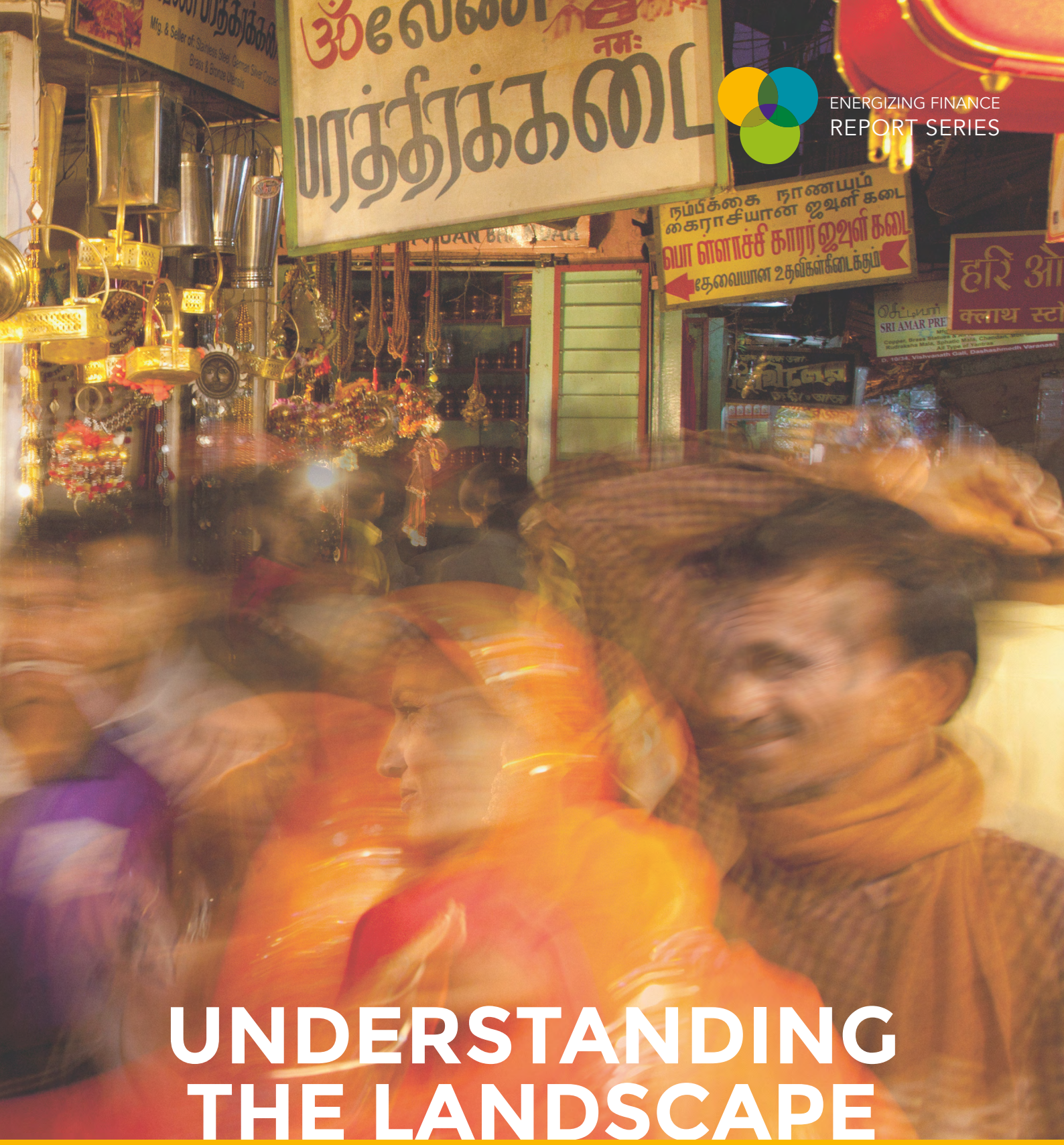

ENERGIZING FINANCE
REPORT SERIES

UNDERSTANDING THE LANDSCAPE

TRACKING FINANCE FOR ELECTRICITY AND CLEAN COOKING ACCESS IN HIGH-IMPACT COUNTRIES

ESMAP
Energy Sector Management Assistance Program

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Washington, DC Office
1750 Pennsylvania Ave NW, Suite 300
Washington, DC 20006, USA

Telephone: +1 202 390 0078
Website: SEforALL.org

Vienna Office
Andromeda Tower 15th floor
Donau City Strasse 6
1220, Vienna, Austria

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FOREWORD

This new report, Understanding the Landscape: Tracking Finance for Electricity and Clean Cooking Access in High-Impact Countries, provides a pathway to refine and improve strategies to accelerate progress in delivering universal energy access.

