, are most likely to deliver inclusive outcomes.
- Section 6 returns to the research questions and summarises key findings.
- Annex 1 contains illustrative country case studies for Bangladesh, Kenya, Nigeria and South Africa.
- Annex 2 provides a bibliography of the literature used in this review.

1 See Brunet (2022), "Does solar energy reduce poverty or increase energy security? A comparative analysis of sustainability impacts of on-grid power plants in Burkina Faso, Madagascar, Morocco, Rwanda, Senegal, and South Africa".

2

Inclusive outcomes and power markets

2.1. Economic development and inclusive outcomes

The world has made significant strides towards eliminating extreme poverty since 1990. Between 1990 and 2019, the number of people living in extreme poverty – under $2.15 per day (2017 PPP) – fell from 38 per cent to 9 per cent.[2] A significant share of this reduction has been delivered by China, which went from 750 million people living in extreme poverty in 1990, to almost none today. However, in some regions extreme poverty remains stubbornly high – at over 35 per cent in sub-Saharan Africa, for example.

Many of those who have escaped extreme poverty live just above the threshold,[3] with almost half of the world's population still in poverty. Across BII investment countries, 75 per cent of the population – three billion people – live on less than $6.85 per day (2017 PPP). In many countries in Africa, such as the Democratic Republic of Congo, Ethiopia, Kenya, Nigeria, Rwanda, over 90 per cent of the population live under $6.85 per day.

While extreme poverty is largely a rural phenomenon, large shares of the population continue to live on less than $6.85 per day in both urban and rural areas. The poorest of the poor tend to be concentrated in rural areas,[4] where access to power is also most limited. While living in an urban area is correlated with higher welfare it by no means guarantees a route out of poverty for all; a billion people live in urban slums or slum-like conditions.[5,6] Urban poverty is often overlooked or underestimated, and higher average incomes in urban regions mask high inequality in towns and cities.

35%

of people in sub-Saharan Africa live in extreme poverty.

2 Data from the World Bank poverty indicators available at https://data.worldbank.org/topic/poverty

3 Olivier de Schutter (2022), "Changer de Boussole – la croissance ne vaincra pas la pauvrété"

4 Castaneda, et al., (2016), "Who Are the Poor in the Developing World?", available at https://openknowledge.worldbank.org/entities/publication/40d87ffe-db7d-5dd6-a2fd-faa0a6e94f53

5 Castañeda, et al., (2018), "A New Profile of the Global Poor", available at https://www.sciencedirect.com/science/article/pii/S0305750X17302735

6 Hatcher (2024), "Why Urban Poverty is Underestimated and Misunderstood", available at https://www.helvetas.org/en/switzerland/how-you-can-help/follow-us/blog/urban-engagement/why-urban-poverty-is-underestimated-and-misunderstood

Girls and young women are particularly exposed to poverty.[7] More women live in poverty than men; for example in sub-Saharan Africa, 127 women aged 25-34 live in extreme poverty for every 100 men.[8] In electrified areas, women tend to have less access to information and communication technologies, limiting access to services and work opportunities. While women play a key role in small-scale agriculture, they have limited access to labour-saving and productive technologies, coupled with low access to consumer financing. Women entrepreneurs tend to run smaller and more informal businesses and are less represented in high-electricity intensity sectors such as manufacturing. For the urban poor, women are over-represented in informal activities and lowest paid activities such as home based and domestic services.[9]

Girls and young women are particularly exposed to poverty.

Poverty is multi-dimensional – wellbeing should not be reduced only to a financial metric. While headline poverty metrics often track the number of people living below a dollar-per-day threshold, human wellbeing and life satisfaction is affected by a multitude of factors. Since the 1990s there has been increasing focus on more holistic approaches to measuring wellbeing, such as the UN Human Development Index since 1990 and the UN Multi-Dimensional Poverty Index since 2011, which tracks ten indicators spanning education, health, and living standards. There are also gender-specific metrics and indexes, such as the UN Gender Development Index since 2014, and the Gender Social Norms Index since 2019. While much of the discussion of this report will focus on financial poverty, improving standards of living across a much wider range of outcome metrics is important, and is noted where possible.

Inclusive outcomes are a goal in and of themselves and social inclusion can unlock higher economic growth. Inclusion is embedded throughout the Sustainable Development Goals (SDGs), for example in: SDG1 – No Poverty, SDG5 – Gender Equality, SDG10 – Reducing Inequalities. However, market-based economics suggests there may be a trade-off between equity and efficiency. The classical economic argument suggests we "*can't have our cake of market efficiency and share it equally*";[10] in order to provide economic incentives and rewards for work and innovation, a level of inequality is required. However, there is growing evidence that societies not only prefer a high degree of equality, but that more equal societies can sustain higher rates of economic growth.[11] Societies with better gender equality see faster growth in industries with a high share of female employment,[12] and improved education and employment opportunities for girls and women can drive higher economic growth.[13]

7 Boudet, et al., (2018), "Gender Differences in Poverty and Household Composition through the Life-cycle", available at https://documents1.worldbank.org/curated/en/135731520343670750/pdf/WPS8360.pdf

8 See the UN Women SDG Report regional fact sheets, available at https://www.unwomen.org/en/digital-library/publications/2018/2/gender-equality-in-the-2030-agenda-for-sustainable-development-2018#view

9 See CARE (2017), "Poor Women in Urban India: Issues and Strategies", available at https://www.careindia.org/wp-content/uploads/2017/05/Poor-Women-in-Urban-in-India.pdf

10 See Okun (1975), "Equality and Efficiency: The Big Tradeoff". Brookings Institution Press (Revised Edition 2015).

11 See Ostry, et al., (2019), "Confronting Inequality: How Societies Can Choose Inclusive Growth". Columbia University Press.

12 IMF Working Paper (2020), "Gender Inequality and Economic Growth: Evidence from Industry-Level Data", available at https://www.imf.org/-/media/Files/Publications/WP/2020/English/wpiea2020119-print-pdf.ashx

13 IDS Working Paper (2013), "Gender Equality and Economic Growth: Is there a Win-Win?", available at https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.2040-0209.2013.00417.x

Access to electricity is likely to be a necessary, if not sufficient, condition to eradicate poverty, transform economies and improve livelihoods. While it is challenging to establish a causal relationship between improved access to (or quality of) electricity and economic growth, access to a minimum level of power at some point becomes a binding constraint on growth and development. The US between 1930 and 1960, and India and Bangladesh in the last two decades have seen a rapid increase in access to and quality of power supply, and economic growth and poverty reduction. Brazil's large-scale electrification programme contributed to sectoral transformation and GDP growth and to raising education, income, job opportunities and livelihoods in rural areas.[14] China achieved a dramatic drop in extreme poverty, over the same period that electricity access was rolled out and electricity consumption rose by a factor of four. No country has reached upper-middle- or high-income status without a high rate of electricity access.

2.2. Baseline context of power access for people living in poverty and for women

There are 675 million people without access to electricity worldwide.[15] Of these, 80 per cent live in rural communities, most of them in sub-Saharan Africa.[16] It is highly likely those without access to electricity are among relatively poorer communities.

Many more people live with poor-quality electricity access. There is no single metric to define poor quality power. Estimates of people with a poor-quality power supply range from 1 billion to 3 billion.[17] While some of these will be in rural areas, many will be urban dwellers.

Lack of access, unreliable, or unaffordable power falls heaviest on the poor. The extreme poor often work in low-productivity sectors, mainly agriculture, and have larger household sizes. On top of lower access rates, poorer areas tend to face more power outages, and households and firms are less able to invest in averting infrastructure.[18] Electricity bills are a much larger proportion of low-income household's total expenditure and can come at the cost of food spending.[19]

14 See Perez-Sebastian, et al., (2020), "Electricity Access and Structural Transformation Evidence from Brazil's Electrification", available at https://documents1.worldbank.org/curated/en/728811584105259025/pdf/Electricity-Access-and-Structural-Transformation-Evidence-from-Brazils-Electrification.pdf, and Government of Brazil, "Light for All – A Historic Landmark, 10 million Brazilians out of darkness", https://antigo.mme.gov.br/documents/36122/1003840/Livro+%60%60UM+MARCO+HIST%C3%93RICO+-+10+milh%C3%B5es+de+brasileiros+sa%C3%ADram+da+escurid%C3%A30%60%60+-+Ingl%C3%AAs.pdf/a3d6b1f1-e213-3ff0-648c-fd280c018f3e?version=1.0

15 IEA, IRENA, UN, WB, WHO (2023), "Tracking SDG7 – The Energy Progress Report – 2023" available at https://www.irena.org/Publications/2023/Jun/Tracking-SDG7-2023

16 Ibid.

17 See the Lighting Global (2020), "Off Grid Solar Market Trends Report 2020", available at https://www.esmap.org/off-grid-solar-market-trends-report-2020, and GEAPP (2022) "Transforming a Billion Lives", available at https://energyalliance.org/wp-content/uploads/2022/06/comp_Transforming-a-Billion-Lives-The-Job-Creation-Potential-from-a-Green-Power-Transition-in-the-Energy-Poor-World.pdf

18 Aidoo & Briggs (2019), "Underpowered: Rolling blackouts in Africa disproportionately hurt the poor" available at https://www.cambridge.org/core/journals/african-studies-review/article/underpowered-rolling-blackouts-in-africa-disproportionately-hurt-the-poor/B35E5D296F337DACD18E3BC462B9A7CB

19 See Qeqe (2022), "The Relationship between Electricity Prices and Household Welfare in South Africa", available at https://www.mdpi.com/1996-1073/15/20/7794

Income and location are important determinants of female-headed household access to electricity. Female-headed households are less likely to be connected to electricity networks, driven mostly by their lower income and rural location.[20] In some settings female-headed households may be richer on average, as households are more likely to identify a female head in less poor households and in less poor countries,[21] in which case they may have higher rates of access to electricity. For example, 60 per cent of female-headed households in Ethiopia have access to electricity compared to 27 per cent of male-headed households, driven by the fact that they mainly live in urban areas. In contrast, in Rwanda and Cambodia, female-headed households are primarily in rural areas and have lower access to grid electricity.[22] The poorest types of female-headed households are generally those where a woman lives alone with or without children and no other adults present.[23]

Female-headed households are less likely to be connected to electricity networks, driven mostly by their lower income and rural location.

How men and women use electricity varies widely and is affected by sociocultural norms. In India, use of new access is dominated by men in the household, or by children.[24] Men and women also purchase and use electric appliances differently; female-led households are more likely to have light bulbs and fans in the kitchen, and are more conscious about expenditure and tend to consume less energy, with a strong preference for appliances that improve domestic work and health. However, women often lack the authority to make purchase decisions.[25]

A significant share of the population both has electricity access and lives in poverty. Figure 1 cross-tabulates poverty and electricity access, based on an assumption that the richest are more likely to have access.[26] The top row shows the total electricity access rate, while the second row shows the share of people with access who live under the poverty line of $6.85 a day. The blue bars show people without access to electricity, while the yellow bars show the share of the population with access that live under the poverty line of $6.85 a day and $.215 a day, respectively.

In some countries there is a substantial population connected to the grid and in extreme poverty. In most countries, extreme poverty is likely to be concentrated among populations that do not have access to electricity. In Burundi, Zimbabwe and Rwanda, over 40 per cent of people live on less than $2.15 per day, and it is likely most of these people do not have access to electricity, as the total electricity access rate is relatively low. On the other hand, in South Africa, Kenya, Bangladesh and India – countries with high or almost 100 per cent electricity rates – around 10 per cent of the population both lives in extreme poverty and already has electricity access.

20 Kojima & Trimble (2016), "Making Power Affordable for Africa and Viable for Its Utilities", available at https://openknowledge.worldbank.org/entities/publication/b46ee555-2c90-5f90-a1f4-aa43fae8377d

21 Castaneda, et al., (2016), "Who Are the Poor in the Developing World?", available at https://openknowledge.worldbank.org/entities/publication/40d87ffe-db7d-5dd6-a2fd-faa0a6e94f53

22 ESMAP (2018), "Beyond Connections: Energy Access Diagnostic Report Based on the Multi-Tier Framework", available at Cambodia, Ethiopia, and Rwanda.

23 Saad, et al., (2022), "Paving the way to understanding female-headed households: Variation in household composition across 103 low and middle-income countries", available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9107795/pdf/jogh-12-04038.pdf

24 Rosenberg, et al., (2020), "Gender inequality persists in electricity use".

25 See Das, et al., (2023), "Frameworks, methods and evidence connecting modern domestic energy services and gender empowerment". Nature Energy, 8(5), 435-449, available at https://www.nature.com/articles/s41560-023-01234-7

26 Note, we do not have data that accurately tabulates access to electricity by poverty rates for all countries, so to make these charts we make the assumption that those who are at higher income levels have access to electricity, while those that don't have access to electricity are the poorest in each country. This will not always hold, and is used here as a reasonable assumption, and is conservative in the sense that it gives us the lowest number of people both living in poverty and with access to energy.

While in some countries expanding access is the major priority for people living in poverty, in others improving existing access will be more impactful. In countries like Burundi, electricity access remains very low at around 10 per cent, and the first order priority for people living in poverty will be in increasing connections. However, there are many countries where a significant share of the population has access but poverty persists. For example, almost all Bangladeshis and Indians are connected,[27] yet the vast majority still live on less than $6.85 per day.

There are, of course, many more countries where both increasing access, and improving quality of access, remain a priority. For example, in Ethiopia, Nigeria, and Rwanda, more than 40 per cent of the population does not have access to power, while almost all of those with access also live on less than $6.85 per day.

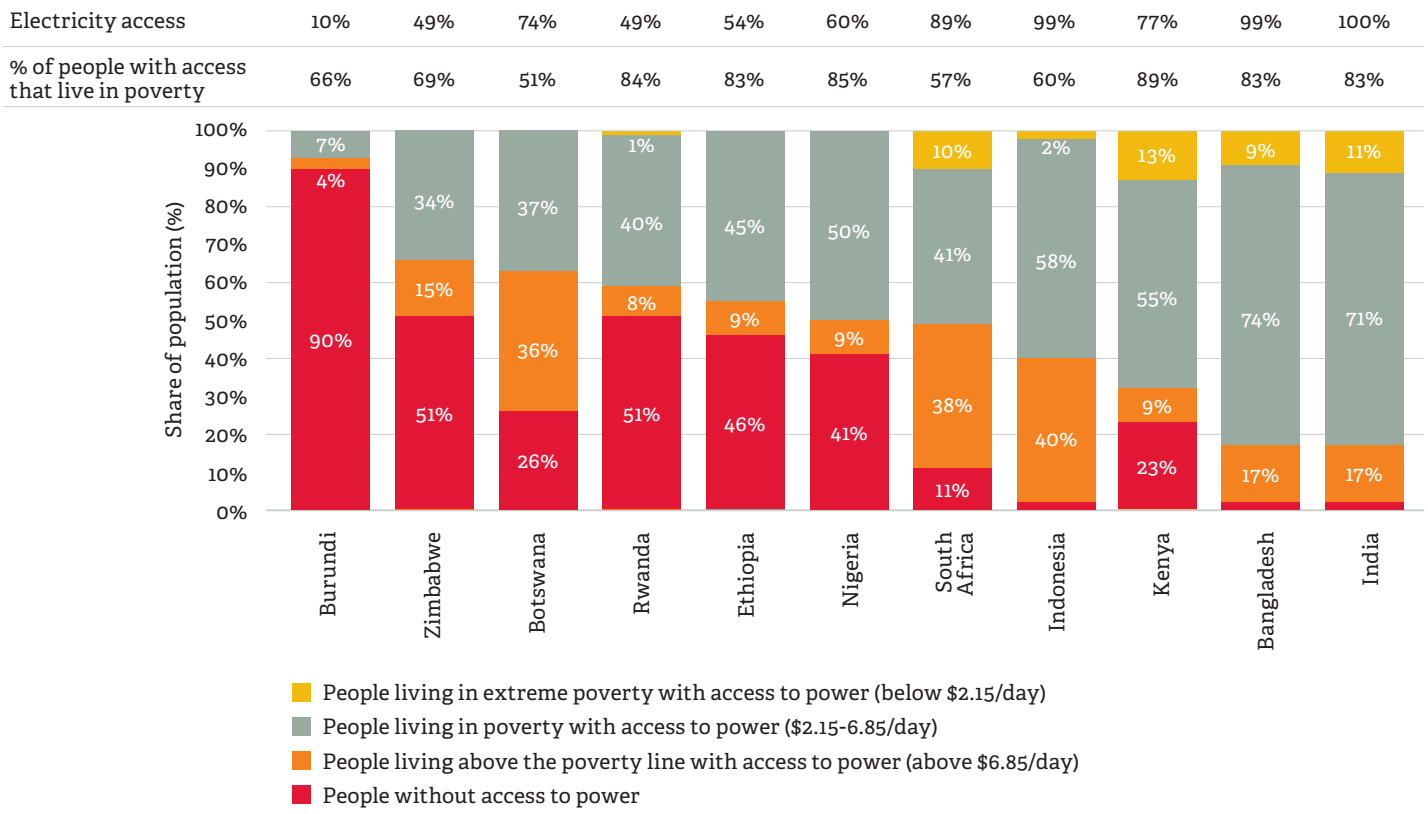


Figure 1: Share of population by poverty and access to electricity
Source: Greencroft analysis of World Bank poverty indicators and SDG7 Tracking electricity access rates by country.

While those living in extreme poverty often depend on agriculture for their livelihood, this is less true for those living on less than $6.85 per day. The extreme poor are highly likely to work in informal agriculture or subsistence agriculture, while the moderate poor are more likely to work in non-agricultural sectors. Taking rural employment as an example, just 24 per cent of the extreme poor work outside of the agriculture sector, while this rises to 40 per cent for the moderately poor.[28]

27 Or at least their village is connected, so network reach is not the issue.

28 Castañeda, et al., (2018) "A New Profile of the Global Poor", available at https://www.sciencedirect.com/science/article/pii/S0305750X17302735

Women workers are over-represented in the services sector, and more likely to be in informal and low-skilled positions. Across BII investment countries, women make up 48 per cent of workers in public administration and services, 40 per cent in agriculture, 37 per cent in manufacturing, but just 6 per cent and 15 per cent in construction and mining, respectively.[29] Women are more much more likely to work in the informal sector or be self-employed, and in lower-paid and lower-skill work.[30,31,32]

Female entrepreneurs tend to operate in less electricity-intensive sectors. Women are globally less likely to be entrepreneurs, except in lower-income countries where they often become micro-entrepreneurs out of economic necessity.[33] They tend to be concentrated in lower productivity sectors and in smaller and less electricity-intensive industries.[34] Female-led SMEs have less access to finance and credit, making it harder to cover costs such as the (often high) connection fee,[35] or to invest in electricity-intensive appliances and production techniques.