The report is specifically geared for government leaders, public and private finance players and energy access enterprises, at the international and domestic level, that all play critical roles in catalyzing action on access to electricity and clean cooking—two cornerstone priorities of the Sustainable Development Goals.

Our findings are especially relevant for countries in Asia and Sub-Saharan Africa, which have significant energy access gaps and promising opportunities to close those gaps more quickly and at less cost. We offer specific recommendations for doing so.

While many studies have estimated the amount of investment needed to meet energy access goals, none has attempted to systematically capture what developing countries are spending on energy infrastructure and, more importantly, the overall effectiveness of those expenditures in delivering modern energy services to more people, more quickly.

This report is part of a unique research effort by Sustainable Energy for All, the World Bank, the African Development Bank, Climate Policy Initiative, E3 Analytics and Practical Action Consulting that for the first time begins to answer these critical questions. Through multiple reports, we evaluated the quantity and impact of energy-related finance from all sources—public and private, domestic and international—for electricity and clean cooking access.

This report analyzes financing commitments for electricity and clean cooking over 2013-14 in 20 high-impact countries in Sub-Saharan Africa and Asia, whose efforts are critical to meeting energy access objectives by 2030. It includes detailed country studies, focused on Bangladesh, Ethiopia and Kenya, looking at domestic finance spending on electricity and clean cooking access.

While the overall data has limitations, we have enough information to get a first-ever picture of how energy access finance is being used in these 20 countries and for what types of infrastructure – whether grid-based electricity that serves commercial, industrial and urban populations, or decentralized electricity solutions, such as household solar systems, that are better suited for rural populations, or biogas and biomass cooking solutions for households.

The report's biggest takeaway is that finance flows for electricity and clean cooking are way too low to deliver universal access.

In the case of electricity, much of the finance today focuses on more expensive grid-based infrastructure, highlighting the need for greater attention on decentralized renewable energy solutions, which can deliver basic modern energy services more quickly and at less cost to rural and hard to reach areas. Our report suggests that by refining electrification strategies with a more balanced emphasis on grid- and off-grid solutions, governments and development institutions can achieve far bigger gains on access to electricity, especially in rural areas. The report highlights early progress in this regard – by countries such as Kenya

and Bangladesh, and development finance institutions like the World Bank and the African Development Bank—but those efforts are still early stage and bigger shifts are needed.

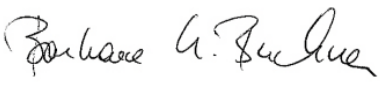
In the case of clean cooking, the challenges are far bigger and more profound. While a handful of countries, like Bangladesh and Indonesia, have made advances on clean cooking, overall investment in clean cooking fuels and technologies is extraordinarily low and bold market-based strategies are urgently needed.

Our research comes at a critical juncture in achieving—or falling short—of the global energy access goals. We have just 13 years left to achieve energy access for all by 2030. Yet, based on the latest 2017 Global Tracking Framework data, just over one billion people globally still lack access to electricity and three billion lack access to clean cooking. The vast majority are in the 20 countries we target in our research.

These numbers are astounding and unacceptable. Lacking access to electricity means food cannot be refrigerated, vaccines cannot be kept safe and school children cannot do homework at night. Similarly, indoor cooking pollution from burning charcoal, wood and other fuels kills several million people every year. There is a larger economic toll, too. Countries that leave these populations behind undermine long-term economic development as well as national security.

We can and must do better to accelerate energy access progress. We hope this report provides a pathway for doing so.

JANE OLGA EBINGER
Policy Director,
Sustainable Energy for All



DR. BARBARA BUCHNER
Executive Director, Climate Finance,
Climate Policy Initiative

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EXECUTIVE SUMMARY

More than one billion people live without access to electricity and many more live with inadequate electricity supply; at the same time, more than three billion lack access to clean cooking technologies (IEA and World Bank, 2017). A lack of—or limited—electricity access means clinics cannot keep vaccines cool, school children cannot do homework at night and businesses cannot run efficiently (United Nations, 2017). Similarly, indoor cooking pollution from burning wood, charcoal, coal and other fuels kills around four million people a year (United Nations, 2017).