2.3. Power sector investment impact pathways

A range of technologies is needed to respond to the challenges of improving access, quality of supply, and affordability of power for people living in poverty and women. For rural communities getting first-time access to clean and modern power supply, distributed renewable energy solutions such as solar home systems may, at least initially, be the most appropriate and lowest-cost solution. Mini-grids are also growing in application, with the potential to provide higher tier access to communities. Expanding and strengthening the quality of the main grid will play a major role, both for those already close to transmission and distribution lines, and over time to provide the higher level of power supply that households want and which many businesses need.

A range of technologies is needed to improve access, quality of supply, and affordability of power for people living in poverty and women.

This study focuses on utility-scale power investments. While the evidence is summarised across large and small power technologies, the focus is on drawing out evidence of the inclusive outcome potential delivered by: (1) utility-scale power generation, (2) transmission and distribution networks, (3) commercial and industrial (C&I) embedded generation, and (4) smart-metering.

Two distinct impact pathways are considered:

- Short-term: through improving outcomes for firms and workers, or for households, for those who have improved access to power compared to those who do not.
- Longer-term structural transformation: operating over the medium to long-term through accelerating economic growth or changing the structure of the economic activity.

29 ILOSTAT, available at https://webapps.ilo.org/shinyapps/bulkexplorer43/?lang=en&id=EMP_TEMP_SEX_ECO_NB_A

30 Pueyo, et al., (2019), "Linking energy access, gender and poverty: A review of the literature on productive uses of energy".

31 UN Women, "Women in the changing world of work – Facts you should know", available at https://interactive.unwomen.org/multimedia/infographic/changingworldofwork/en/index.html

32 ILO (2018), "Women and Men in the Informal Economy: A Statistical Picture", available at https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_626831.pdf

33 Pueyo, et al., (2019), "Linking energy access, gender and poverty: A review of the literature on productive uses of energy".

34 Pueyo, et al., (2019), "Linking energy access, gender and poverty: A review of the literature on productive uses of energy".

35 IFC (2011), "Strengthening Access to Finance for Women-Owned SMEs in Developing Countries", available at https://documents1.worldbank.org/curated/en/101351468156252909/pdf/667610WP00PUBL065805B0Strengthening.pdf

Each impact pathway could operate through three impact mechanisms. As described in Section 1 and summarised in Figure 2 below, these are: (1) access to power, (2) reliability of power, (3) affordability of power.

Power to households can deliver improved standards of living and may help boost incomes. Improvements to standards of living include freeing up time for non-remunerated activities such as unpaid work in and around the home, and leisure activities. Further benefits include improved health and safety, cash savings which can be spent on other goods and services, or improved educational outcomes from access to lighting and information technologies. Financial poverty could be alleviated if improved power supply enables more time to be spent on paid activities, and if power supply opens up access to new income-generating activities, or increases the productivity of time at home to generate income.

Power to households can deliver improved standards of living and may help boost incomes.

Power for firms could be a key driver to reduce financial poverty through higher employment and wages. To drive large-scale reductions in financial poverty, improving access to economic opportunities through improved productivity and access to new jobs is a pre-requisite. This is particularly the case for people living in poverty and women, who often have less access to jobs, or lack the skills and the assets needed to unlock higher-earning opportunities. In the short term, access to reliable and affordable electricity may support investment in and access to capital equipment which raises productivity in low-skill jobs, while over the longer term can support a shift to a higher productivity, higher-skill economy.

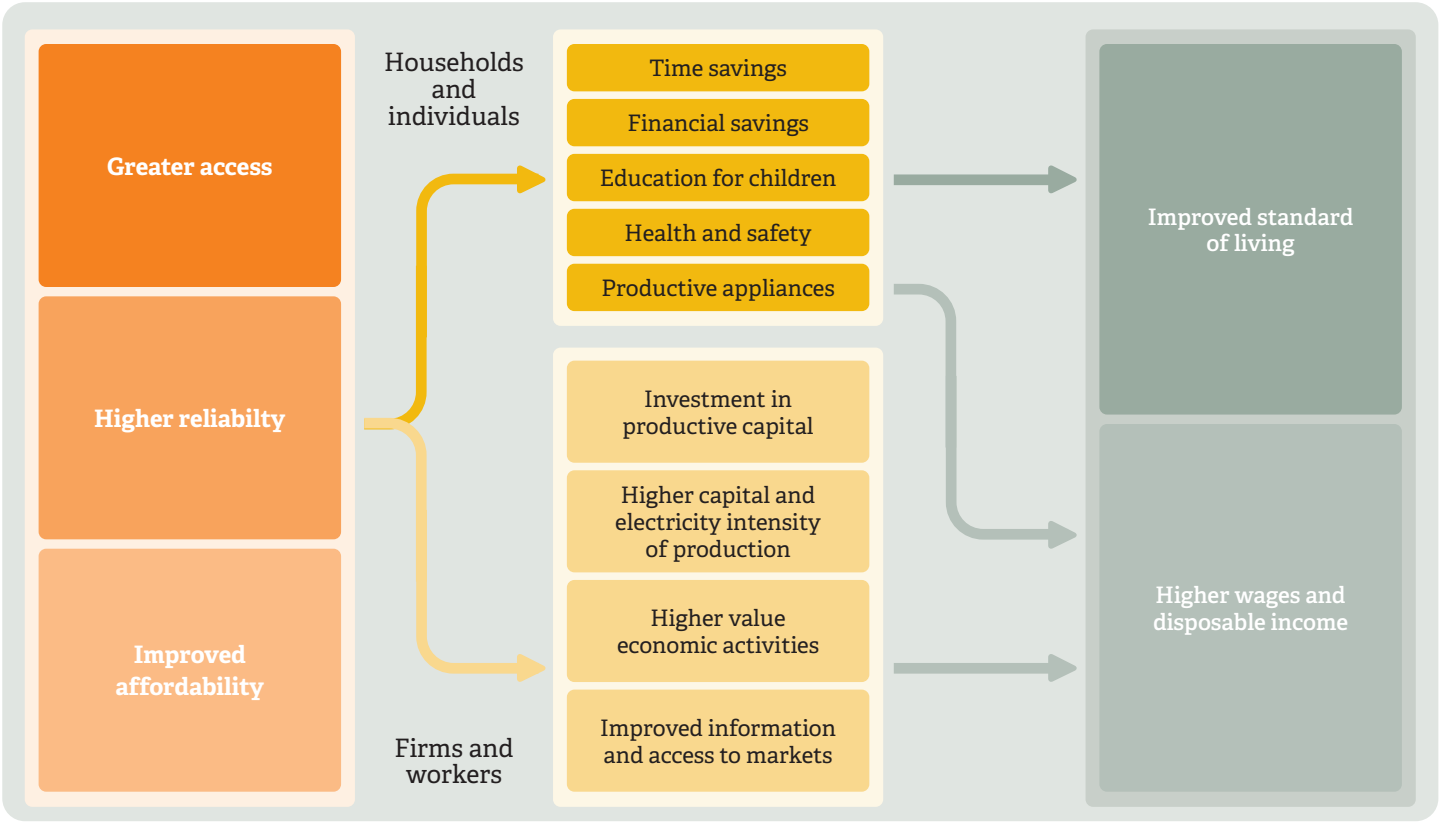


Figure 2: Power sector – short-term impact pathway to delivering inclusive outcomes
Source: Greencroft Economics

In the longer term, inclusive outcomes may be delivered through transformation of the structure of the economy and accelerated growth. As shown in Figure 3, improving the quality of electricity supply may contribute to GDP growth, which can improve the outcomes of women and people living in poverty. It may also change the nature of growth and affect the growth of certain sectors and activities, which may offer opportunities for people living in poverty and women.

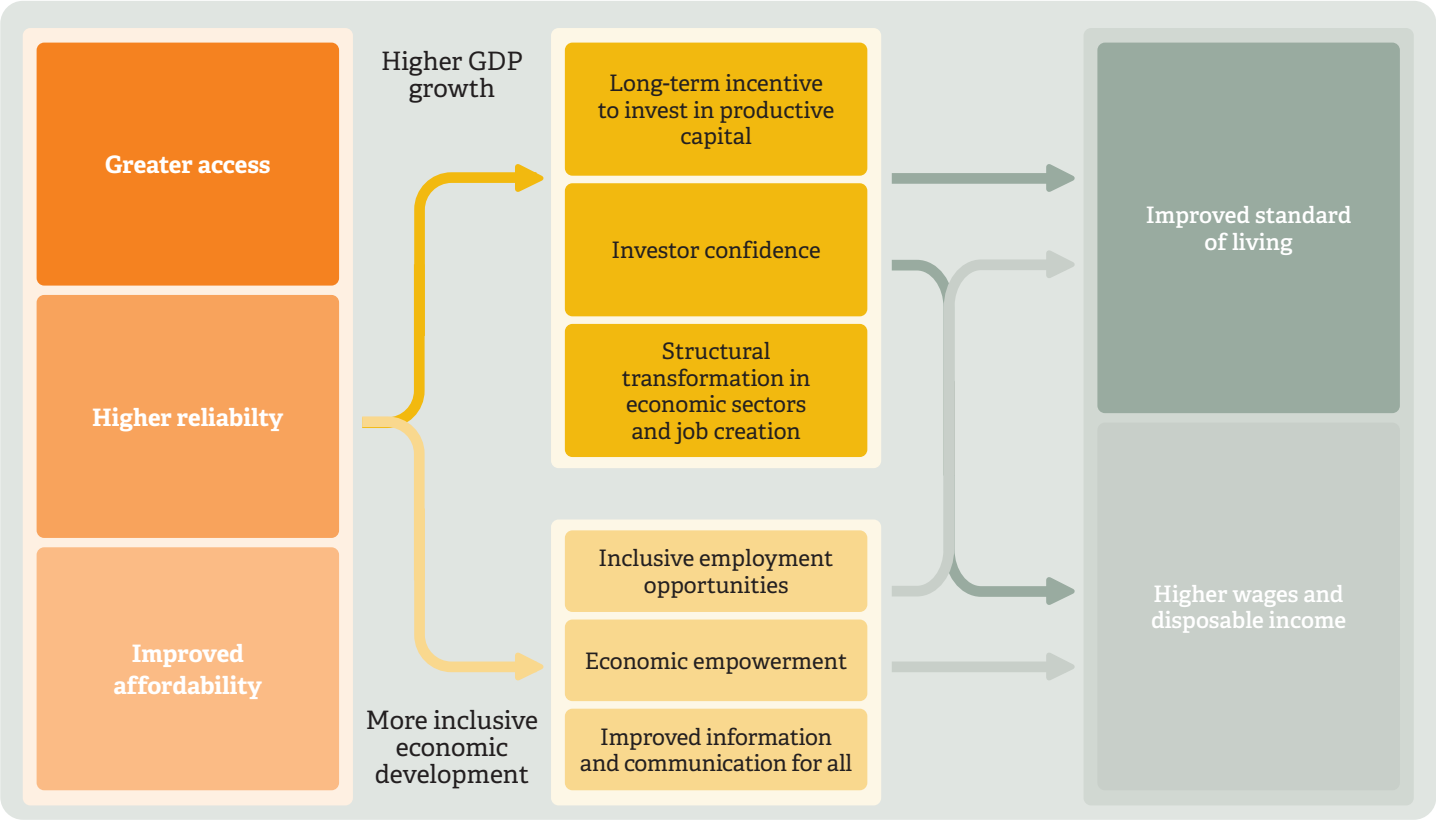


Figure 3: Power sector – longer-term impact pathway to delivering inclusive outcomes
Source: Greencroft Economics

While this study focuses on investment-level inclusive outcomes, system planners should address all three mechanisms as part of an integrated electricity system approach. The three mechanisms are intrinsically linked. An investment to improve reliability may increase costs, which reduces affordability, with different impacts on consumer welfare depending on whether the customer places a higher value on reliability, or on cheaper electricity. Similarly, investment in generating and T&D assets could be used to increase access holding reliability constant, or to boost reliability holding access rates constant (or a balance of the two).

There may be trade-offs between delivering improved outcomes for a large population living on less than $6.85 per day, versus those living in extreme poverty. Power sector investments may have different effects on the 'intensive' and on the 'extensive' margin; between existing connections versus new connections. Rolling out new connections is, at least in the short term, the best way to improve outcomes for the poorest of the poor who do not currently have access to electricity. However, it may deliver limited benefits in terms of economic transformation and improvement in financial poverty outcomes. It may also come at a cost to other poor (albeit less poor) customers, who are already connected but have an unreliable or expensive power supply.

There may be trade-offs between delivering improved outcomes for a large population living on less than $6.85 per day, versus those living in extreme poverty.

As an illustration, reducing theft improves outcomes for people living in poverty with a legal connection, but worsens outcomes for (likely poorer) people with illegal connections. Overhead bundling of cables in Karachi improved reliability for those legally connected to electricity network.[36] However, it reduced usage (and wellbeing) from people previously connecting illegally. Not only is this a useful analogy that illustrates the point on extensive versus intensive margin effects made above, but it also represents a substantial challenge in and of itself in many emerging countries. Electricity theft and meter tampering range from 4.4 per cent in India to 20 per cent in Pakistan, and 30 per cent in Nigeria.[37]

Providing access for all may imply higher costs for those who already have access, or would need some form of subsidisation. While increasing access rates helps on the extensive margin (i.e., by connecting people previously without a connection), it may imply cross-subsidisation by existing customers, as is the case in electricity networks across the world. This may generate disbenefits on the intensive margin (those already connected and consuming). Another risk of increasing connections quickly is that where there is very limited ability or willingness to pay for consumption, utilities may face financial challenges as they face higher marginal cost to serve and lower marginal revenue generation. See the example of Kenya's grid rollout described in Annex A1.2.

36 Meeks, et al., (2023), "The Economic and Environmental Effects of Making Electricity Infrastructure Excludable"

37 Clou (2023), "Meter tampering: The major cause of non-technical losses", available at https://www.smart-energy.com/industry-sectors/smart-meters/meter-tampering-the-major-cause-of-non-technical-losses/

3

Overview of evidence

3.1. Summary of literature review approach

Literature was identified building out from a core reference list and through consultations with experts. Over half the papers are peer-review academic journal publications, with the remainder working papers and grey literature. To determine relevance, each paper is tagged against each impact mechanism. Half of the papers reviewed are 'highly' relevant and a third 'medium', while the remainder of papers provide useful context but do not make a major direct contribution to answering the research questions.

Six proxies were identified which appear in the impact literature and may relate to inclusive outcomes. There is limited evidence speaking directly to the impact of power sector investments on women and people living in poverty. Therefore, proxy indicators were considered to allow a more flexible mapping of the evidence to attributes that may relate to people living in poverty and women. These indicators include:

- Urban versus rural: there is a higher incidence of poverty in rural settings, and the potential for power sector projects will differ in urban compared to rural settings.
- Sector of employment: the poor are over-represented in agriculture and labour-intensive (low skill) manufacturing, while women are over-represented in small-scale agriculture and service and hospitality sectors.
- Employment formality: people living in poverty often work (entirely or partly) in informal labour markets.
- Skill-level: poorer households tend to have lower formal skill levels. In the short term, improving the prospects of low-skill workers may be important to reduce poverty, while in the longer-term creating better access to higher skill work.
- Labour intensity: high concentration of work for poorer people in labour-intensive sectors.
- Size of business: women and poor are both over-represented in small-scale businesses.

To evaluate the overall strength of evidence, each paper was assessed against its unique quantitative contribution. Each paper was categorised according to its contribution to evidencing each of the two impact pathways (short term and long term), and the three impact mechanisms (access, reliability, and affordability). For papers providing quantitative estimates, each was assessed to determine its unique contribution to the research question and impact mechanisms, to avoid double counting or overstating the extent of academic evidence.

There is more evidence on short-term impacts than on longer-term structural transformation. A third of the papers consisted of meta-studies, which are not generating new evidence, but review existing studies. Most studies focus on short-term impacts; 53 studies against 15 longer-term structural transformation studies.

There is a clear geographic focus on sub-Saharan Africa in the literature. Almost 60 per cent of the papers assessed focus on the sub-Saharan Africa region. One-third of the papers focus on Asia, and 3 per cent on Central and South America.

	Studies	Access	Reliability	Affordability
Total papers				
Short-term	55	26	27	10
Longer-term structural transformation	15	6	10	4
Meta	34	23	13	11
Total	104	55	50	25
Unique quant contribution				
Short-term	54	25	27	10
Longer-term structural transformation	11	5	7	2
Total	65	30	34	12

Figure 4: Overview of evidence by impact pathway
Source: Greencroft Economics.
Note: The three columns for access, reliability, and affordability do not sum to the total number of studies, as papers may cover more than one of the three mechanisms.

3.2. Overview of evidence by impact pathway and mechanism

There is limited evidence explicitly breaking out the impact of power access, reliability, or affordability by poverty level. As summarised in Figure 5, while lots of papers look at impacts on households or on firms in a range of different geographical contexts, very few explicitly collect data and report according to poverty level of beneficiaries. Much of this literature is highly relevant given the context of the study, where there is likely to be a high share of people living under $6.85, but empirical evidence explicitly breaking down impacts by poverty level is limited.

There is much less impact evidence breaking down access, reliability or affordability by gender. While there is a relatively rich amount of literature exploring how energy may empower and improve outcomes for women, there is relatively less empirical data that separates the impact of improved access, reliability, or affordability specifically for women. Even where there are papers, the findings are often inconclusive or inconsistent across studies (see Section 4).

This paucity of evidence on power and gender impacts reflects both data limitations and the challenges of identifying impacts. Only recently has data disaggregated by gender become more available on energy access and consumption patterns, through for example the ESMAP energy access diagnostic reports. While data collection increasingly disaggregates by gender, such as the share of female-headed households with access to electricity, there remain large data gaps with sparse indicators typically only available for comparison across a handful of countries.[38] The papers explicitly researching the relationship between electricity and gender are often grey literature and use anecdotal or interview-based evidence.

There is a larger body of evidence on the importance of reliability than of affordability. While the evidence on the impact of first-time access to electricity is for some impact types ambiguous (represented by grey bubbles), for reliability it is almost always positive. For affordability, the extent and direction of evidence is slightly weaker.

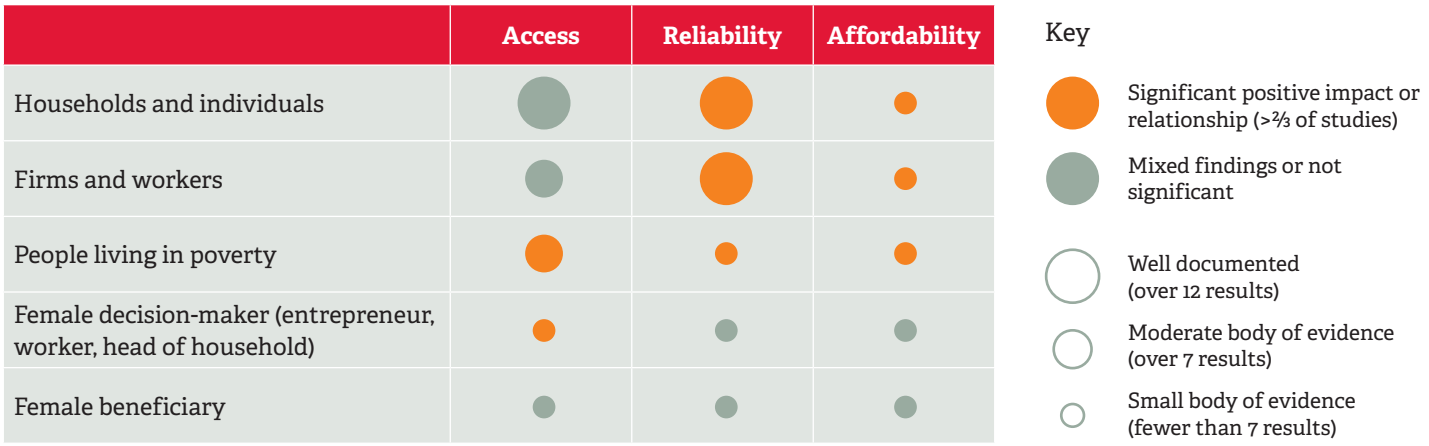


Figure 5: Overview of evidence by impact type
Source: Greencroft Economics.
Note: [1] The size of the circle does not represent the size of the effect or impact, but rather the number of studies reviewed that produce a finding in this category. [2] The size of the grey bubbles represents how many papers were read for that impact type.

3.3. Limitations and caveats in the literature review

While two-thirds of the papers use quantitative evidence, they often rely on the same underlying data. For example, when assessing the impacts of reliability, most papers rely on the same underlying data from the World Bank Enterprise Surveys, which consists in most countries of a cross-sectional data set, not always collected for all countries in all years. This means much of the findings are based on the same data, with the same limitations to that data, and without triangulation from studies confirming similar findings using different datasets.

For reliability, measurement matters and there are weaknesses in commonly used reliability metrics. Many papers rely on data on 'system average interruption duration index' (SAIDI) or the 'system average Interruption frequency index' (SAIFI). However, the reliability of SAIDI and SAIFI recorded by utilities is low in low-income countries; there can be significant variation in the calculation of these metrics when using different data sets.[39] While there are alternative datapoints – for example Afrobarometer surveys – these are typically incomplete in terms of providing a comparable cross-section of countries over time and present significant and systematic bias in the self-reporting.[40] There are recent innovations to allow more granular measurement of reliability, for example using nLine sensors,[41] but these are too recent to allow for large-scale studies and cross-country comparison.

38 The Market Classification Dashboard has collected the ESMAP gender data.

39 Taneja (2018), "Measuring Electricity Reliability in Kenya"

40 Seitz, et al., (2023) "Blackout or Blanked Out? Monitoring the Quality of Electricity Service in Developing Countries", available at https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-10423

41 See more at https://blog.nline.io/

When it comes to assessing impact, there is a range of quality – and even the findings of the most methodologically robust have been challenged. For example, while there is lots of qualitative analysis of the positive relationship between power access and end user outcomes – with a large quantity of grey literature supporting this argument – there is a (smaller but arguably higher quality) number of academic papers that does not find such strong positive benefits. Even where robust econometric techniques have been deployed, it often proves difficult to generalise the findings beyond the context of the original study, or there is debate on the strength of the original findings when seeking to replicate them with slightly different data or methodologies.[42]

42 See the Bensch (2020) response to the influential and well-cited Dinkelman (2011) paper: "Effects of Rural Electrification on Employment: A Comment on Dinkelman (2011)", available at https://www.econstor.eu/bitstream/10419/214184/1/1690488735.pdf

4

Evidence by impact pathway

4.1. Short-term impact pathway

4.1.1. Access

The positive impacts of electricity access on the standard of living for poor and rural households are well established. A range of studies find improvements in income generation, education for boys and girls, health and safety improvements, female empowerment and a reduction in gender-based violence from access to even small-scale electricity and lighting. Burgess (2022) finds that consumer surplus is positive from any source of electricity and that grid and off-grid access can deliver similar gains.

The positive impacts of electricity access on the standard of living for poor and rural households are well established.

Box 1: Inclusive outcomes for a rural household living in extreme poverty

Many of these rural households do not have access to electricity. Improving access delivers livelihood benefits, including changing time use across household members and improving safety, health and education for children.

On its own, access is unlikely to drive a shift to higher incomes and bring an escape from financial poverty, and makes only a small difference to asset ownership.

Improving affordability frees up budget for essential goods and services, improving standard of living, but does not drastically alter electricity consumption.

If the household has an electricity connection, it is highly unreliable. Small improvements in reliability may not be enough to drive change, but getting to a minimum service threshold may stimulate demand and offer employment outside of agriculture and the home.

The empirical evidence is mixed on whether increasing access improves financial outcomes for the poor. The Jeuland, et al., (2021) meta review concluded that despite the "*buzz*" around the potential of off-grid solar, energy access is not always "*golden*" and there are trade-offs between "*income and other development (e.g., health or environmental quality)*" outcomes.[43] The Economist also concluded there is limited evidence of entry-level electricity and lighting transforming lives, and that "*solar lamps appear not to rescue people from poverty*".[44] Several academic studies also find negligible impacts.[45] The overall conclusion is that access *alone* is unlikely to drive changes in financial poverty, which would need higher tiers of (reliable) power.

Electricity access alone is unlikely to drive changes in financial poverty – reliability of power is also a factor.

For women, access to electricity may reduce drudgery, free-up time, and improve employment opportunities. Grogan & Sadanand (2012) find that rural electrification in Nicaragua increased the likelihood that women worked outside the home by 23 per cent, with no similar effect on men. Electricity access can also contribute to shifting traditional gender roles. In sub-Saharan Africa, households with electricity report lower incidences of gender-based-violence, due to better access to information through television.[46]

The short-term impact of electricity access on women may be limited unless accompanied by changes in societal norms and ability to access market opportunities. Where traditional gender roles prevail, impact of new access to electricity may be limited. Rosenberg (2020) notes that in some cases "*despite electricity access, most respondents felt less able to do what they wanted*".[47] As described in Section 2.2, the differences in gender roles at the local setting, and between urban and rural regions, will impact the inclusive outcomes that access electricity can have.

Access to power can unlock the benefits of access to other technologies and services such as ICT. Electricity access has a strong effect on ICT usage and the penetration rate of internet and smartphones.[48] This, in turn, can deliver a range of positives impacts, such as access to finance and information, improved job opportunities and productivity. Where gender constraints exist in the household and society, digital-based jobs that can be performed from home can boost female labour force participation.[49]

Electricity access has a strong effect on ICT usage and the penetration rate of internet and smartphones.

As electricity access expands into rural and poorer communities, average electricity consumption tends to reduce at least in the short-term. Lukuyu, et al., (2021) find that new mini-grid customers tend to be low quantity consumers.[50] While consumption increases where there is access to finance to purchase appliances, or when the cost of electricity is reduced, this increase is not sustained and drops after over time. Taneja (2018) notes that "*many newly-connected customers only consume limited amounts of electricity*". In general, the benefits of rolling out access to customers with low ability and willingness to pay may be limited, as they consume little electricity and electricity access alone does not change their income earning potential.

43 Jeuland (2021), "Is energy the golden thread? A systematic review of the impacts of modern and traditional energy use in low- and middle-income countries"

44 The Economist (2019), "Electricity does not change poor lives as much as was thought", available at https://www.economist.com/international/2019/02/09/electricity-does-not-change-poor-lives-as-much-as-was-thought

45 See Wolfram (2018), "Wolfram (2018), Does Solving Energy Poverty Help Solve Poverty? Not Quite", available at http://emiguel.econ.berkeley.edu/wordpress/wp-content/uploads/2018/03/Does-Solving-Energy-Poverty-Help-Solve-Poverty_-Not-Quite-%E2%80%93-Energy-Institute-Blog.pdf, or Burlig & Preonas (2021), "Out of the Darkness and into the Light? Development Effects of Rural Electrification", which finds that after three to five years, while electricity consumption increased after rural electrification in India, other impacts on development outcomes were limited.

46 Sievert (2015), "Rural Electrification and Domestic Violence in Sub-Saharan Africa", available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2706469

47 Rosenberg, et al., (2020), "Gender inequality persists in electricity use"

48 Houngbonon & Quentrec (2019), "Access to Electricity and ICT Usage: A Country-level Assessment on Sub-Saharan Africa", available at https://www.econstor.eu/bitstream/10419/201728/1/ITS2019-Aswan-paper-01.pdf

49 Jalota & Ho (2024), "What Works For Her? How Work-from-Home Jobs Affect Female Labor Force Participation in Urban India", available at https://www.dropbox.com/scl/fo/z3v4gxqpkvc4p9ntjy0ie/h?dl=0&e=1&preview=Jalota_Suhani_WhatWorksForHer.pdf&rlkey=ca71mbrtewdo92exnmop1q0b8

50 Lukuyu, et al., (2021), "Building the supply of demand: Experiments in mini-grid demand stimulation", available at https://www.sciencedirect.com/science/article/pii/S2352728520300129

Access to electricity changes the way firms operate, but in rural settings may not change income levels if local demand remains unchanged. Lenz, et al., (2021) find that grid extension in rural Rwanda results in enterprises extending operating hours and the range of products offered.[51] However, at community level, overall income levels were not affected as aggregate local demand had not changed. So while the distribution of income and expenditure between businesses may change, the impact on overall wage levels and poverty in rural communities may be limited. In Ghana, Akpandjar & Kitchens (2017) find that access to electricity increased total and wage employment and decreased agricultural employment. However, the study did not find evidence that total wages, hours or productivity per worker increased.[52] Fetter & Usmani (2020) find that in villages that produced an external export product, guar,[53] total employment increased following access to electricity, with no effects in other villages.

Manufacturing appears to be the sector most affected by electricity access, as it is an energy-intensive sector with limited ability to substitute for power. Kassem (2021) finds in Indonesia that electricity access significantly increases in the number of manufacturing firms, employment levels in manufacturing, and output levels.[54] More important for manufacturing is the assurance of a reliable power supply (see Section 4.1.2).

Manufacturing appears to be the sector most affected by electricity access, as it is an energy-intensive sector with limited ability to substitute for power.

Electrification can improve formal and wage-based employment opportunities. Meeks (2023) finds that mini-grid roll out in in Nepal increased the number of formal manufacturing establishments, creating employment opportunities and shifting labour away from self-employment and subsistence farming, for both males and females.[55] Electricity access also enables access to ICT for firms, which can increase productivity, by improving coordination and information, for example on pesticides, seeds and fertilisers, improving productivity and yields.[56]

Given the economic sectors in the locations where new electricity access occurs, it is highly likely new electricity access for firms will reach workers living below $6.85 per day. Few studies look at impacts on wage levels directly, and none breaking down by the income level of the employee. Nonetheless, given the high share of the population in BII investment countries living in poverty, it is highly likely that firms gaining new access will employ almost exclusively people living in poverty.

51 Lenz, et al., (2017), "Does Large-Scale Infrastructure Investment Alleviate Poverty? Impacts of Rwanda's Electricity Access Roll-Out Program", available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2621601

52 Akpandjar & Kitchens (2017) "From Darkness to Light: The Effect of Electrification in Ghana, 2000–2010", available at https://www.journals.uchicago.edu/doi/10.1086/693707

53 An input in oil fracking highly demanded by the US.

54 Kassem (2021), "Does Electrification Cause Industrial Development? Grid Expansion and Firm Turnover in Indonesia", available at https://www.crctr224.de/research/discussion-papers/archive/dp052

55 Meeks (2023), Electrification to Grow Manufacturing? Evidence from Mini-grids in Nepal, available at http://www.robynmeeks.com/wp-content/uploads/2023/01/MTW_Off_the_grid__20230113.pdf

56 Casaburi & Kremer (2014), "Harnessing ICT to Increase Agricultural Production: Evidence From Kenya", available at https://arefiles.ucdavis.edu/uploads/filer_public/2014/03/27/casaburi_et_al_ict_agriculture_20140306.pdf

Cole & Fernando (2012), "The Value of Advice: Evidence from Mobile Phone-Based Agricultural Extension", available at https://dash.harvard.edu/handle/1/10007889

Deichmann, et al., (2016), "Will digital technologies transform agriculture in developing countries?", available at https://documents.worldbank.org/en/publication/documents-reports/documentdetail/481581468194054206/will-digital-technologies-transform-agriculture-in-developing-countries

Ogutu, et al., (2014), "Impact of information and communication technology-based market information services on smallholder farm input use and productivity: The case of Kenya", available at https://www.sciencedirect.com/science/article/abs/pii/S0305750X14001703

The benefits through employment for women are less well-established and depend on social and cultural factors. Dinkelman (2011) found that rural electrification in South Africa freed up women's time and led to a substantial increase in female employment and entry into new economic activities. However, women's wages fell in districts where electricity was expanding more rapidly. Das, et al., (2020) find women often undertake the same tasks, but that these can be pushed to evening hours where electricity is available.[57] This situation is mirrored in high-income countries, where as women have entered the workforce they still perform most of the household tasks.[58] As noted in Section 2.2 and in the Bangladesh case study in Annex A1.1, the impact on female employment outcomes is dependent on other factors such as access to labour markets.

Although electricity access can improve firm performance and outcomes for workers, it may be limited in generalisability, or the effects may be relatively small. For example, Bensch (2020) challenges the findings of Dinkelman (2011) and finds non-significant results. Rathi & Vermaak (2018) use South Africa and India as case studies and find that electrification raised incomes for those already in paid work, but that in India both genders worked fewer hours while in South Africa there was no employment effect (although women benefit more from higher earnings).

Households and firms continue to have a strong preference for the grid – including among poorer customers. Even once an off-grid solution is provided, households prefer a grid connection (Wolfram 2016). Preference for the grid is strongly observed even among relatively poor customers; as soon as households have a solid roof they are twice as likely to choose grid over off-grid technologies (Burgess, et al., 2022). What matters is providing a sufficient level and quality of electricity to power higher-load appliances. While distributed renewable energy can support productivity increases, it remains to be seen whether small-scale solutions can provide economy-wide productivity increase in the way that a full grid connection can.[59]

There is broad consensus that access to power is not enough on its own. For example, while Meeks, et al., (2023) find a small but significant impact of electrification on manufacturing sector development, this is only present where the main grid is near.[60] This complements existing research, and our interviews with academics and practitioners, that access to markets and trading centres to sell labour or products are a pre-requisite to unlocking the benefits of electrification.

In summary, the evidence of improving electricity access alone delivering inclusive financial outcomes is weak. While intuitively access to electricity could improve income-generating opportunities for households, there is limited evidence to support this. The impact of expanding electricity access to households is more likely to be in improving standard of living, such as time savings, improved health and safety, improved education, and female empowerment.

57 Das, et al., (2020), "A Virtuous Cycle? Reviewing the evidence on women's empowerment and energy access, frameworks, metrics and methods", available at https://energyaccess.duke.edu/publication/a-virtuous-cycle-reviewing-the-evidence-on-womens-empowerment-and-energy-access-frameworks-metrics-and-methods/

58 OECD (2019), "Employment: Time spent in paid and unpaid work, by sex", available at https://stats.oecd.org/index.aspx?queryid=54757

59 Tier 5 refers to the ESMAP tiers of energy access, defined in ESMAP (2016), "Beyond Connections – Energy Access Redefined", available at https://www.esmap.org/node/56715

60 Meeks (2023), Electrification to Grow Manufacturing? Evidence from Mini-grids in Nepal, available at http://www.robynmeeks.com/wp-content/uploads/2023/01/MTW_Off_the_grid__20230113.pdf

4.1.2. Reliability

People living in poverty are much more likely to have a low-quality electricity connection. Power cuts are more likely to affect poorer communities,[61] because: (1) they are more likely to live in locations with lower quality infrastructure resulting in local distribution network or generation constraints, (2) poorer regions generate less revenue for utilities, so are prioritised for planned outages, (3) they have a less powerful voice in lobbying for improvements. Across a sample of over 30 African countries, 28 per cent of the poorest households report having reliable electricity compared to 73 per cent of the wealthiest.[62] In African cities, 65 per cent of respondents report a reliable connection, compared to 24 per cent in rural areas.[63]

People living in poverty are much more likely to have a low-quality electricity connection.

Where reliability is improved, relatively wealthier households benefit most initially, albeit many of these people are likely living on less than $6.85 per day. For the same reasons described in the paragraph above, as reliability improves it benefits relatively richer communities and urban areas first. Lee, et al., (2022) find that many Africans seek alternative energy supply to the grid given poor reliability, and that when reliability improves it disproportionately benefits wealthier customers.[64] Given the high share of people living in poverty connected to the grid, improving reliability is likely to improve outcomes for the moderately poor, but less so for the extreme poor.

Poorer households are likely to spend a disproportionate amount on measures to avoid outages. Niroom & Jenkins (2020) find that the bottom third of customers by electricity bill size spend 167 per cent of their bill on measures to avert outages, compared to 40 per cent for the top third of consumers. The burden of expenditure to avert outages falls disproportionately on those that purchase smaller amounts of electricity, and are also relatively poor.[65]

Poorer households are likely to spend a disproportionate amount on measures to avoid outages.

There is a strong body of evidence linking power reliability to improved outcomes for poor beneficiaries. In India, Chakravorty, et al., (2014) rural households saw income increases three times higher for those with a high-quality grid connection compared to those with access, but an unreliable service. Samed & Zhang (2016) found reliability doubled the income gain from electrification in India, and that while access resulted in a 15 per cent increase in non-farm income and 11 per cent increase in total income, a reliable connection increased these impacts to 37 per cent and 17 per cent, respectively.[66]

A key determinant of the type and scale of impact for firms is how they mitigate or adapt to the risk of outages. Firms may invest in backup generation to maintain power supply, or they may adapt their production methods when the power goes out. In short, where the cost (e.g., lost revenue) of power outages to the firm is higher than the cost of investing in and running backup supply, they will choose to incur the costs of paying to mitigate outages. The size of the firm matters, as there are economies of scale in investing in backup supplies. Energy-intensity of production also matters, as does the nature of production – particularly if processes need to be run continuously.