Despite the scale of these challenges, relatively little has been known—until now—about the volume or composition of finance directed to the energy sectors in the developing world. Finance is critical to support the achievement of Sustainable Development Goal 7, which aims for universal energy access by 2030—including in electricity and clean cooking—and calls for energy to be affordable, reliable and sustainable.[1] While there have been a number of attempts to estimate the amount of investment needed to meet universal energy access goals, none have attempted to systematically analyze what these countries are actually spending on energy access.

This report aims to advance the understanding of finance directed toward the developing world's energy sectors, covering both electricity and clean cooking. The report covers the 20 developing countries—known as the high-impact countries—that together are home to 80 percent of those living without access to modern energy globally. Given their weight in terms of unserved populations, they jointly provide a reasonable first-order approximation for the overall energy access situation globally. The analysis of finance to support energy access is considered, therefore, from two angles:

1. The first—the "global approach"—draws on international databases for the 20 high-impact countries for electricity and clean cooking. The advantage of this approach is that it paints a broad picture of the global situation and is relatively effective at capturing international public finance for large-scale projects. The main disadvantage is a more limited coverage of domestic finance, which is known to be a significant share of overall financing flows to the sector and could amount to 20-40 percent of the total, based on the case studies in this report. While data on domestic private finance was available in some cases, there was limited information on domestic public finance in international databases. Results are reported on aggregate for these 20 countries and are influenced by flows to larger countries, such as India.

2. The second—the "country approach"—is based on collecting data at the national level for three high-impact countries—Bangladesh, Ethiopia and Kenya—using databases and surveys of governments, utilities and other local institutions. These countries were chosen for their varying levels of economic and energy sector development, to provide a regional contrast between Africa and Asia, and also because baseline energy access surveys were underway. The advantage of this approach is that it provides for more precision and is better able to capture domestic public

[1] *Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all by 2030.*

finance—although availability of domestic private finance remains limited. The main disadvantage is the higher cost and longer time frame required, which limited its application to just three countries.

Inevitably when piloting a new approach, data limitations are encountered, and results should therefore be considered indicative. Such limitations can offer insights on where to strengthen data tracking systems for future work. For example, better data tracking is needed for private finance of decentralized energy systems. Also, there is a need to better distinguish between finance that generates new electricity connections versus improved service for existing connections. Finally, there is a need across all data collection systems to more thoroughly capture clean cooking investments.

Overall, finance for energy access is not on track to meet universal energy access goals.

Finance commitments for electricity will need to increase significantly to meet international electrification targets. The annual average level of finance for electricity across the 20 high-impact countries was at least $19.4 billion over 2013-14, covering the full electricity supply chain from generation through transmission and distribution to off-grid electricity. Only about $6 billion of this total is estimated to result in both *new and improved* access to electricity for residential users through investments along the electricity supply chain. This falls well below the $45 billion needed annually to meet 2030 goals for universal electrification (SEforALL, 2015). Indeed, detailed case studies show that countries allocated $13-33 per capita per year to finance for electricity, equivalent to between 2-3 percent of their GDP. As a point of reference, the cost of basic electricity access—like a small solar home system—is between $50-100 for a typical household of five people, while the cost of providing a higher service level with grid electricity can be considerably greater (World Bank, 2015).

Finance commitments for clean cooking, on the other hand, are so low that they could not be expected to have any significant impact on the cooking access gap. Annual residential clean cooking investment needs are at least $4.4 billion per year (SEforALL, 2015); however, trackable clean cooking investment across all 20 high-impact countries amounted to an average of just $32 million per year. In absolute terms, finance for clean cooking in high-impact countries comes to under $1 per capita per year. As a point of comparison, the cost of providing an improved cookstove for one household—excluding fuel costs—is estimated at around $8 for an advanced biomass cookstove, rising to around $40 for an alcohol stove (GACC, 2017b). An LPG stove typically costs in the region of $55 in up-front costs and around $250 in (unsubsidized) fuel costs (Putti et al., 2015).