61 Aidoo & Briggs (2019), "Underpowered: Rolling blackouts in Africa disproportionately hurt the poor", available at https://www.cambridge.org/core/journals/african-studies-review/article/underpowered-rolling-blackouts-in-africa-disproportionately-hurt-the-poor/B35E5D296F337DACD18E3BC462B9A7CB

62 These numbers are percentages of total households (those who are and who are not connected to the grid). The numbers change when looking at data of only those households with a connection to the grid. Of those households in poverty, 66 per cent report reliable electricity, versus 86 per cent of the wealthiest respondents.

63 Ibid.

64 Lee, Kim, Kang, & Han (2022), "Still lacking reliable electricity from the grid, many Africans turn to other sources", available at https://www.afrobarometer.org/wp-content/uploads/2022/04/ad514-pap10-still_lacking_reliable_electricity_from_the_grid-many_africans_turn_to_alternative_sources-afrobarometer-10april22.pdf

65 This effect is driven by the smaller bill size of poorer customers – so averting expenditure takes up a larger share of the bill. It does not appear to be the case that poorer households pay more in absolute terms to avoid outages (which could be the case if for example they are worse affected by load shedding or poor quality power supply).

66 Samad, & Zhang (2016), "Benefits of Electrification and the Role of Reliability: Evidence from India", available at https://documents1.worldbank.org/curated/en/980911479147772730/pdf/WPS7889.pdf

Investing in backup power supply has both short and long-term consequences for firms, which stand to benefit in different ways from improving power supply. For firms with backup generation, improving reliability reduces their costs, which can allow firms to grow and potentially raise employment or wage levels. For firms which do not have backup generation, it may improve their productivity. Finally, in the longer-term, it may result in firms choosing to enter a new more power-intensive sector, or to invest in electricity-intensive productive assets to improve the productivity within their current sector of activity.

Investing in backup power supply has both short and long-term consequences for firms.

Agriculture has relatively low dependency on reliable power supply, although electricity can enable higher productivity through irrigation, mechanisation, storage and agri-processing. Much of the evidence on providing reliable power supply to the agriculture sector finds relatively muted effects – with larger impacts on firms and workers in other sectors. This is because much of the work is outdoors, and electricity-intensive tasks can be substituted by manual labour-intensive work. However, electricity is a key input to irrigation and mechanical crop processing, which can improve yields and agricultural income levels.[67]

Given their reliance on reliable power supply, manufacturing firms are far more likely to invest in backup generation, at significant cost. In India, investment in electricity-generating capital is 20 times and four times higher for manufacturing firms and service sector firms respectively, than for retail firms.[68] Indian manufacturing firms with generators lose 0.7 per cent of their output due to power supply issues, while firms without generators lose 10.3 per cent of output.[69] In South Africa, backup generation is much higher in manufacturing than in the commercial sector, and the hourly cost of using a backup generator is between around 150 per cent and 1,300 per cent higher than grid tariffs.[70] Even so, the manufacturing sector bears around 40 per cent of the cost of load shedding in South Africa.[71]

Smaller firms are less able to invest in backup generation and either adapt employment patterns or lose revenue when power goes out. Small manufacturing firms adjust both the number and the working hours of employees to work around periods of power outages, but without necessarily changing wage levels. Single-person firms have less ability to adapt, and lose revenue when power goes out.[72]

Smaller firms are less able to invest in backup generation and either adapt employment patterns or lose revenue when power goes out.

In general, a marginal improvement in power reliability is far less important for firms than achieving a minimum quality of service. Willingness to pay is much higher for an improvement to (near) complete reliability, than for a small improvement to a service that remains essentially unreliable.[73] This fits with the logic of the evidence above, as to avoid the cost of investing in backup generation, or to incur the costs of investing in electricity-intensive assets, firms need to have confidence power will be available (almost) all of the time. As discussed in Section 4.3, this may have implications for the types of power sector investments that are best suited to delivering inclusive outcomes via impacts on workers.

67 Falchetta (2021), "Energy access investment, agricultural profitability, and rural development: time for an integrated approach", available at https://iopscience.iop.org/article/10.1088/2634-4505/ac3017

68 Burgess, et al., (2023), "Electricity Supply and Economic Growth: Evidence from a Large Experiment in Bihar", available at https://pedl.cepr.org/sites/default/files/WP 3858 BurgessGreenstoneRyanSudarshan ElectricitySupplyEconomicGrowth_0.pdf

69 Alcott, et al., (2005), in Walsh, Theron, Seedat, & Reeders (2020), "Estimating the economic cost of load shedding in South Africa", available at https://www.novaeconomics.co.za/our-work/estimating-the-economic-cost-of-load-shedding-in-south-africa

70 Kingsley, et al., (2020), "Economic impact of electricity supply interruptions in South Africa", available at http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1991-16962020000200004

71 Walsh, et al., (2020), "Estimating the economic cost of load shedding in South Africa" , available at https://www.novaeconomics.co.za/our-work/estimating-the-economic-cost-of-load-shedding-in-south-africa

72 Hardy, et al., (2016), "Lights Off, Lights On The Effects of Electricity Shortages on Small Firms", available at https://documents1.worldbank.org/curated/en/652241576769009597/pdf/Lights-Off-Lights-On-The-Effects-of-Electricity-Shortages-on-Small-Firms.pdf

73 For example, Deutschmann (2022) finds that WTP for marginal service improvements is significantly lower than WTP for uninterrupted service.

Box 2: Inclusive outcomes for a medium-skilled worker in informal manufacturing

The firm already has access to power, but suffers frequent and long outages. As a result, the worker (likely male) works long hours and adjusts his shifts to the availability of power, at low wages and irregular working patterns.

The firm does not invest in technologies that improve productivity, as they cannot afford to run backup generation, instead relying on low labour productivity outputs that suppress wages.

As power reliability improves, the firm scales up and more firms enter, with a sector-wide change in production techniques to higher electricity-intensity, higher-value production methods.

Some workers lose their jobs as firms shift to more capital-intensive production techniques, but those that stay in the sector move to higher wage employment. Over time, as the sector grows, the effect of economic growth and transformation may outweigh the substitution away from labour to capital, generating an aggregate increase in employment.

The implication for inclusive outcomes is that in the short-term, the benefits are likely to accrue to poor, but not the poorest workers. Reliable power supply does not immediately transition households away from agricultural livelihoods in the two to four years following grid connection.[74] However, various studies find reliable power access does increase non-farm income more than farm-income.[75] Mensah (2024) finds that energy-intensive firms in the non-agriculture sectors respond to unreliable supply by reducing wages and employment, and that this affects skilled jobs.[76] However, the same research finds no significant gender impacts; outages reduces employment outcomes of workers irrespective of gender. Given the concentration of the extreme poor in low-skill agricultural work, their employment outcomes are likely to be less affected than those of slightly less poor (but still living under $6.85) who are more likely to be working in energy-intensive sectors such as manufacturing.

The benefits of improving reliability for firms with and without gensets have high potential to deliver inclusive outcomes, in different ways. For firms with gensets, improving reliability creates a significant reduction in costs, which all other things equal allows them to scale up, take on more workers, and potentially improve wage levels. The workers in industries where gensets are common – in particularly manufacturing and industry – are likely to have relatively low- and medium-skilled workers who live below the poverty line. However, they may be less likely to be sectors in which women are highly represented. For firms without gensets, the short-term benefits are in improving productivity and reducing losses, benefits which would be expected to some extent to flow through to workers. The more important benefit for these firms is more likely to be through incentivising structural change and investment in productive (electricity-intensive) assets, and by encouraging entry of new firms into electricity-intensive industries. This longer-term impact is likely to reach people who would otherwise be in lower productivity and low wage jobs, and may offer new economic opportunities for women.

74 Pelz, et al., (2023), "Short-run effects of grid electricity access on rural non-farm entrepreneurship and employment in Ethiopia and Nigeria", available at https://www.sciencedirect.com/science/article/pii/S2452292922000819

75 UN ESCAP (2021), "Systematic Review of the Socio-economic Impacts of Rural Electrification", available at https://www.unescap.org/sites/default/d8files/knowledge-products/Systematic-Review-of-the-Socio-economic-Impacts-of-Rural-Electrification 26 Feb.pdf

76 Mensah (2024), "Jobs! Electricity Shortages and Unemployment in Africa", available at https://documents1.worldbank.org/curated/en/659751524142624281/pdf/Jobs-electricity-shortages-and-unemployment-in-Africa.pdf

4.1.3. Affordability

Where affordability is low, access often does not lead to an immediate increase in electricity consumption or investment in electricity-intensive appliances. Taneja (2018) notes that the "h*igh cost of providing grid electricity connections does not necessarily justify the benefits derived by newly-connected grid customers*". Aufhammer & Wolfram (2014) find in China that appliance ownership is highly dependent on income thresholds. Households in rural India do invest in new appliances, but at a very slow pace after electrification (Richmond & Urpelainen, 2019).

The demand response of poor households to price changes is relatively muted. Qeqe (2022) finds that South African households adjust their budgets to maintain a level of electricity consumption, rather than change consumption in response to price changes. Pueyo, et al., (2013) find that that price elasticity among poor customers is highly inelastic, while in the US, Fowlie, et al., (2017) find that low-income Californian customers are less responsive to pricing programmes, among generally low engagement with tariff options.[77]

Connection fees are a bigger obstacle than unit tariffs. In electrified villages in Bangladesh, higher-income households benefit significantly more than poorer counterparts due to prohibitive connection fees.[78] In Ethiopia, the lowest connection charge represents 130 per cent of average monthly household income.[79] Pueyo, et al., (2013) find that unit tariffs are less frequently reported as a barrier to connection and increased use than connection fees/upfront costs. Given that connection fees reflect the cost to the utility of making and maintaining the connection, the fee may be high by design, to prevent connection from low consumption, non-economically viable, customers.

Improving affordability for low ability to pay customers may imply trade-offs between providing high-quality and affordable access for existing users. Blimpo & Cosgrove-Davies (2019) note that "*in most countries in Africa, connecting an additional household is unprofitable*". Social tariffs may provide a solution to high unit tariffs. However, these are easier to provide for when there is a large enough majority of the customer base that can afford to pay cost-reflective tariffs plus a cross-subsidy markup. Where connection rates are low and ability to pay also low, there may be a trade-off between promoting access for all and making sure those who do have access represent financially viable customers for utilities, and providing those who are connected with a high enough quality of service to deliver the benefits of reliable power access described in Section 4.1.2.[80]

77 Fowlie, et al., (2017), "Default Effects and Follow-On Behavior: Evidence from an Electricity Pricing Program", available at https://www.nber.org/system/files/working_papers/w23553/w23553.pdf

78 World Bank (2009), "Welfare Impacts of Rural Electrification", available at https://documents1.worldbank.org/curated/en/230801467997272474/pdf/WPS4859.pdf

79 Kojima & Trimble (2016), "Making Power Affordable for Africa and Viable for Its Utilities", available at https://openknowledge.worldbank.org/entities/publication/b46ee555-2c90-5f90-a1f4-aa43fae8377d

80 To overcome high connection fees, some funders are prepared to provide one-off grant funding to buy down the initial capital costs. However, these new connections may also increase long-run operating costs for relatively low revenue generating customers, which creates a financial challenge for utilities.

Women are more likely to experience affordability issues, in the household or as entrepreneurs. Female-led SMEs have less access to finance and credit, making it harder to set up a business and pay for recurring costs, such as electricity.[81] Female-led households in rural areas tend to be poorer; and poorer households generally spend a larger share of income on electricity needs.[82] For example, in Kathmandu, Nepal low-income households spent 14 per cent of their income on energy versus 3 per cent for high-income households.[83] Furthermore, women also tend to spend more household expenditure on family needs such as food, clothing, housing, fuel, and lighting.[84] A higher electricity price will come at the expense of other household's expenditures.

For productive activities, availability and reliability are more important than price. This is true for firms and households, where studies show a much higher willingness to pay for a fully reliable service. For productive use by households and for many firms, energy costs represent only a small percentage of total production costs and firms could face higher costs due to voltage drops or blackouts.[85]

The main inclusive outcome benefits of improving affordability are likely to be in freeing up expenditure for other purposes. At low levels of consumption and demand elasticity, lowering tariffs may not elicit a change in electricity usage patterns. However, it does reduce overall spending and thereby free up savings which can be spent on access to other basic goods and services.

For firms, reliability is a more important consideration than pricing. As noted in Section 4.1.2, energy-dependent firms either spend a significant amount on backup services, or risk losing revenues. Qualitative evidence from Ethiopia confirms that while cost is an issue, it is not as disruptive to businesses as poor quality power supply.[86] In India, manufacturing firms in states with greater reliability raise consumption, despite higher per-unit prices.[87] In Senegal, both formal and informal sector firms are willing to pay a premium over tariffs for high quality electricity service.[88]

For firms, reliability is a more important consideration than pricing.

Price does matter for firms – if the cost of a factor of production increases, firms tend to produce less and switch to other inputs. In India, firm output, machine intensity and labour productivity all decline following a price increase.[89] However, no link was found between the price of electricity and employment growth, perhaps as employment tends to decrease as firms contract, but increase firms substitute towards more labour-intensive production.

81 IFC (2011), "Strengthening Access to Finance for Women-Owned SMEs in Developing Countries", available at https://documents1.worldbank.org/curated/en/101351468156252909/pdf/667610WP00PUBL065805B0Strengthening.pdf

82 Samad & Zhang (2016), "Benefits of Electrification and the Role of Reliability: Evidence from India"

83 Shrestha, et al., (2021), "Role of gender participation in urban household energy technology for sustainability: a case of Kathmandu", https://link.springer.com/article/10.1007/s43621-021-00027-w

84 Muhammad, et al., (2021), "Consumption pattern of male and female headed households: Evidence for Pakistan", available at https://ker.org.pk/index.php/ker/article/view/361/190

85 Pueyo, Gonzalez, Dent, & DeMartino (2013), "The Evidence of Benefits for Poor People of Increased Renewable Electricity Capacity: Literature Review", available at https://www.ctc-n.org/sites/default/files/resources/er31_final_online.pdf

86 EEG (2022), "Working Paper: Study on the impact of electricity tariff increases on enterprises' electricity consumption and response in Ethiopia", available at https://discovery.ucl.ac.uk/id/eprint/10133100/

87 Mahadevan (2022), "You Get What You Pay For: Electricity Quality and Firm Response", available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4040285

88 Deutschmann, et al., (2021), "Measuring Willingness to Pay for Reliable Electricity: Evidence from Senegal", available at https://www.sciencedirect.com/science/article/pii/S0305750X20303363

89 Abeberese (2017), "Electricity Cost and Firm Performance: Evidence from India", available at https://www.jstor.org/stable/26616164

4.2. Longer-term structural transformation pathway

The relationship between access to power and economic growth has been well-explored, although remains inconclusive. One of the major challenges is that over time, electricity access and GDP growth both tend to rise, so identifying which causes the other to rise is challenging. There is also undoubtedly a two-way relationship; electricity offers at least the possibility of economic growth, while economic growth increases ability to pay for and demand for electricity. While there are lots of examples where electrification, economic growth, and poverty reduction have gone hand-in-hand, there are also cases where rapid electrification has not necessarily led to strong development outcomes. For example, Ghana has achieved around 80 per cent access to electricity since 2016, and yet still today has almost 80 per cent of its population living under $6.85 per day.

Improving power reliability can deliver substantial benefits for long-run GDP. For example, Andersen & Dalgaard (2013) find that across sub-Saharan Africa, a 1 per cent increase in outages reduces long-run GDP per capita by 2.86 per cent.[90] Similar GDP impacts have been estimated in other studies in South Asia and sub-Saharan Africa, and it seems reasonable to conclude the reliable power access can have a significant impact on economic growth rates.

Improving power reliability can deliver substantial benefits for long-run GDP.

Power reliability is an important determinant of capital formation which can drive economic growth. There is ample evidence that in the absence of a reliable electricity connection firms and households do not invest in electricity-intensive appliances that could open up new and higher income economic opportunities. In sub-Saharan Africa, electricity is the second-biggest obstacle to growth as reported by firms, following access to finance, while in South Asia it is the fourth-biggest obstacle (after access to finance, political instability, and tax rates). In these regions, 40 per cent and 24 per cent of firms identify electricity as a major constraint, respectively.[91]

Box 3: Inclusive outcomes for a woman on less than $6.85 per day

The impact on women will vary a lot by context – in some settings access rates are already high, and improving access is unlikely to be the most impactful mechanism.

Where first-time access is provided, it allows a reallocation of time. In some contexts this may result in an increase in work hours and a diversification away from agricultural employment, but more often it will not alone change working patterns which remain defined by cultural norms. Gender-based violence is likely to decrease, as are educational outcomes for girls and improved empowerment including through access to information.

Improving affordability frees up budget for other essential goods and services, improving standard of living, and may enable investment in productive assets to diversify economic activities.

In the longer-term, electricity access can contribute to a higher-skilled female workforce, better able to take advantage of higher-wage job opportunities which are less dependent on physical strength.

90 Andersen & Dalgaard (2013), "Power outages and economic growth in Africa", available at https://web2.econ.ku.dk/dalgaard/Work/published/1-s2.0-S0140988313000406-main.pdf

91 The World Bank Enterprise Surveys, available at https://www.enterprisesurveys.org/en/data/exploretopics/infrastructure

While in the short-term improved power reliability may have limited (although still significant) effects, in the long term, larger benefits can be delivered as economies have time to adjust. Fried & Lagakos (2023) find that eliminating power outages affects output per worker by 15 per cent, with impacts up to five times larger in the long-run. This reflects the importance of electricity in capital formation, and that beyond a certain level of output and productivity power is not easily substitutable by other factors of production and becomes a binding constraint. Over the long term, reliable power supply encourages investments in electricity-intensive production techniques, and provides firms and investors with stable incentives to invest in higher-value-add sectors, incentivising entry of new firms, lowering entry costs, increasing competition, and forcing unproductive firms to exit.[92]

It is reasonable to conclude that while reliable power may not be sufficient to drive growth, it is necessary. For economies to develop and engage in more complex, higher value-add activities access to reliable and affordable power is essential; it is a binding constraint.[93] No country has reached upper middle-income status with a modern productive economy without having high access to reliable power.

While reliable power may not be sufficient to drive growth, it is necessary.

Over the longer term, improving access to reliable power may have stronger benefits for poor communities. In the short term, the gains for low-skill workers, workers in the agriculture sector, and small firms, may be limited. However, over the longer term as economies adjust, sectors grow at different paces, and workers can upskill. There may therefore be a shift in the share of the population that work in low paid jobs towards higher productivity sectors and higher wages.

The benefits for women will depend on empowerment and social norms. Access to power should reduce the importance of manual labour and level the playing field for women to access sectors that have traditionally been male dominated. However, for this to take place, the roles women are expected to fulfil need to change – with a more equal allocation of household chores and greater acceptance of women in the workplace. While there has been limited research on this type of pathway, Vidart (2024) finds that some of the benefits of electrification on the US have taken a generation for women to access, as girls education and training has improved and societal norms have shifted, facilitating the entry of women into economic opportunities.[94]

While the evidence is limited, it is likely that widespread access to reliable and affordable electricity would favour a more equal access to the opportunities of economic growth. For example, as described in the Nigeria case study in Annex A.3, high GDP growth rate in the absence of accompanied growth in access to power may be more likely to be concentrated in a few sectors (e.g., extractive industries) and in a few locations within the country.

4.3. By power sector project type

To develop a successful, financially viable, and impactful electricity network, countries should develop and implement a coherent least cost electrification plan. Demand forecasts should account for potential demand from existing customers and from new connections. On the supply side, grid and off-grid generation technologies each have a role to play, with T&D infrastructure phased to connect highest ability to pay customers first, while reaching further out to more remote or lower ability to pay communities over time.

92 Kassem (2021), "Does Electrification Cause Industrial Development? Grid Expansion and Firm Turnover in Indonesia", available at https://www.crctr224.de/research/discussion-papers/archive/dp052

93 See the McCulloch (2016) review based on applying the Hausmann-Rodrik-Velasco framework: "Is Electricity Supply a Binding Constraint to Economic Growth in developing countries?", available at https://www.gov.uk/research-for-development-outputs/is-electricity-supply-a-binding-constraint-to-economic-growth-in-developing-countries

94 Vidart (2024), "Human Capital, Female Employment, and Electricity: Evidence from the Early 20th-Century United States", available at https://academic.oup.com/restud/article-abstract/91/1/560/7039347

For investors operating at project- rather than system-wide level, this section discusses how different power sector projects may be more or less susceptible to deliver inclusive outcomes. There may be trade-offs against different objectives, such as local environmental sustainability, climate change mitigation and adaptation, productivity and economic growth, and inclusive development.

4.3.1. Utility-scale generation

Increasing utility-scale generation can make existing connections more reliable or support increasing access. In this discussion of increasing generating capacity, the focus is on improving the quality of power provided, holding connection rates constant. The potential to contribute to increasing access to electricity is discussed in the context of expanding T&D networks in Section 4.3.3. Investment in new generating capacity may also contribute to improving affordability if it follows a least-cost electrification plan, and if new and more generation replaces costlier generation as it is retired.

High shares of intermittent generation can lead to substantial system integration costs – with evidence this can increase energy poverty. Davis, et al., (2023) note that integrating a high share of renewables in the US could entail significant costs for power transmission, the costs of which are not declining – and indeed appear to be increasing – even if the cost of renewable energy generation itself has seen significant declines. The incidence of such costs often falls heaviest on poorer consumers; Monyei (2019) shows that large-scale integration of intermittent renewable energy generation in Germany, California, and Australia has resulted in increased tariffs and increased energy poverty, while Mastropietro (2019) likens renewable energy sources for electricity charges to regressive taxation that could intensify energy poverty.

There may be trade-offs between environmental sustainability and inclusive outcomes. In some countries, renewable energy is providing both reliable baseload electricity, and dispatchable electricity to meet peak-load demand. For example, in Kenya 80 per cent of electricity generation comes from renewables including hydropower, geothermal, and increasingly wind and solar. However, where intermittent renewable energy makes up a high share of generating capacity, this may offer lower performance in terms of reliability and affordability, which are important to delivering inclusive opportunities.

Ensuring a reliable and low cost supply to meet demand across the load curve is essential to generating and maintaining inclusive economic development opportunities. Getting the mix of generating resources right is important. Over-prioritising intermittent resources which make up a high share of installed capacity, or without sufficient strengthening of transmission and distribution networks can cause problems. For example, see the South Africa case study in Annex 1.4.

4.3.2. Embedded C&I generation

Commercial C&I can reduce costs and improve reliability for individual commercial customers. For example, C&I solar costs around $6-8 cents per kilowatt hour in Kenya, while consumption from the grid ranges between $13-20 cents.[95] Providers can offer a combination of, for example, solar and storage to provide for standalone reliability, or for reliability when the grid goes down.[96]

95 African Review (2023), "East Africa: a region on the rise", available at https://africanreview.com/energy/power-generation/east-africa-a-region-on-the-rise

96 As offered for example by Sustainable Power Solutions, available at https://sps.africa/solar-pv-and-battery-storage-systems/

There may be spillover benefits to other firms and households, if C&I generation improves system-wide reliability or lowers system costs. For grids with two-way metering and wheeling arrangements in place, C&I embedded generation may help reduce outages by selling into the local distribution networks when demand exceeds supply, or by providing cost-effective peak load to large commercial customers. For networks where there are localised bottlenecks or generation shortfalls, embedded C&I may help meet demand if it is oversized (i.e., has spare capacity to sell into the grid), or if at times when the needs of the firm are lower than its embedded generation capacity coincide with times when grid-demand is relatively high.

However, there are important system-wide considerations, including ensuring financial viability of the energy system as a whole. There is a (at least perceived) risk to the financial viability of integrated energy providers if a significant share of their customer base opts to invest in self-generation. This has already caused stress on utility performance in Kenya and in South Africa.[97,98,99] For example, ESKOM reported that Small-scale Embedded Generation (SSEG) has risen 350 per cent from 2022 to 2023, impacting its revenue base (see Annex A1.4 South Africa case study).[100]

C&I solar may be well-suited to industries where higher productivity can be generated and which deliver inclusive outcomes. For example, in light manufacturing, textiles, and small-scale trades, where there is a high concentration of poor workers. Embedded generation at constructions sites and mines is likely to raise productivity and wages for poor men, but less so for women who make up a small minority of workers in these sectors.

It is also worth considering the potential replacement effects of capital for labour. Embedded generation may shift production to higher-productivity activities, which raises the marginal productivity of labour, improving outcomes for those who are employed. However, it may also result in substitution away from labour in favour of capital, which may mean some workers lose out through unemployment. In the longer term, a richer capital formation may contribute to higher productivity overall, but may require support to help workers transition to higher skilled, capital-intensive employment.

4.3.3. Transmission and distribution

Transmission and distribution (T&D) is essential to ensure power generated can be conveyed to households and firms. The drive to integrate increasingly high shares of intermittent renewable energy into electricity networks will require significant investment in strengthening T&D networks to integrate these generation sources.

Lack of T&D capacity is often a principal cause of poor power sector reliability in emerging markets. As noted in Section 4.1.1, households and firms prefer a grid connection, even when they have access to distributed energy solutions. However, in many energy markets, losses and faults through the T&D network mean that even when generating capacity is installed, it is not providing the reliable service levels needed to deliver the benefits described above. There is then a critical trade-off between expanding the reach of T&D networks to serve new connections as quickly as possible, versus improving the quality of power for those already on weakly-performing networks.

97 Energy for Growth Hub (2020), "The problem with Kenya Power's revenue model in three graphs", available at https://energyforgrowth.org/article/the-problem-with-kenya-powers-revenue-model-in-three-graphs/

98 Shumba, et al., (2018), "The impact of small-scale embedded generation on municipal revenue", available at https://www.sseg.org.za/wp-content/uploads/2019/10/The-impact-of-SSEG-on-municipal-revenue-SEA-2019.pdf

99 Fakude & Ogudo (2021), "The impact of large-scale solar generation on utility revenue", available at https://ieeexplore.ieee.org/document/9543302

100 South Africa Parliamentary Monitoring Group (2023), available at https://pmg.org.za/committee-question/23629/

Poorly maintained T&D networks can also increase safety risks. These often fall on the poor given that poor quality infrastructure tends to be in relatively poorer communities.

Improving both the reach, and quality, of T&D infrastructure is likely to have a significant impact on outcomes for people living in poverty. Given the importance of a near-completely reliable power supply for driving productivity improvements and investment in capital-intensive activities, T&D infrastructure needs to be highly reliable to provide households and firms with power of sufficient quality to transform livelihoods.

4.3.4. Consumer side metering technologies

Prepaid metering can impact consumption, consumer price elasticity and utility revenue. After switching from postpaid monthly billing to prepaid electricity, customers reduce their electricity usage by around 14 per cent, with the largest reductions coming from high consumers and poorer customers.[101] Prepayment means customers experience the price of electricity more directly and are more aware of their usage levels. It provides customers with greater control and better insight into their bills. It is also notable that while prepayment meters reduces consumption, this does not come at the expense of the utility, which while losing revenue can offset this by an increase in customer collection rates, lower payment recovery costs, and timely payments. Indeed, it has been shown that switching poorer customers generates the greatest net revenue gains for the utility.[102]

Smart meters can help manage voltage fluctuations and enable load management and detection of faults to reduce power outages. First, smart metering can improve the quality and granularity of data on system reliability issues, which is important given the often poor quality of data on reliability metrics (discussed in Section 3.3). Secondly smart meters can detect faults and enable direct management of load to minimise service disruption. Meeks, et al., (2023) find that smart meters in the Kyrgyz Republic improved reliability resulting in a significant increase in consumption and in appliance ownership.

While smart meters can improve reliability, these are likely to be relatively incremental improvements. While smart meters could help go from a mostly reliable power supply to a highly reliable power supply, they are unlikely to have a substantial impact on reliability where the baseline is a highly disrupted power supply (i.e., where reliability is down to systemic issues with availability of power generation, or due to transmission and distribution bottlenecks).

Metering technologies may boost consumer affordability and can enable tailored tariff structures to support poorer customers, while improving utility's revenue collection rates. Across Africa, payment collection rates declined between 2013 and 2020 and most utilities do not fully recover costs.[103] Metering can facilitate payment collection,[104] which where cost-effective would improve financial performance of the utility and enable tariffs to reduced.[105] Smart meters can also provide data that supports better targeting of social tariffs to boost affordability particularly for the poor, or to offer tariffs for people to choose to consume during lower cost-per-kwh times.

101 Jack & Smith (2020), "Charging Ahead: Prepaid Metering, Electricity Use, and Utility Revenue"

102 Ibid.

103 World Bank/ESMAP (2023) "Utility Performance and Behavior in Africa Today (UPBEAT) Update Briefing", available at https://documents1.worldbank.org/curated/en/099092923144024459/pdf/P176468083bba20340a3520c1ffc74398ad.pdf

104 See SteamaCo (https://steama.co/), a UK-based company providing smart metering technology in sub-Saharan Africa, using artificial intelligence (AI) and smart-meters to support utilities in monitoring energy uses, distribution losses and opportunities for revenue.

105 Jack & Smith (2020) "Charging Ahead: Prepaid Metering, Electricity Use, and Utility Revenue"

In emerging markets, there may be practical constraints which limit the effectiveness of smart metering to deliver benefits. The common practice of sharing a meter to offset connection fees decreases the ability to tailor tariffs to improve affordability, as these grouped households can appear to the utility as a single (richer) household, and charged a higher tariff.[106] Furthermore, the potential benefits from smart social tariffs require a relatively sophisticated and well-functioning retail market which can support time-of-use or seasonal tariffs – which is often not yet practical in emerging markets.

The cost-effectiveness of smart metering is likely to depend substantially by context. While common in developed economies such as much of Europe and the US, smart meters remain relatively new in regions like sub-Saharan Africa and South Asia. They are a relatively expensive technology to deploy, and the cost-effectiveness in delivering improved reliability or affordability of power sector services remains to be determined.

106 Kojima & Trimble (2016) "Making Power Affordable for Africa and Viable for Its Utilities", available at https://openknowledge.worldbank.org/entities/publication/b46ee555-2c90-5f90-a1f4-aa43fae8377d

5

Inclusive outcomes and power sector investments by country context

A range of contextual factors will affect what type, and the extent to which, power sector projects deliver inclusive outcomes. From the evidence review above, there is clearly no single pathway (short or long term) or mechanism (access, reliability, affordability) that will be effective in improving inclusive outcomes in all contexts.

For every investment we make, we calculate an Impact Score,[107] which is based on the expected development impact of the investment. Every eligible investment will receive Productive, Sustainable, and Inclusive scores. The sum of the three scores will result in a Total Impact Score. The Inclusive score is based on the profile of the stakeholders that the investment is expected to positively benefit. We consider inclusion across three dimensions: cross-country inequality, within-country inequality, and reaching or empowering otherwise excluded groups.

This section complements and expands on BII's default country inclusion scores. The BII default scores are based on the poverty gap, GDP per capita, and fragility, with alpha representing the countries scoring highest on inclusive outcomes, through to delta as the lowest-scoring countries for inclusive outcomes.[108] This section explores how impact in terms of inclusive outcomes from power sector investments may differ from the default country scoring approach.

The focus is on energy access and poverty metrics, noting a lack of data disaggregated by gender. While data is increasingly collected to explore both the electricity access context of, and impacts on, women, there is not yet the same extent of cross-country comparable data on women's access to electricity as there is on overall access rates, nor on poverty rates.

107 BII (2022), "Impact Score 2022 – 26 Strategy Period", available at https://assets.bii.co.uk/wp-content/uploads/2022/02/24121022/British-International-Investment-Impact-Score-2022-26.pdf

108 BII (2022), "Impact Score 2022 – 26 Strategy Period", available at https://assets.bii.co.uk/wp-content/uploads/2022/02/24121022/British-International-Investment-Impact-Score-2022-26.pdf

5.1. Power access and reliability across country contexts

5.1.1. Power access transition status

In 37 BII investment countries, almost all populations already had access to power for many years. This includes India, Indonesia and much of North Africa, where access rates are high and there has been time to strengthen the power of power supply. In these contexts, the conditions are ripe for increasing power market sophistication, with focus moving to providing high minimum service levels of power reliability, potentially including wide-scale adoption of smart-metering and embedded generation with two-way metering based on a well-organised set of power market rules and regulations.

At the other end of the spectrum, there are eight countries where most of the population lacks access to power, which has not changed much in the last five years. This includes, for example, Burundi and much of the Sahel region. For these countries, making progress on access and reliability has high potential to deliver inclusive outcomes. A key trade-off may be between expanding access for the (large population) of very poor, or prioritising high-quality access for those with access to power networks. These low and stagnant access contexts will need a coordinated approach between investors, donors, and governments to work on the broader macroeconomic and policy conditions needed to ensure access to power can deliver economic transformation and increase employment opportunities and incomes.

Most of BII's investment countries sit somewhere between – with 21 undergoing a rapid transformation of their energy sectors. In these countries, it is likely that broader macroeconomic and policy conditions can not only facilitate the energy transition taking place, but also maximise the benefits of new and improved access to power. For these countries, we suggest improving reliability of power supply should be the top priority, through the right mix of utility-scale power generation and strengthening T&D networks while they continue to roll out. A further 27 countries have medium levels of access but growth in access is slower.

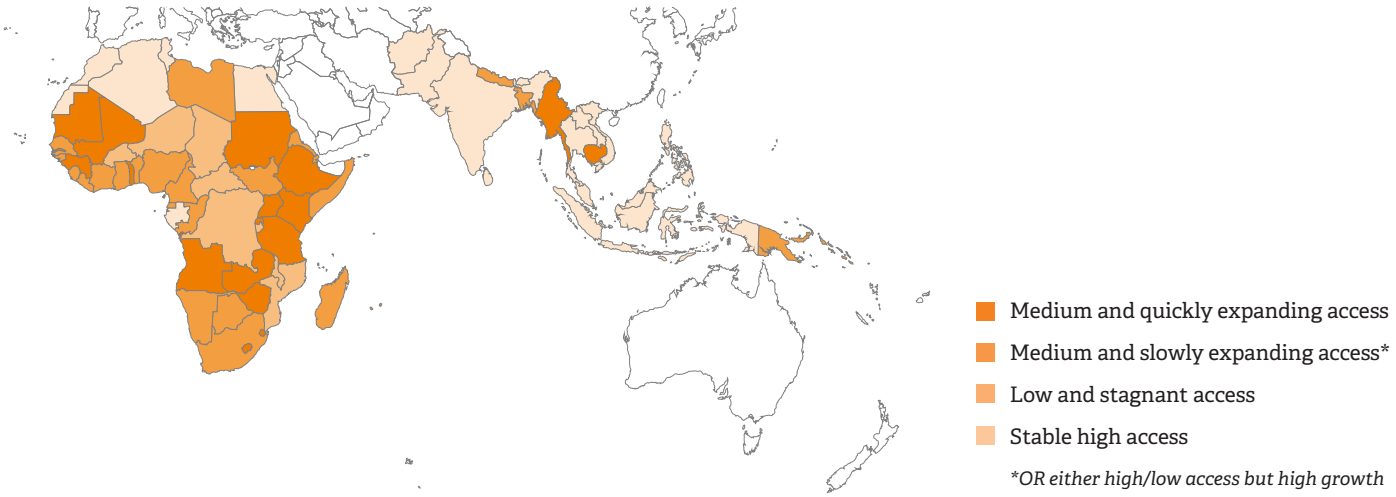


Figure 6: Classifying countries by electricity access trends
Source: Greencroft Economics, based on SDG7 Tracking data.
Note 1: Graph focuses on BII priority countries in Africa and Asia – data gaps appear as white.
Note 2: [1] the four classification categories should not necessarily be interpreted as ordinal (i.e. from most to least impactful), and are intended to help identify which impact mechanism, and what power sector investments, are most suited to delivering inclusive outcomes.
[2] Medium and quickly expanding = electricity access between 40-90 per cent and access growth of >15 per cent in the last five years; Medium and slowly expanding = access between 40-90 per cent and growth <15 per cent[109]; Low and stagnant = access below 40 per cent and access growth below 35 per cent; Stable high access = access >90 per cent and access growth <15 per cent.