ELECTRICITY FINDINGS

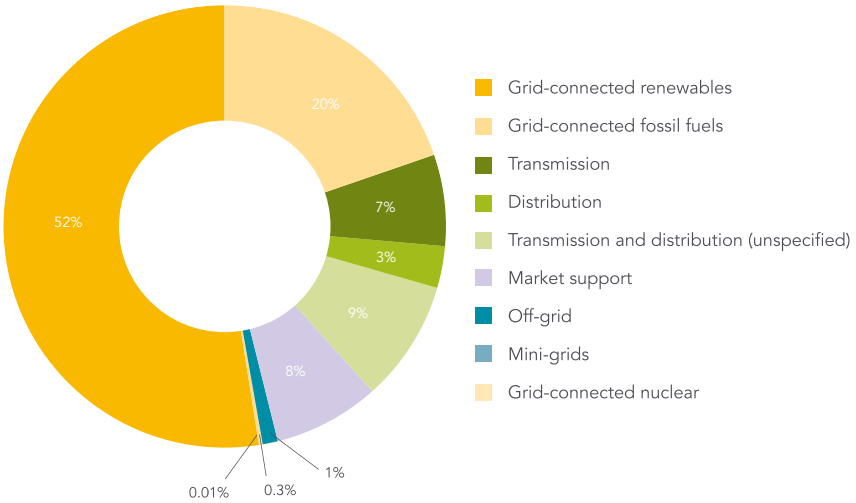
Almost all finance commitments for electricity that could be tracked in the high-impact countries were aimed at grid electricity. Only one percent of total finance for electricity—or around $200 million per year—is directed to support investment in off-grid solutions, such as solar home systems (SHS) and mini-grids, across the high-impact countries (Figure ES1). Due to limitations in data tracking, this likely underestimates the financing of small-scale, decentralized private firms active in this space. A further eight percent of total finance went to market support activities, encompassing a wide range of technical assistance including, among other things, the development of markets for the private sector provision of decentralized energy solutions. By contrast, 90 percent of trackable finance went to the development of national electricity infrastructure, including to grid-connected generation projects (which accounted for 72 percent of the total) and transmission and distribution infrastructure (19 percent of the total).

The country case studies generally found a higher share of finance going to transmission and distribution infrastructure (ranging between 35-50 percent of the total). This may reflect the fact that transmission and distribution projects are often smaller and more likely to be

domestically financed than large generation projects and so can be more readily captured through country-level field work. Additionally, approximately 50 percent of trackable finance went to grid-connected generation in each of the three "deep-dive" countries (Bangladesh, Ethiopia and Kenya).This reflects the importance of expanding electricity generating capacity to ensure that electricity supply keeps pace with the demands of growing and industrializing economies.

Two-thirds of finance for grid-connected generation projects went to renewable energy, twice as much as for fossil fuels. Renewable energy here encompasses hydropower, geothermal, wind, solar and biomass. This suggests that most finance commitments tracked for electricity may be helping to meet climate goals and is consistent with the growing focus of developing countries on renewable energy development (REN21, 2015).

Figure ES1 - Share of finance for electricity by technology type across the high-impact countries



Note: Average over 2013-14

At least a third of finance commitments for electricity benefit new or improved access for residential consumers of electricity, with the balance going to expand electricity supply to industry and support growth in the wider economy.[2] Based on the "global approach," about 30 percent of finance for electricity is estimated to benefit residential electricity access, averaging $6 billion per year, with the rest benefiting commercial and industrial customers. This split is based on relative consumption shares of these two customer groups, as well as their usage of different segments in the electricity supply chain. Similar conclusions emerged from the country case studies for Ethiopia and Bangladesh, with Kenya slightly higher at around 40 percent.