109 OR, low access high growth (above 15 per cent), OR high access high growth (above 15 per cent).

The potential for inclusive outcomes from utility-scale power is probably not ordered according to current access rates and trends. As proposed in Figure 6, utility-scale investments are more likely to drive inclusive outcomes in countries with the right conditions to simultaneously improve access and economic opportunities – such as those with a medium level of access. The countries with the lowest potential for utility-scale power to deliver inclusive outcomes are those that already have high and stable energy access for many years, as the potential to improve power sector outcomes in these countries is probably lowest. The next category, also relatively limited in terms of potential to deliver inclusive outcomes, are countries with low electricity access and low progress on electricity access. In these countries utility-scale power projects will struggle to make a major difference to the lives of people living in poverty, unless a range of other interventions also happen concurrently to shift overall development trends. The final two categories are where inclusive outcomes are more realisable with utility-scale power – countries with a medium level of electricity access, and particularly where access rates are improving quickly.

The power transition scores are highly correlated with the BII default scores. There is a high concentration of Alpha and Beta countries in the two 'high-impact' categories proposed above – with a moderate current level of electricity access, and in some cases a rapid energy transition ongoing. Most of the Gamma and Delta countries fall into the last category, where access is already high and has been for several years. The only major difference here is that there are seven 'Alpha' countries on the BII default score which place in the third power transition category, for low and stagnant access, where it may be hard to achieve inclusive outcomes through the types of utility-scale investment looked at in this report.

	Alpha	Beta	Gamma	Delta
Medium access, quick expansion	7	14	0	0
Medium access, slow expansion	9	12	5	1
Low access, stagnant	7	1	0	0
Stable high access	1	2	10	24

Figure 7: BII impact default scores compared to energy access transition scores
Source: Greencroft analysis
Note: the yellow colour scheme is a heatmap based on number of entries in each cell of the matrix.

5.1.2. Power access and poverty nexus

There are several major population centres and economies where most of the population has access to electricity and nonetheless lives in poverty. This category comprises 22 BII priority countries, including India, Bangladesh, and Pakistan in South Asia, and Nigeria, South Africa, Ghana, and Egypt in Africa. In these contexts, there is high potential for inclusive outcome from improving power supply reliability and a shift for workers to higher labour productivity and higher wages.

At the other end of the spectrum, ten countries have high poverty rates, but very few of those people have access to electricity. This correlates highly with the 'low and stagnant' access category above, comprising Burundi and much of the Sahel region.[110] As described above, improving access is clearly a high priority for the large populations living in (often extreme) poverty, especially to deliver important improvements in standards of living. However, there may be less potential for power sector investments (alone) to drive reductions in financial poverty.

110 While this could represent countries that have very low poverty levels, in practice given the BII focus countries, it almost entirely represents high poverty but low electricity access countries.

Figure 8: Classifying countries by poverty rates and access to electricity
Source: Greencroft Economics, based on SDG7 Tracking data.
Note 1: Graph focuses on BII priority countries in Africa and Asia – data gaps appear as white.
Note 2: Six countries where poverty rates are less than 15 per cent and energy access rates are high are excluded as shown by grey pattern fill: Bhutan, Maldives, Malaysia, Mauritius Seychelles, Thailand.
Note 3: [1] the four classification categories should not necessarily be interpreted as ordinal (i.e., from most to least impactful), and are intended to help identify which impact mechanism, and what power sector investments, are most suited to delivering inclusive outcomes.
[2] High = over 50 per cent of the population on less than $6.85 per day and with access to power; Medium-high = over 35 per cent; Medium = over 15 per cent; Low = less than 15 per cent.

The potential for inclusive outcomes from utility-scale power is likely to be highest where a large share of the population is living in poverty and already has access to electricity. As proposed in Figure 8, countries with a small proportion of the population living in poverty and with access to electricity are less well suited to utility-scale power delivering inclusive outcomes. At the other end of the spectrum, countries with a large share of their population both living in poverty and with access to electricity are most likely to see inclusive outcomes delivered by utility-scale power projects.

Inclusive outcome potential from the power sector may be lower in the poorest countries. The results of this classification are substantially different from the BII default country scores, as shown in Figure 9.[111] Indeed, while it is extremely plausible some power sector investments will have a high impact on inclusive outcomes where there is a large share of the population with access to electricity, none of BII's Alpha countries belong to this category, as while they have high poverty they have very low access to electricity. As noted in Section 4.2, access to power will be a pre-requisite for longer-term transformation, but this will need a confluence of other factors and will not be guaranteed by improving access to and quality of power alone.

	Alpha	Beta	Gamma	Delta
High access and poverty	0	10	10	2
Medium-high access and poverty	5	9	3	6
Medium access and poverty	10	4	1	6
Low access and poverty	6	3	1	0

Figure 9: BII impact default scores compared to poverty <> electricity access scores
Source: Greencroft analysis
Note: the yellow colour scheme is a heatmap based on number of entries in each cell of the matrix.

111 For this analysis, 11 countries are excluded due to data limitations. Furthermore, six Delta countries (Bhutan, Maldives, Malaysia, Mauritius, Thailand and the Seychelles) are excluded as they fall into a fifth category (almost 100 per cent access rate and very low poverty rates).

5.1.3. Power market reliability for firms

We do not propose a single classification based on reliability, as there are many different ways to measure reliability, and low quality data. As described in Section 3.3, metrics such as SAIDI and SAIFI are often low reliability, especially in emerging market contexts. The impact of power reliability also depends on a range of factors, including the extent (how many people of firms affected), whether outages are planned or unplanned, and the duration and frequency of outages.

Looking at the share of firms that experience outages, power reliability clearly remains a major challenge across much of sub-Saharan Africa and South Asia. Over 70 per cent of firms across SSA experience outages, and over 55 per cent in South Asia. This compares to close to zero per cent for most of Western Europe or China. The worst-affected countries in Africa include Togo, Cameroon, and South Africa (all with over 90 per cent of firms experiencing power outages), with many others including Nigeria, Kenya, Uganda, Ethiopia all close to or over 80 per cent. In South Asia, 51 per cent of Pakistani firms experience outages, over 70 per cent in Bangladesh and in Nepal, compared to just 20 per cent in India.

There is significant variation in how firms respond to poor power reliability – in some countries backup gensets are widely used, whereas in others they are not. For example, in Bangladesh and Madagascar, most firms do not have a backup genset despite high rates of outages. Whereas in Pakistan and Nigeria back-up generation is used by a substantial majority of firms. This likely reflects both the nature of the outages faced, and economic structure. In highly agrarian economies, or where manufacturing remains low electricity intensity – and can substitute power for a large and low-wage workforce – firms are less likely to invest in backup generation. As economies shift into higher capital-intensity sectors, or where the cost of backup generation is low relative to labour (as was the case in Nigeria, for example, with substantial fuel subsidies in place up to 2023), firms will be more likely to invest in backup generation.

Where backup generation is commonplace, embedded C&I and improving system reliability are likely to deliver short-term inclusive outcomes. The high share of backup generation indicates that firms are willing and able to incur the cost of investing in alternative power supply, so there is likely to be a commercial market for embedded generation. At the same time, improving the power supply from the grid itself could substantially reduce the cost of power (a key factor of production) for firms, improving competition, performance, and wage levels.

Where backup generation is less common, it may be a higher priority to strengthen grid-based power and support embedded C&I for sectors that drive longer-term economic transformation. Access to reliable power is a pre-requisite for enabling structural transformation to a higher productivity economy, which can deliver better employment opportunities and wages for workers living in poverty, and if accompanied by changes in cultural norms for women. Improving the reliability of the energy system is the top priority, while installing embedded C&I for sectors which improve employment opportunities for people living in poverty and women could also be highly impactful (e.g., manufacturing and agri-processing).

In all of these settings, a well-coordinated system-wide approach is needed. The sequencing of investments is important, to ensure that generation (especially renewable energy) can be conveyed to users and to make sure customers do not experience outages even though there is generating capacity available that cannot be delivered.

Where grids are relatively reliable, a holistic approach will be needed to get all the way to high service standards. For example, India has made both fast progress initially on access, and recently on reliability. Other countries in the high-reliability group include Egypt and Morocco. In this context, while a system-wide approach is still needed, there is probably more potential for impact through investment in more sophisticated power market investments such as embedded C&I generation and smart metering, as the energy system is more likely to be able to absorb and maximise the benefits of these types of investments.

Power reliability clearly remains a major challenge across much of sub-Saharan Africa and South Asia.

75%

of firms across sub-Saharan Africa experience outages.

5.2. Other conditions to maximise the inclusive outcomes of power sector investments

If and how reliable and affordable access of electricity delivers inclusive outcomes depends on complementary conditions in the economy. Access to (reliable and affordable) electricity is a pre-requisite but does not on its own guarantee economic transformation nor improved outcomes for the poor or for women.[112] The benefits of electrification depend on other economic and social factors within an economy, at the macro and regional level, such as level of unemployment, physical and IT infrastructure, transportation access to roads, and access to markets.

Availability of physical infrastructure and proximity to markets are key to unlocking higher incomes from improved power supply. Rural SMEs have higher electricity consumption if they are close to roads, markets or financial service providers.[113] In urban areas, the growth of neighbourhood population and access to roads are highly correlated with SME electricity use.[114] In regions gaining new or improved access to power, but where local aggregate demand does not change, there may be a redistribution of economic output, but may not be a significant overall increase in incomes. Where links to external markets (within the country or for exports) exist, this may increase potential for power supply to improve the outcomes of poor workers and women, by selling into a market where demand can sustain increased local production without an immediate impact on prices.

Labour market conditions and the broader macroeconomic climate also play a key role in the extent to which firms and households can move into productive and higher-value activities. The impact of electrification, and subsequent uptake of productive or time-saving appliances, depends on macroeconomic policies and readiness. For example, openness to trade and ease of doing business impact the price of such appliances as well as the structure of the economy.[115] Labour market conditions also matter; where there is high unemployment or underemployment, the time savings associated with access to power are less likely to translate into increases in employment or wages.[116]

Access to finance is often a key barrier to unlocking the benefits of electrification. Particularly for people living in poverty, the ability to pay the full cost upfront of electricity-intensive appliances may be limited. Welfare programmes and targeted concessional consumer financing for productive appliances may be needed to catalyse electricity consumption and to maximise the benefits of electrification.

Access to finance is often a key barrier to unlocking the benefits of electrification.

Finally, while this study focuses on four types of utility-scale power investments, these would need to fit within development of the energy system. This includes following a least-cost electrification plan and ensuring the right mix of generating, transmission and distribution, and retail services (including tariff options) are developed. This may also include unbundling of the non-network assets, such as generation and retail services.[117]

112 See Muhwezi, et al., (2021), "Ingredients for growth: Examining electricity consumption and complementary infrastructure for Small and Medium Enterprises in Kenya", available at https://www.sciencedirect.com/science/article/pii/S2352728521000142?via%3Dihub

113 Ibid.

114 Ibid.

115 Cubas (2016), "Distortions, infrastructure, and female labor supply in developing countries", European Economic Review Vol.87, available at https://www.sciencedirect.com/science/article/abs/pii/S0014292116300976

116 Rathi & Vermaak (2018), "Rural electrification, gender and the labor market: A cross-country study of India and South Africa", World Development Vol. 109, available at https://www.sciencedirect.com/science/article/abs/pii/S0305750X18301645?via%3Dihub

117 By network services we mean transmission and distribution, which at local level is typically a natural monopoly. It does not make sense to have more than one transmission or regional distribution network, and so is typically provided by a single regulated distribution operator.

6

Key findings from the research questions

RQ1 A large share of the population in BII investment countries both have access and live under $6.85 per day

A large proportion of the population in developing countries are both poor and have access to electricity. Across BII priority countries, 75 per cent of the population, some three billion people, live in poverty. Many of these people already have access to power; in India and Bangladesh over 80 per cent of the population both have access to power and live in poverty, and almost everyone living in poverty has access to electricity in these two countries. In large African countries such as Nigeria, Ethiopia, and South Africa, between 40 per cent and 60 per cent of people have access to power and yet remain in poverty.

Increasing access rates remains an important goal enshrined in SDG7 and delivers livelihood benefits. Access to lower-tier energy systems, and access for the poorest rural communities, has demonstrated the potential deliver important livelihood benefits. This includes reduced expenditure on other forms of energy access, education for children, improved health and safety, and changing the allocation of time use within households, including freeing up time for non-remunerated work around the household and leisure time.

RQ2 Improving the quality of service of electricity connections appears to be the most impactful mechanism on financial poverty

Improving the quality of access may change financial poverty metrics by more than increasing access rates alone. The impact on incomes and employment opportunities from improving access to (or reliability and affordability of) power at very low ability to pay and consumption levels is limited. For people living in poverty who already have access to electricity, and have higher financial means, skills, and access to markets, the potential to deliver employment opportunities and income increases appears to be higher.

The evidence on improving incomes for people living in poverty is most compelling around improving the reliability of electricity connections. Where people living in poverty have an electricity connection, it is more likely to be relatively lower quality and will be exposed to more voltage fluctuations and power outages. This holds back households from investing in productive assets which may provide a rate of return, and more importantly reduces the opportunities for (higher) wage employment.

For firms, the evidence is robust and positive on the impact of improving power reliability. Poor reliability constrains production and investment in productive assets. Over the longer term, models predict that access to reliable power has a significant effect on capital formation and economic growth, which can drive inclusive outcomes.

In the short term, the inclusive outcomes delivered by improving power reliability may be concentred among moderately poor men. The major shift occurs in the manufacturing sector, which tends to be relatively male dominated, and in regions that are connected to demand centres, often near urban areas. The workers in these firms are likely to be living under $6.85 per day, but less likely to be in extreme poverty. The type of work carried out by women tends to be less electricity-intensive, and in the short term, the ability of women to access the benefits of improved power supply-related employment opportunities may be limited by social norms.

To deliver impact, reliability needs to brough all the way up to minimum service levels and standards. Incremental changes from poor reliability to slightly less poor reliability are unlikely to improve outcomes for women or people living in poverty.

Over the longer term, reliable power supply is a pre-requisite for structural economic transformation that could deliver a more fundamental change in inclusive outcomes. For economies to develop and transition workers from low wage, low skill jobs concentrated in the agriculture sector, access to reliability is a binding constraint that cannot be substituted by other factors of production.

RQ3 Affordability matters for households to free up expenditure for other purposes but does not appear to transform outcomes or short-term behaviour

Improving affordability improves inclusive outcomes from a wellbeing perspective. Reducing the size of energy bills matters, as poorer customers spend a higher share of their expenditure on power or on mitigating the risk of power outages. Reducing expenditure on power frees up resources that can be used for access to other basic goods and services.

Affordability appears less likely to deliver transformation in financial poverty. At least among the very poor, where ability and willingness to pay for power and for other assets is low, there is low elasticity of demand for electricity. So, improving affordability is less likely to deliver transformation on behaviours in terms of how the poor use electricity, or put it to productive ends.

For firms, cost of power matters, but much less than having a reliable power supply. The willingness to pay of firms for a (near) fully reliable supply tends to be far higher than electricity tariffs. While higher costs of power – a key factor of production of course – will affect output levels and competitiveness, this is likely a lower priority for firms than in the first instance having a high quality and reliable power supply.

The financial viability of utilities may be a more important concern; obliging utilities to serve non-cost-recovery customers in high-poverty settings may be counter-productive. Similarly, there may be trade-offs between environmental sustainability, and financial viability / affordability objectives. While renewable energy generation costs have fallen sharply, system integration costs can be substantial, and there is evidence that integrating a high share of renewables pushes up costs and increases energy poverty.

RQ4 Women may benefit less than men from improved power in the short-term, but in the longer term much more substantial outcomes can be delivered for women

There are potential livelihood and empowerment benefits for women. Improving access to power for women can improve empowerment, reduce drudgery and free up time that can be allocated to other activities, and reduce gender-based violence. Improving affordability is important for women, who tend to be less able to afford electricity and have less access to credit.

In the short-term, financial outcomes may be strengthened more for poor men than for women. There is weaker evidence that improved access to, or reliability of, power improves employment outcomes or wages for women. This may be due to sociocultural norms that result in lower employment and wages for women, which access to power alone does not change.

Over the longer-term, intergeneration change and shifting societal norms may deliver larger benefits for women. Improved access to power in households and schools improves education outcomes for girls, which means the next generation of women is better placed to take advantage of a shift to slightly higher skilled and higher productivity work which power supply can help unlock. Improved power supply and access to ICT can also help change cultural norms and empower women, such that over time societal expectations and prejudices on the role of women change.

RQ5 The most impactful power sector investment for delivering inclusive outcomes is highly dependent on context

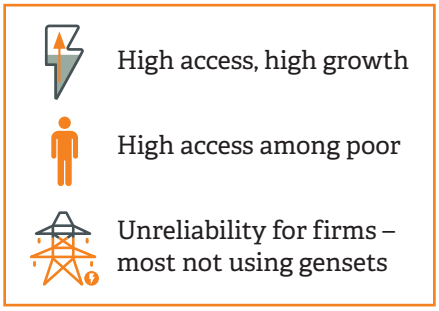
At one end of the spectrum, there are countries where almost all people already have access to power. At the other end, there are countries where access to power is very limited, and almost everyone with access to power is poor, but far more people are poor(er) and do not have access to power. How best to deliver large-scale inclusive outcomes will be very different in each of these two settings, and the range in between. The potential for power sector investments to deliver inclusive outcomes at scale may imply a trade-off between countries with higher extreme poverty rates (where the impact of power sector investments may be limited), versus countries with high rates of people living on less than $6.85 per day but where the power sector has sufficient reach and sophistication. In these countries, such improvements to power supply can improve the outcomes of a larger share of the population.

Given the centrality of ensuring reliability of power supply, different investment types will be better suited in different contexts. Smart-metering, for example, can improve reliability and may be helpful where it can take reliability all the way to ensuring there are no outages. However, in most contexts, the most impactful way to deliver large-scale inclusive outcomes will be on providing a high-quality power supply to firms, so getting the right balance of available power supply and high-performing T&D networks is essential. This will also mean careful management of the pressure to deploy increasing shares of renewable – often intermittent – generating capacity, with making sure demand can be met at all times.

Annex 1: Country case studies

- Bangladesh
- Kenya
- Nigeria
- South Africa

A1.1 Bangladesh case study



Bangladesh electrified rapidly between 1978 and 2022

Household electrification has reached 99 per cent. Some connections were facilitated by the large-scale Solar Home System (SHS) programme, which connected 20 million people (12 per cent of total population) between 2003 to 2018. However, most people have now been reached by the main grid, with SHS increasingly serving as back-up to outages, and/or rooftop PV with net metering connected to the local grid.