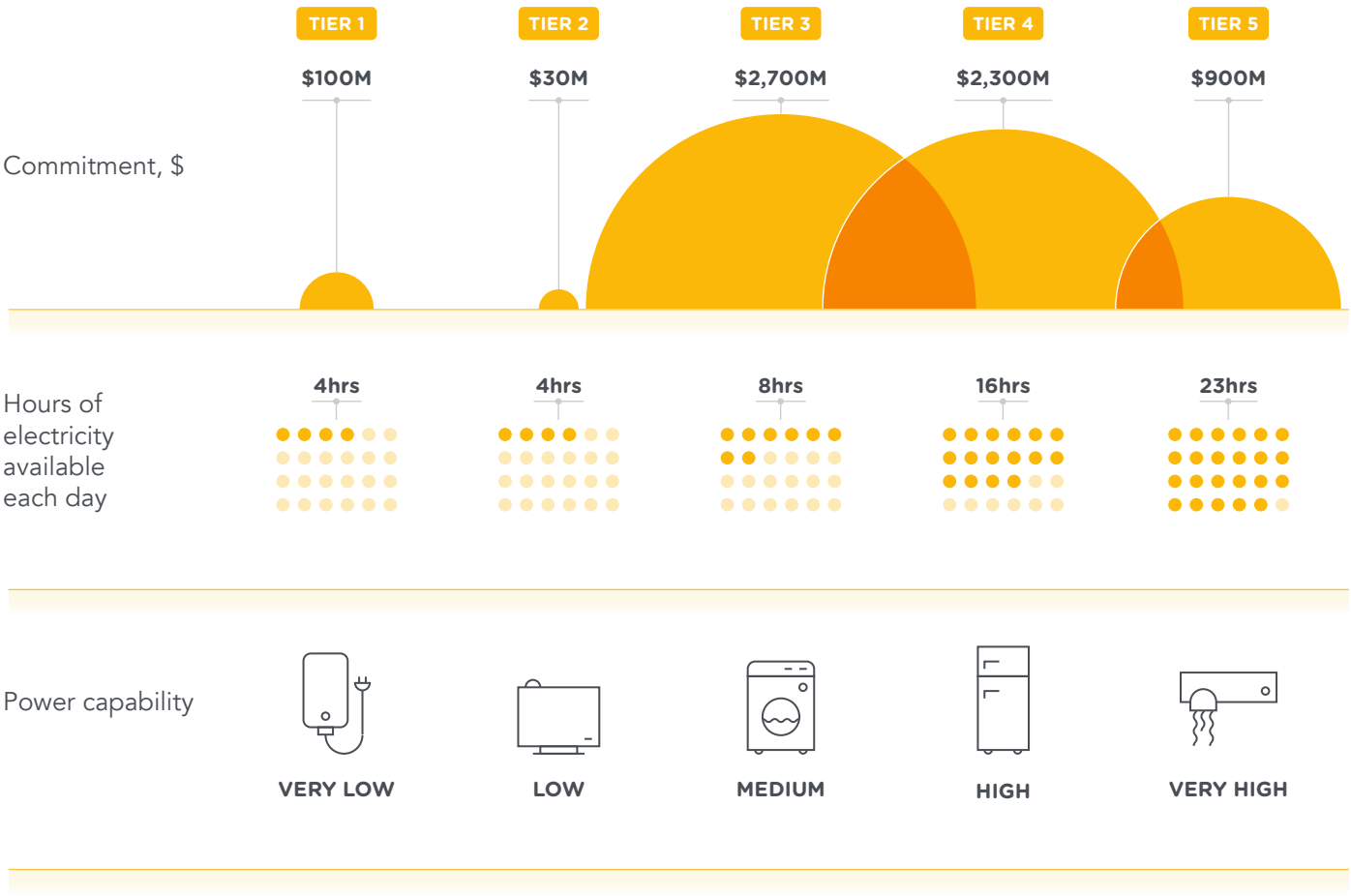
Most finance for residential electricity access supports a medium or high level of energy service. The World Bank's Multi-Tier Framework (MTF) provides a way of estimating electricity access based on a spectrum of service levels, ranging from Tier 1—representing a basic lighting service for a few hours each day—to Tier 5—representing at least 23 hours-a-day of grid supply (Figure ES2). An approach has been piloted through this research to

[2] Calculations on the share of investments benefiting residential and other customers differed slightly by methodology - see Annex 1 of the main report for discussion of the global and country approaches.

map finance commitments to Tiers of energy service. This illustrates that finance for residential electricity access primarily supports service provisions at Tiers 3-4. Finance for Tier 1 and Tier 2, while smaller, nonetheless represents an important step forward for quality of life that can bring electricity access relatively quickly and cost-effectively to rural communities.

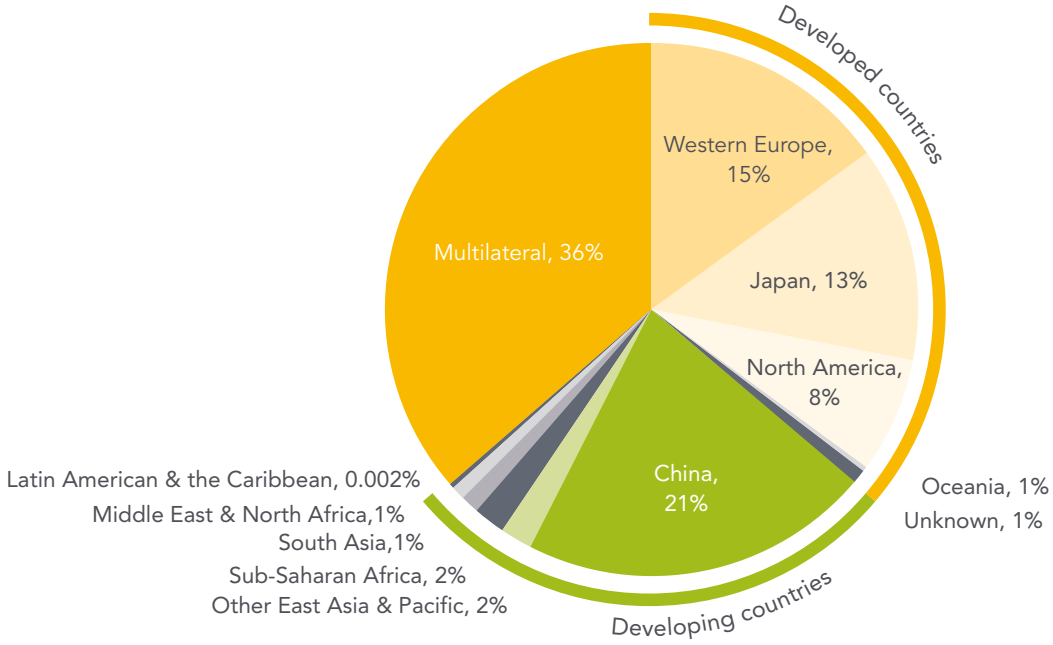
Finance for electricity typically accounted for 0.25-2.0 percent of GDP, with substantial variation across countries. Most countries reported finance commitments for electricity equivalent to 0.25-2.0 percent of their GDP and, in 12 of the 20 countries total finance for electricity accounted for less than one percent of GDP. Malawi and Afghanistan stand out for having finance for electricity accounting for almost eight percent and five percent of GDP respectively, which is consistent with large aid and other commitments to those countries. The country approach was typically able to capture larger volumes of finance than was possible using the global approach in the same

Figure ES2 - Finance commitments supporting residential electricity, by Tiers of energy access (average in 2013-14)



Source: Adapted from IIED (2016), based on IEA and WB 2015: http://pubs.iied.org/pdfs/16623IIED.pdf

Figure ES3 - Sources of international finance for electricity flowing to the 20 high-impact countries



Note: Average over 2013-14. The figure includes public and private sector sources.

countries. In the country case studies, additional domestic finance commitments were captured, boosting the GDP share to around 2 percent of GDP for Ethiopia and Kenya and 3 percent of GDP for Bangladesh.

International investment has been the largest source of finance for electricity. In aggregate, across the 20 high-impact countries, international finance represented an annual average of $11.7 billion per year, or just over half of commitments captured. This comes almost entirely from public sector institutions, though the sources and terms vary across countries. In Kenya, for example, half of the financing flows originate from multilateral sources, chiefly the World Bank, while in Ethiopia more than half of the financing comes from bilateral sources, largely as non-concessional finance from China. China was also the largest bilateral donor across the 20 high-impact countries (Figure ES3).

A closer look reveals that national governments can also be a significant source of finance for electricity by drawing from their own budgets. In Ethiopia and Kenya, around 20 to 25 percent of finance for electricity is domestically sourced. By contrast, in Bangladesh around 45 percent of finance for electricity comes from domestic sources: about two-thirds from the central government budget and one-third from internal cash generation (or balance-sheet financing) from public utilities. The contribution of international capital is correspondingly smaller. Repeating detailed country case studies across the 20 high-impact countries would likely reveal a higher level of domestic finance in both absolute and proportional terms than could be captured under the aggregated global approach.