Bangladesh went from 0.5GW installed capacity in 1972 to 25GW in 2022.[118,119] Most of this capacity comes from gas (51 per cent), followed by furnace oil (28 per cent), and to a lesser extent coal (8 per cent).[120]

Reliability is improving, but still poses a major challenge to firms

Firms continue to report highly unreliable power, despite improved reliability metrics. Official data shows power shortages reduced from 21 per cent in 2009 to 2 per cent in 2016.[121,122] Nonetheless, 71 per cent of firms state they experience electrical outages, with no noticeable reduction since 2011, although the number of outages in a typical month has decreased from 65 to 26.[123]

Of firms that experience outages, only 34 per cent use a backup generator.[124] Almost 80 per cent of firms are small or medium-sized, and for these firms the cost of running a generator may be too high, or they are unable to bear high upfront costs. Nonetheless, the national diesel genset market has been growing, driven by a combination of power unreliability and industrial growth.[125]

118 Barkat, et al., (2002). "Economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh", available at https://www.hdrc-bd.com/wp-content/uploads/2018/12/6.-Economic-and-Social-Impact-Evaluation-Study-of-Rural-Electrification-Program-in-Bangladesh.pdf

119 BPDP (2022), "Annual Report 2021-22", available at https://bpdb.portal.gov.bd/sites/default/files/files/bpdb.portal.gov.bd/annual_reports/7b792f67_bf50_4b3d_9bef_8f9b568005c9/2022-11-29-05-22-0dea17e09d8a84e72a63312df6b5bdc6.pdf

120 Ibid.

121 Measured by the share of maximum load shedding to maximum demand.

122 Zhang (2019), "In the Dark: How Much Do Power Sector Distortions Cost South Asia", available at https://openknowledge.worldbank.org/server/api/core/bitstreams/ae0fa02f-a4c7-5888-8bf7-0b05a659119e/content

123 WB Enterprise Survey, data from 2022, available at https://www.enterprisesurveys.org/en/data/exploretopics/infrastructure

124 Ibid.

125 BusinessWire (2021), "Bangladesh Diesel Genset Market 2021-2027", available at https://www.businesswire.com/news/home/20210429005450/en/Bangladesh-Diesel-Genset-Market-2021-2027-Market-Forecast-by-KVA-Rating-Applications-Regions-and-Competitive-Landscape---ResearchAndMarkets.com

There is a risk reliability may worsen, with several threats to power supply. There was significant load shedding in 2023, with outages at a rate of over 20 per cent, and almost half of installed capacity not in use.[126] In the decade up to 2016, less than 80 per cent of available capacity was operational most of the time,[127] and transmission network capacity is not growing fast enough to keep up with power generation.[128] Bangladesh's power sector is vulnerable to shocks, such as heatwaves pushing up demand, reliance on gas imports, and closing of powerplants due to coal shortages.[129]

Despite the high rate of electricity access, poverty levels remain high

While less than 10 per cent of the population live below $2.15 per day, 83 per cent live under $6.85 per day.[130] Almost all households have access to electricity, but remain in poverty. There is some evidence that the rural electrification programme contributed to raising household income, reducing poverty and improving education levels. Income of electrified households increased by 64 per cent three years after the baseline and was 27 per cent higher than income of non-electrified households.[130] However, similar positive trends have been observed for households without electricity, albeit smaller in magnitude, suggesting other unobserved factors contributed to economic growth.[132,133]

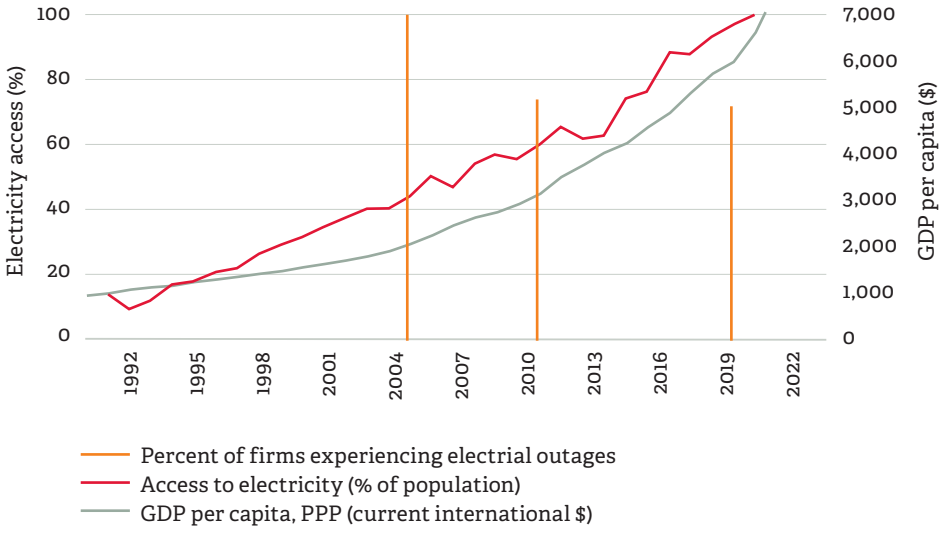


Figure 10: Electricity access and reliability and GDP trend in Bangladesh
Source: WB World Development Indicators, WB Enterprise Survey.

126 NewAge Bangladesh (2023), "Load-shedding across Bangladesh sets record at 2,925MW", available at https://www.newagebd.net/article/201704/load-shedding-across-bangladesh-sets-record-at-2925mw

127 Zhang (2019), "In the Dark: How Much Do Power Sector Distortions Cost South Asia", available at https://openknowledge.worldbank.org/server/api/core/bitstreams/ae0fa02f-a4c7-5888-8bf7-0b05a659119e/content

128 World Bank (2016), "Bangladesh: Ensuring a Reliable and Quality Energy Supply", available at https://www.worldbank.org/en/results/2016/10/07/bangladesh-ensuring-a-reliable-and-quality-energy-supply

129 Mahmud (2023), "Bangladesh suffers long power cuts amid worst heatwave in decades", available at https://www.aljazeera.com/news/2023/6/8/bangladesh-suffers-long-power-cuts-amid-worst-heatwave-in-decades#:~:text=The%20industries%20in%20Bangladesh%2C%20including,to%20cut%20or%20delay%20output

130 WB Poverty & Inequality indicators, available at https://pip.worldbank.org/poverty-calculator

131 Barkat, et al., (2011), "Socio-economic Impact Study of the Rural Electrification Development Project (REDP)", available at https://www.hdrc-bd.com/wp-content/uploads/2018/12/22.-final-report-redp-impact-study.pdf

132 Barkat, et al., (2002), "Economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh", available at https://www.hdrc-bd.com/wp-content/uploads/2018/12/6.-Economic-and-Social-Impact-Evaluation-Study-of-Rural-Electrification-Program-in-Bangladesh.pdf

133 Barkat, et al., (2011), "Socio-economic Impact Study of the Rural Electrification Development Project (REDP)", available at https://www.hdrc-bd.com/wp-content/uploads/2018/12/22.-final-report-redp-impact-study.pdf

GDP per capita growth has been accompanied by economic transformation. In the last 30 years, value-add as a share of GDP for services, manufacturing and industry increased by 4 per cent, 9 per cent, and 14 per cent, respectively, while the share of agriculture dropped by 20 per cent. More than half of value-add now comes from the services sector, followed by 34 per cent for industry and 22 per cent for manufacturing.[134] This growth is correlated with electricity access improvement.

Female labour force participation has barely improved. While male labour force participation hovered around 90 per cent between 2000 and 2016, female participation increased only slightly from 30 per cent to 40 per cent.[135] Impact evaluations of the REP find beneficial outcomes for women in terms of reduced gender-based violence, improved empowerment, access to credit, and work within the home (particularly sewing), but less evidence of significant changes in work outside the home. Reasons for this include the need to change social norms, such as purdah and expectations on the role of women outside the household. An exception is the high growth of the ready-made garment sector, where women comprise 80-85 per cent of workers.[136]

Implications for inclusive outcomes from power sector investments

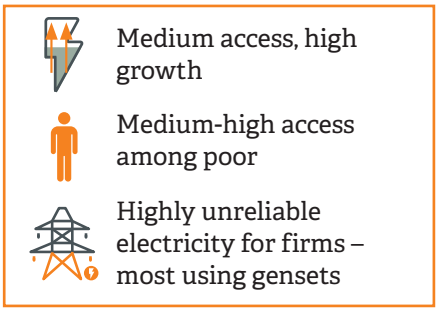
- At high access, decarbonising the energy mix through renewable utility-scale power presents high potential and could address generation availability challenges and the high cost of imported fuels. At the same time, utility-scale power generation reliability is a major priority for inclusive outcomes – so getting the right mix of capacity to serve the load curve is important.
- Investment in T&D will be essential as available generating capacity improves to ensure power is conveyed to end users.
- With two-way metering in place, there is good potential for embedded generation to expand, with a focus on high-growth and inclusive employment sectors such as ready-made garments and light manufacturing.

134 WB Development Indicators, available at https://databank.worldbank.org/source/world-development-indicators

135 World Bank (2019), "Female labour force participation in Bangladesh", available at https://openknowledge.worldbank.org/server/api/core/bitstreams/b230c353-e01c-56e7-b348-5ebdaca1f6ee/content

136 ILO Newsroom (2014), "A quiet revolution: Women in Bangladesh", available at https://www.ilo.org/global/about-the-ilo/newsroom/comment-analysis/WCMS_234670/lang--en/index.htm

A1.2 Kenya case study



Steep growth in GDP per capita and electricity access

Electricity access has increased rapidly. Electrification was below 10 per cent in the early 1990s and has doubled since 2011 from 36 per cent to 77 per cent;[137] the largest increase in sub-Saharan Africa over this period. Installed capacity also increased from 1.6GW to 3GW between 2012 and 2022.[138] Over 80 per cent of electricity generated comes from renewable energy, especially hydro and geothermal, with contributions from solar and wind.[139,140] GDP per capita has also maintained robust growth, at an average of almost 4 per cent between 1990 and 2022.

Poverty remains high among grid-connected and unconnected households

Over 90 per cent of the population lives below $6.85 per day. Furthermore, 36 per cent live below $2.15. It is likely that most households between $2.15 and $6.85 per day already have some form of access to electricity, while unconnected households are more concentrated in rural and unserved communities living below $2.15 a day.

Much of the remaining electricity access gap is in regions where poverty is relatively high. For example, Turkana has an access rate of 8 per cent, West Pokot 12 per cent and Wajir 14 per cent, and these regions also have low monthly consumption expenditures. More than half of the population in these underserved regions live more than 5km from the electricity grid, and are likely also to be relatively far from paved roads and with no or limited access to financial services.[141]

Consumption has not increased in line with access, while reliability also lags behind

Revenue per customer has decreased as the grid rolls out and reaches lower ability to pay and lower consumption users. The '*Last Mile Connectivity Project*' aimed to connect every household within 600m of a distribution transformer, increasing electricity access and improving socio-economic conditions.[142] As a result of the new connections, average electricity revenue generated per customer for the energy company decreased drastically; while the number of connections doubled, total consumption increased by only 25 per cent.[143] This underscores the challenge of connecting low(er) ability to pay customers; even high-consuming rural customers use significantly less than their urban counterparts.[144] This can be explained by high electricity costs, poor reliability, lack of access to financing for electrical equipment, or damaged equipment.[145]

137 WB World Development Indicators, available at https://databank.worldbank.org/source/world-development-indicators

138 Dalberg (2023), "Powering Kenya's Progress", available at https://dalberg.com/our-ideas/powering-kenyas-progress-support-to-gok-on-the-energy-sector-white-paper/

139 IRENA (2023), "Renewable energy statistics 2023", available at https://www.irena.org/Publications/2023/Jul/Renewable-energy-statistics-2023

140 Trade Gov. (2022), "Kenya - Country Commercial Guide", available at https://www.trade.gov/country-commercial-guides/kenya-energy-electrical-power-systems#:~:text=Kenya%20has%20also%20aggressively%20tried,rural%20Kenya%20stands%20at%2065%25

141 USAID (2020), "Off-grid Solar Market Assessment Report for 14 Underserved Counties of Kenya", available at https://www.usaid.gov/sites/default/files/2022-05/Power-Africa-Off-Grid-Solar-Market-Assessment-Brief-14-Underserved-Counties-Kenya-20210311.pdf

142 Kassem, et al., (2022), "Revisiting the Last Mile: The Development Effects of a Mass Electrification Program in Kenya", available at https://www.dropbox.com/s/qmk8qjrcbwn5isb/LMCP_IE.pdf?e=1&dl=0

143 Energy for Growth Hub (2020), "The problem with Kenya Power's revenue model in three graphs", available at https://energyforgrowth.org/article/the-problem-with-kenya-powers-revenue-model-in-three-graphs/

144 Fobi, et al., (2018), "A longitudinal study of electricity consumption growth in Kenya", available at https://qsel.columbia.edu/assets/uploads/blog/2018/publications/a-longitudinal-study-of-electricity-consumption-growth-in-kenya.pdf

145 Ibid.

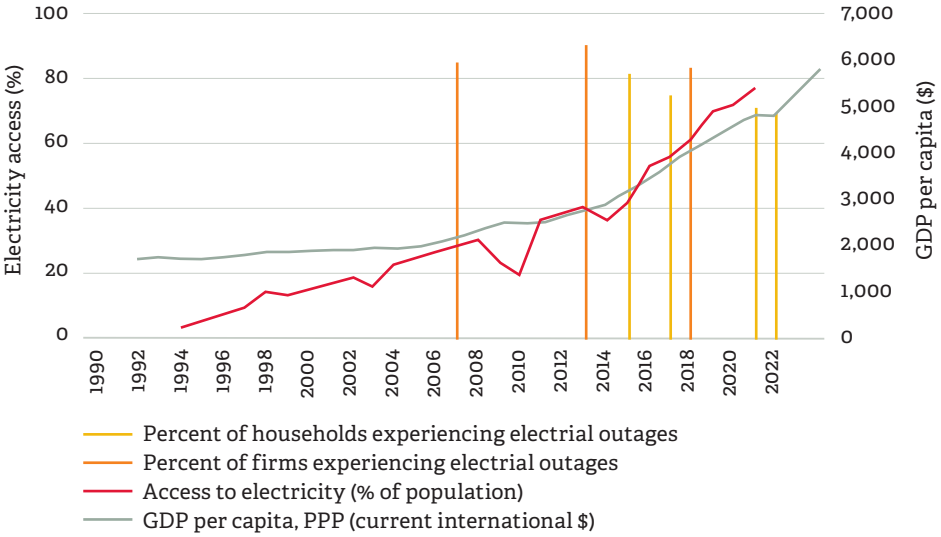


Figure 11: Electricity access and reliability and GDP trend in Kenya
Source: WB World Development Indicators, WB Enterprise Survey, Afrobarometer surveys.

Most firms and households report experiencing outages, despite some signs of improvement in the last two decades. Over 80 per cent of firms report experiencing outages, while 68 per cent of households do (Figure 11). Over 65 per cent of firms use backup generators. This falls more heavily on poorer households; for example in Nairobi, low-income households receive over twice the outage duration and frequency as high-income households.[146]

One of the results of unreliability is increasing reliance on embedded generation. High-consumption commercial and industrial clients, which present more than half of Kenya's utility revenue, are increasingly opting for cheaper and more reliable captive solutions, such as rooftop solar.[147] This contributed to a decline in utility's profit of 92 per cent in 2019,[148] underscoring the importance not only of increasing connections, but of providing a high quality of services for electricity-intensive businesses.

Growth fuelled by the service sector

Growth in GDP has been driven by a booming service sector. Since the 1970s, agriculture has been slowly decreasing, from 30 per cent to 20 per cent of GDP. Meanwhile industry and manufacturing have hovered around 18 per cent and 10 per cent of GDP, respectively. Tourism, telecommunications and financial services have grown to account for 55 per cent of GDP.[149] This expansion has been attributed to improved physical and IT infrastructure, which contributed half a percentage point to Kenya's annual GDP per capita growth over the last decade.[150] This complementary infrastructure can have a multiplier effect on reaping the benefits from improved access to reliable electricity.[151]

146 Ferrall, et al., (2022), "Measuring the reliability of SDG 7: the reasons, timing, and fairness of outage distribution for household electricity access solutions", available at https://iopscience.iop.org/article/10.1088/2515-7620/ac6939/pdf

147 Energy for Growth Hub (2020), "The problem with Kenya Power's revenue model in three graphs", available at https://energyforgrowth.org/article/the-problem-with-kenya-powers-revenue-model-in-three-graphs/

148 Ibid.

149 WB World Development Indicators, available at https://databank.worldbank.org/source/world-development-indicators

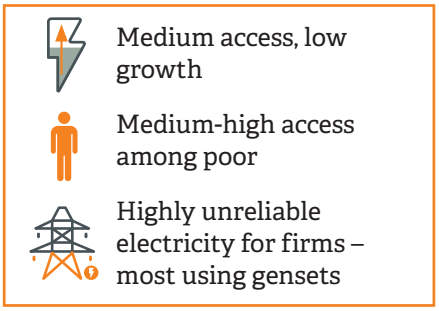
150 World Bank (2010), "Kenya's Infrastructure: A Continental Perspective", available at https://www.researchgate.net/profile/Cecilia-Briceno-Garmendia/publication/228304223_Kenya's_Infrastructure_A_Continental_Perspective/links/0c96052973a64e53c1000000/Kenyas-Infrastructure-A-Continental-Perspective.pdf

151 Muhwezi, et al., (2021), "Ingredients for growth: Examining electricity consumption and complementary infrastructure for Small and Medium Enterprises in Kenya".

Implications for inclusive outcomes from power sector investments

- Increasing connections in the short term appears to have limited impact as rural households have low electricity consumption levels. Enhancing financial poverty outcomes may need a focus on improving reliability of connections, or technical assistance to work on 'demand activation' to ensure new connections also unlock economic activities.
- There is a high share of renewable energy in the generating mix, but with at times unreliable power; investments should seek to improve reliability of power supply through the right mix of base and peak load, and T&D infrastructure.
- Embedded generation is already rolling out, and should continue while also working to ensure the right balance and rules to ensure a fair playing field and opportunity for cost-recovery of investment in grid infrastructure.

A1.3 Nigeria case study



Slow growth in electricity access, but high GDP growth

Electricity access has slowly improved over the past 30 years. From the 1990s to 2022, electricity access increased from 35 per cent to 60 per cent, although population growth means that in absolute terms more people – 85 million in total – are not connected to the grid today.

Between 2000 and 2014, Nigeria's economy grew rapidly. GDP per capita growth rose by 6 per cent per year, to reach $5,416 after which the growth rate flattened out.

At 60 per cent, Nigeria's rate of electricity access is lower than peers with similar GDP per capita. Ivory Coast, Kenya and Ghana each have a similar GDP per capita, but electrification rates of 71 per cent, 77 per cent and 86 per cent, respectively.[152] These three countries all had a lower electricity access rate than Nigeria in 1990, but have improved much more over the past three decades. Installed generating capacity is also low compared to peers. Despite having the largest population and economy in Africa, Nigeria has just 10 per cent of the installed capacity of South Africa.[153]

Poverty rates remain high among grid-connected and unconnected households

Over 90 per cent of the population lives below $6.85 a day. This represents more than 143 million people, 40 per cent of whom do not have access to electricity, which is likely to be a constraint to moving to higher incomes and quality of life. However, most of the population live under $6.85 per day, but already have access to electricity, reinforcing that electricity alone is not sufficient to break out of financial poverty.

Reliability of power is a major issue, with widespread use of backup generators

While access has shown a gradual improvement, reliability has not. The share of firms experiencing outages decreased from 95 per cent to 76 per cent between 2007 and 2014, but surveys report a persistently high share of households experiencing outages at least half of the time. Nigeria has the second-most unreliable grid of countries covered by the Afrobarometer surveys, just above Malawi. Of connected households, just 14 per cent report that their electricity works "most" or "all" of the time.[154]

152 WB World Development Indicators, available at https://databank.worldbank.org/source/world-development-indicators

153 IFC (2019), "The Dirty Footprint of the Broken Grid", available at https://www.ifc.org/content/dam/ifc/doc/mgrt/20190919-full-report-the-dirty-footprint-of-the-broken-grid.pdf

154 Afrobarometer (2022), "Still lacking reliable electricity from the grid, many Africans turn to other sources", available at https://www.afrobarometer.org/wp-content/uploads/2022/04/ad514-pap10-still_lacking_reliable_electricity_from_the_grid-many_africans_turn_to_alternative_sources-afrobarometer-10april22.pdf

Backup generation rivals the grid in terms of capacity and consumption, and is very costly to the Nigerian economy. Generators amount to 13GW – equivalent to the installed capacity of the regional electricity grids,[155,156] while end users spend more on generator fuel than on consumption from the grid.[157] Electricity from generators is more expensive at $0.40/kWh,[158] than the main grid at $0.10/kWh.[159] Operations and maintenance costs add an additional 10-20 per cent on top of this.[160] Industrial users spend as much as 1.3 per cent of GDP annually on large diesel generators.[161]

The removal of fuel subsidies may spur demand for improved grid reliability. President Bola Tinubu removed fuel subsidies in 2023,[162] which increased the costs of running generators. However, electricity tariffs also increased, with local papers reporting that "Nigerians pay premium for unavailable electricity".[163]

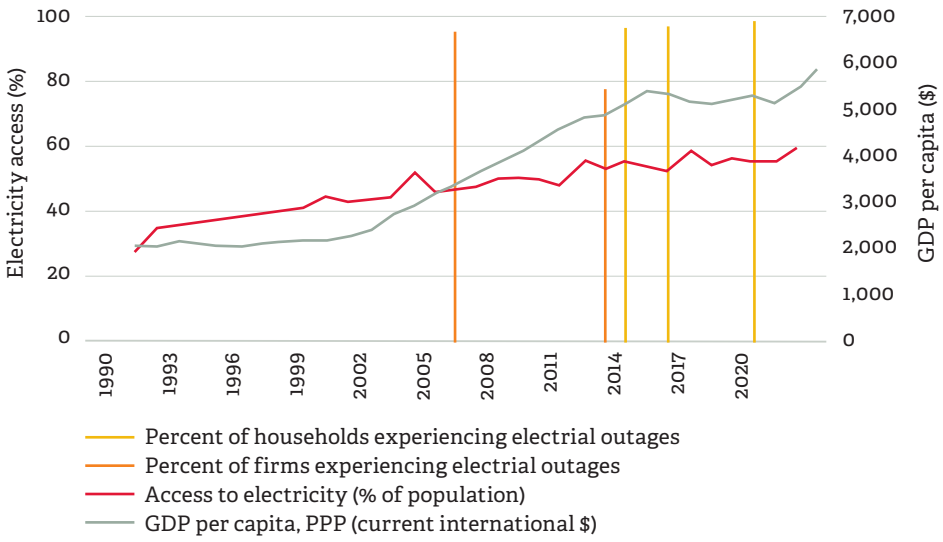


Figure 12: Electricity access and reliability and GDP trend in Nigeria
Source: WB World Development Indicators, WB Enterprise Survey, Afrobarometer surveys.

155 IFC (2019), "The Dirty Footprint of the Broken Grid"

156 Nigeria Energy/IRENA (2023), "Renewable Energy Roadmap Nigeria", available at https://www.nigeria-energy.com/content/dam/markets/emea/nigeria-energy/en/2023/docs/NE23-NigeriaEnergyRoadmap-Report.pdf

157 IFC (2019), "The Dirty Footprint of the Broken Grid"

158 Offgrid Nigeria (2021), "Diesel power generation still cost rural villages N150/kWh in Nigeria", available at https://www.offgridnigeria.com/4928-2/#:~:text=%E2%80%9CMeanwhile%2C%20Nigeria's%20population%20continues%20growing,kWh%20(%240.40%2FkWh)

159 Climatescope, "Nigeria", available at https://www.global-climatescope.org/markets/ng/

160 IFC (2019), "The Dirty Footprint of the Broken Grid"

161 Ibid.

162 IISD (2023), "Nigeria Must Ensure its Fuel Subsidy Reform Sticks for the Long Term", available at https://www.iisd.org/articles/deep-dive/nigeria-fuel-subsidy-reform

163 The Guardian Nigeria (2023), "Amid 168% tariff hike in 8yrs, Nigerians pay premium for unavailable electricity", available at https://guardian.ng/news/amid-168-tariff-hike-in-8yrs-nigerians-pay-premium-for-unavailable-electricity/

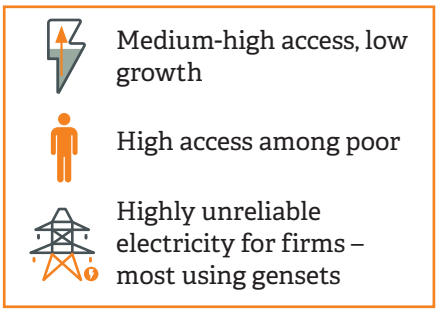
Concentration of economic opportunities

Growth has been fuelled since the 70s by a small set of sectors and regions, in particular by a high oil price and in the 2000s a booming financial and telecommunications sector.[164] Growth has been concentrated around Lagos and resource-rich areas,[165] such that most areas and sectors have not profited from this economic growth, coined as "jobless growth".[166] The share of agriculture in GDP has increased slightly, while transition sectors such as manufacturing and industry decreased during the period of economic growth from 48 per cent of GDP in 2000 to 30 per cent in 2015.[167] So far, Nigeria's development is not reaching the whole population, with 80 per cent of workers employed in sectors with low level of productivity.[168]

Implications for inclusive outcomes from power sector investments

- Improving reliability of existing connections is a high priority to unlock growth in higher value-add sectors and to offer employment opportunities.
- There is a large share of the population without access to electricity – continuing both grid expansion and off-grid to rapidly improve standards of living is also a high priority.
- Investment in power generation, and in improving the performance of the regional distribution companies, is a priority for improving reliability and affordability, noting the relatively high electricity tariffs in Nigeria.
- Removal of fuel subsidies offers an opportunity to make grid-based electricity affordable relative to gensets, with potential to decarbonise electricity consumption and provide a high reliability service.

A1.4 South Africa case study



High electricity access and GDP growth, but high poverty

Electricity access and GDP per capita have risen steadily over the past 30 years. Around 90 per cent of the population has electricity access. While GDP per capita has risen, there is persistent poverty with around 60 per cent of the population living under $6.85 per day and 20 per cent under $2.15 per day. Given the high rates of electricity access, most people in poverty already have access, and this has not (yet) resulted in a transformation in the financial outcomes and lifted them out of poverty.

Electricity generation relies heavily on coal and is very centralised. The country relies on coal for electricity generation, around 85 per cent or 42GW of its total installed capacity of 52GW.[169,170] Eskom, the national power utility, supplies 95 per cent of the total electricity demand.[171]

164 Nigerian Ministry of Foreign Affairs (n.d.) "Economy", available at https://foreignaffairs.gov.ng/nigeria/nigeria-economy/

165 McKinsey (2023), "Microregional data uncover a richer picture of development in Nigeria", available at https://www.mckinsey.com/featured-insights/middle-east-and-africa/microregional-data-uncover-a-richer-picture-of-development-in-nigeria

166 Dada (2018), "Jobless Growth in Nigeria: Determining Employment Intensive Sectors", available at https://scholarlypublishingcollective.org/psup/african-development/article-abstract/20/2/69/200128/Jobless-Growth-in-Nigeria-Determining-Employment?redirectedFrom=PDF

166 WB World Development Indicators, available at https://databank.worldbank.org/source/world-development-indicators

168 Brookings (2023), "Nigeria in 2023: Bridging the productivity gap and building economic resilience", available at https://www.brookings.edu/articles/nigeria-in-2023-bridging-the-productivity-gap-and-building-economic-resilience/

169 US Gov Trade (2024), "South Africa - Energy", available at https://www.trade.gov/country-commercial-guides/south-africa-energy

170 Trace (2020), "South Africa's crippling electricity problem", available at https://www.opml.co.uk/blog/south-africa-s-crippling-electricity-problem

171 GreenCape (2020), "2020 Energy Services Market Intelligence Report", available at https://greencape.co.za/assets/ES_MIR_29_3_22_FINAL.pdf

Reliability is the main issue with the country facing a load-shedding crisis

Since 2007, load shedding has been a major issue, with 2023 the worst year so far, seeing outages on 335 days.[172] Load shedding between 2007 and 2019 is estimated to have cost the economy $1.8 billion, dampening GDP growth by a similar magnitude as the 2008 financial crisis.[173]

Available generating capacity has not kept up with rising demand. Outdated and poorly maintained coal power stations are one of the main drivers of blackouts,[174] while power shortages by 2007 were predicted in the late 90s, due to poor maintenance and rising demand.[175,176] ESKOM is in a position of financial unsustainability, with the national energy regulator warning of a "utility death spiral".[177] Highly subsidised tariffs have deterred private sector investment,[178] and despite a doubling of tariffs between 2008 and 2013, Eskom tariffs remain far from cost-reflective.[179] High debt is pushing the utility to raise tariffs, which drives commercial and industrial customers to install their own generating assets, resulting in Eskom seeking to recover rising costs from a shrinking customer base.

Lack of reliable electricity supply is the biggest obstacle to firm growth. 92 per cent of firms experience outages and 63 per cent use generators.[180] As a comparison, on average 74 per cent of sub-Saharan African firms experience outages. 55 per cent of firms choose electricity as their biggest obstacle to growth.[181]

Households and firms opt for self-generation to limit the risks of load shedding

Households have been increasing their generator use and consumption of alternative sources. For example, in Gauteng, 0.8 per cent of residents had access to solar or wind, and 0.3 per cent had a generator in 2013. By 2021, these had increased to 5 per cent and 4 per cent, respectively.[182] Access to solar power within the lowest income group increased from 0.3 per cent to 3 per cent, in the highest-income bracket rose from 4 per cent to 12 per cent. For generators these numbers are from 0.2 per cent to 2 per cent for the lowest income group and 3 per cent to 17 per cent for the highest income group.[183]

172 Daniels (2023), "2023 cumulative load shedding worst in 15 years", available at https://www.iol.co.za/capetimes/news/2023-cumulative-load-shedding-worst-in-15-years-3994e911-8df7-4968-a201-b0e3f6e1792d#:~:text=According%20to%20Eskom%2C%20there%20were,economic%20impact%20is%20at%20R12

173 Walsh, et al., (2020), "Estimating the economic cost of load shedding in South Africa", available at https://www.novaeconomics.co.za/our-work/estimating-the-economic-cost-of-load-shedding-in-south-africa

174 OECD (2023), "Africa's Development Dynamics 2023", available at https://www.oecd-ilibrary.org/development/africa-s-development-dynamics-2023_3269532b-en

175 Predicted in the 1998 Energy Sector White Paper, as described in Walsh, et al., (2020), "Estimating the economic cost of load shedding in South Africa", available at https://www.novaeconomics.co.za/our-work/estimating-the-economic-cost-of-load-shedding-in-south-africa

176 Phaahla (n.d.), "The state of electricity in South Africa – Part I: The problems in Eskom", available at https://hsf.org.za/publications/hsf-briefs/the-state-of-electricity-in-south-africa-part-i-part-i-the-problems-in-eskom

177 The National Energy Regulator of South Africa (NERSA) has described Eskom as in a "utility death spiral", see US Gov Trade (2024), "South Africa - Energy", available at https://www.trade.gov/country-commercial-guides/south-africa-energy

178 Walsh, et al., (2020), "Estimating the economic cost of load shedding in South Africa", available at https://www.novaeconomics.co.za/our-work/estimating-the-economic-cost-of-load-shedding-in-south-africa

179 Ibid.

180 The World Bank Enterprise Surveys, available at https://www.enterprisesurveys.org/en/data/exploretopics/infrastructure

181 Ibid.

182 Fatti & Khanyile (2023), "Justice implications of household access to alternative water and electricity", available at https://www.gcro.ac.za/outputs/vignettes/detail/accessing-alternative-water-and-electricity-sources-and-justice/

183 Ibid.

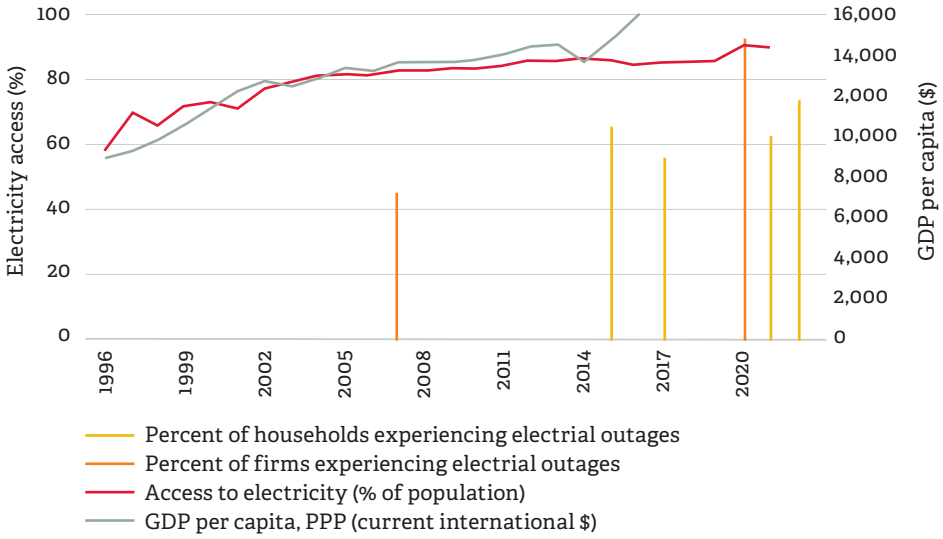


Figure 13: Electricity access and reliability and GDP trend in South Africa
Source: WB World Development Indicators, WB Enterprise Survey, Afrobarometer surveys.

The decentralised energy market is growing through small-scale embedded generation and corporate PPA market. The This is in part due to supportive energy policies and regulations, and energy financing programmes.[184] Small-scale embedded generation (SSEG), dominated by rooftop solar PV, is quicky rising,[185] especially in municipalities concentrated in the Northern and Western Cape regions, and Gauteng. The rooftop solar PV market expected to reach to $4 billion by 2035,[186] while the corporate PPA market is growing with companies signing contracts for solar generation ranging from 1MW up to 150MW.[187]

Unequal spoils of GDP growth

Economic transformation since the 1980s was characterised by a booming skilled-services sector. The value-add of agriculture, manufacturing and industry have declined, with the value-add as a percentage of GDP reducing by almost 50 per cent for these three sectors.[188] The services sector, on the other hand, has been increasing from a value-add as a percentage of GDP of 47 per cent in 1980 to 62 per cent in 2022.[189] Steady GDP per capita growth of 3 per cent masks inequality and lack of job opportunities; South Africa has the highest unemployment rate globally, at 29 per cent,[190] in part because of a weak export-oriented manufacturing sector, which typically has both high labour productivity and a high demand for low-skilled labour.[191]

184 GreenCape (2020), "2020 Energy Services Market Intelligence Report", available at https://greencape.co.za/assets/ES_MIR_29_3_22_FINAL.pdf

185 Small-scale Embedded Generation (SSEG) Municipal Resource Portal (2023), "Status update", available at https://www.sseg.org.za/wp-content/uploads/2023/12/SSEG-Graph-SA-2023-web-res.pdf

187 GreenCape (2020), "2020 Energy Services Market Intelligence Report", available at https://greencape.co.za/assets/ES_MIR_29_3_22_FINAL.pdf

188 SolarPower Europe (2023), "Global Market Outlook For Solar Power 2023 - 2027", available at https://www.solarpowereurope.org/insights/outlooks/global-market-outlook-for-solar-power-2023-2027/detail

189 WB World Development Indicators, available at https://databank.worldbank.org/source/world-development-indicators

180 Ibid.

190 Ibid.

191 Rodrik (2008), "Understanding South Africa's economic puzzles", available at https://scholar.harvard.edu/files/dani-rodrik/files/understanding-south-africa.pdf

Implications for inclusive outcomes from power sector investments

- Addressing power market constraints causing unreliability is the highest priority, while also managing the viability and performance of Eskom.
- Decarbonising generation and working to replace the ageing coal-fired fleet of power plants offers opportunities to both deliver sustainability outcomes and inclusive outcomes. The government's new resource plan envisions a boost in electricity generation of 29.5GW, led by renewables (14.4GW from wind and 6GW from solar PV).[192]
- Given the high access rate, closing the remaining gap is a high priority for inclusive outcomes, as those still lacking access are likely also the most lacking in economic opportunities. High inequality is also a major topic in South Africa, and a cause of unrest.
- Embedded C&I generation is a rapidly expanding opportunity, with many municipalities now having two-way metering and wheeling arrangements in place, and supporting policies and incentives offered.[193]
- Eskom has decided to invest in smart-meters, with a programme totalling around $1 billion. It hopes to recover 7GW into the grid.[194] This could support better targeting of social tariffs based on time-of-use tariffs.

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About Greencroft Economics

Greencroft Economics is a boutique economic consultancy, founded in June 2019, to advise public and private sector clients on sustainable development in emerging economies. greencrofteconomics.com

For further information:

- **British International Investment**
  Hayat Abdulahi
  habdulahi@bii.co.uk
  bii.co.uk/insight