International private finance constituted a small proportion of total finance for electricity tracked, averaging 6 percent of total commitments—a little over $1.2 billion per year—while there is relatively little data on domestic private finance. It proved difficult to

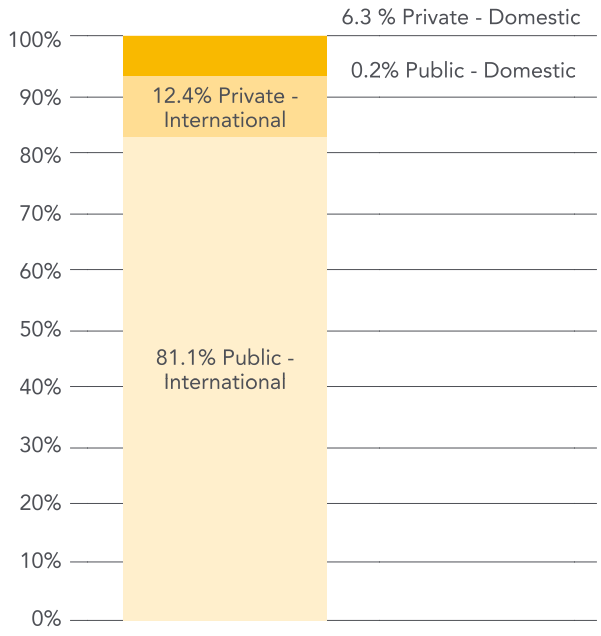
obtain data from domestic private sector institutions on their domestic financing for electricity, whether they were commercial banks funding public utilities or small-scale companies engaged in decentralized energy services. For several of the 20 high-impact countries, zero domestic private finance was tracked. The two notable exceptions were India and the Philippines where there were much higher levels of private sector domestic finance tracked (around 40 percent total country flows in the case of India and almost 75 percent in the Philippines). However, it is difficult to say whether these countries are genuine outliers or simply reflect varying levels of data across the 20 high-impact countries.

The analysis predominantly focuses on 2013 and 2014 and may not reflect more recent market trends. For example, the market for off-grid solar power has accelerated significantly since the beginning of 2014. Although the entire sector market remains small—having attracted globally $511 million of investment from 2008 to 2015 (BNEF, Lighting Global and GOGLA, 2016)—companies providing pay-as-you-go solar systems alone raised $223 million of funds in 2016 (BNEF, 2017).

COOKING FINDINGS

Total finance commitments for residential clean cooking were estimated to average $32 million over 2013-14 for the 20 high-impact countries. International public funding was the largest source representing 80 percent of the overall flows in the two-year period. While public finance accounted for much of the finance for clean cooking, commercial lending to small enterprises is also beginning to flow (Figure ES4). In Kenya, for example, commercial debt was also provided to distributed-energy companies providing clean cooking services and about half of the finance was channeled to non-governmental organizations.

Figure ES4 - Sources of finance for clean cooking



Note: Average over 2013-14

In most countries, finance for cooking targeted two main technologies: biogas digesters and biomass cookstoves. Due to the small sample of projects and the large influence of outliers, it is hard to draw firm conclusions about the technological preferences of cooking financiers. Nevertheless, barring one large City Gas Distribution Project in India, funds were mainly allocated to biogas digesters, averaging $17 million of finance annually, followed by biomass cookstoves, averaging $5.9 million a year.

The majority of financial commitments made in clean and improved cooking solutions flowed to the residential sector. Excluding the City Gas Distribution Project, which benefited both the residential and non-residential sectors, over 95 percent of tracked commitments increased residential access to clean cooking solutions, mostly through biomass stoves. It is estimated that about 70 percent of cooking finance provided a medium level of access (Tier 3), while most of the remainder provided a more basic level of access (Tier 1) through improved biomass stoves.

CONCLUSIONS

Investment in electricity and clean cooking access is falling far short of the levels required. Clean cooking, in particular, suffers from extremely limited investment. Funding for grid-connected electricity is substantially higher but still falls short of the levels needed to meet universal access to electricity by 2030. While grid-connected technologies are—and will remain—indispensable for electricity access, decentralized approaches to electricity, which are particularly relevant to remote rural populations, captured barely one percent of the overall funding and will also need to increase substantially.

The research has highlighted that better data tracking is essential to improve the coverage and granularity of financial information in some areas. Also, pilot methodologies for allocating finance commitments across different types of energy assets and different Tiers of energy service can be more tailored to the local context as baseline access surveys from the MTF become available. Nevertheless, this research demonstrates the value of combining the global approach with a more extended set of detailed country case studies in a future iteration of this work, to yield additional information on domestic financing, an important channel of finance for energy.

ABBREVIATIONS

$	United States Dollars
ABPP	Africa Biogas Partnership Programme
BEIA	Biomass Energy Initiative for Africa
ACCES	Africa Clean Cooking Energy Solutions
AfDB	African Development Bank
AIM	Access Investment Model
BNEF	Bloomberg New Energy Finance
BPDB	Bangladesh Power Development Board
CCGT	Combined-cycle gas turbine
COGS	Cost of Goods Sold
CPGL	Coal Power Generation Ltd
CPI	Climate Policy Initiative
DBE	Development Bank of Ethiopia
DFID	Department for International Development, United Kingdom
DEEP	Developing Energy Enterprises Program
DFIs	Development finance institutions
EEP	Ethiopian Electric Power
EEU	Ethiopian Electric Utility
EnDev	Energizing Development Program
GACC	Global Alliance for Clean Cookstoves
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GE	General Electric
GERD	Great Ethiopian Renaissance Dam
GLPGP	Global LPG Partnership
GOGLA	Global Off-Grid Lighting Association
GVEP	Global Village Energy Partnership
GW	Gigawatts

HFO	Heavy fuel oil
IBRD	International Bank for Reconstruction and Development
IDCOL	Infrastructure Development Company Limited
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IIEFA	Institute for Energy Economics and Financial Analysis
IPP	Independent power producer
IRENA	International Renewable Energy Agency
IT	Information Technology
KENGEN	Kenya Electricity Generation Company
KETRACO	Kenya Electricity Transmission Company
KNEB	Kenya Nuclear Electricity Board
KPLC	Kenya Power and Lighting Company
kWh	kilowatt-hours
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum gas
MFIs	Multilateral Financial Institutions
MOEP	Ministry of Energy and Petroleum, Kenya
MOWIE	Ministry of Water, Irrigation and Electricity, Ethiopia
MPEMR	Ministry of Power, Energy and Mineral Resources, Bangladesh
MSRP	Manufacturer's suggested retail price
MTF	Multi-Tier Framework
MW	Megawatts
NGO	Non-governmental organization
NICS	National Improved Cook Stove program
ODA	Overseas Development Assistance
OECD	Organisation for Economic Cooperation and Development
OPIC	Overseas Private Investment Corporation
PE	Private equity
PGCB	Power Grid Company of Bangladesh
PLATTS	S&P Global Platts
REA	Rural Electrification Authority
REB	Rural Electrification Board
REF	Rural Electrification Fund
REDD+	Reducing emissions from deforestation and forest degradation in developing countries
SDG	Sustainable Development Goal

SEforALL	Sustainable Energy for All
SHS	Solar home system
SOE	State-owned enterprise
Solar PV	Solar photovoltaic
TJ	Terajoules
UEAP	Universal Electricity Access Project, Ethiopia
UNIDO	United Nations Industrial Development Organization
WB	World Bank
WLPGA	World LPG Association
Wp/kWp	Watt-peak/kilowatt-peak
VC	Venture capital

GLOSSARY

Asset: a resource with economic value owned by an individual, company or country; for example, an onshore wind farm.

Centralized electricity solutions: extensions of a country's electricity grid and/or power sources connected to a country's existing electricity grid.

Clean and improved fuels and technologies for cooking: The report tracks financial commitments for: advanced biomass stoves and fuel infrastructure, alcohol stoves and fuel infrastructure, biogas digesters, electric stoves, improved biomass stoves, LPG stoves and fuel infrastructure, natural gas stoves and fuel infrastructure, and solar cookers. These are referred to as "clean cooking solutions" or "clean fuels and technologies for cooking" throughout the report.

Finance for clean cooking: the portion of energy finance commitments supporting clean and improved fuels and technologies for cooking.

Commitments: a firm pledge to provide funds to a specific investment project with the expectation that project will go ahead.

Concessional finance: finance where the investing or lending party provides financing at rates and/or terms better than or below standard market rates/terms. Often concessional finance is provided in exchange for non-financial goals such as promoting low-carbon investment.

Decentralized electricity solutions: provision of electricity that does not take place through a country's centralized grid. Examples of decentralized electricity solutions would include off-grid solar home systems and local mini-grids not connected to the main electricity grid.

Domestic finance: finance where the funding institution is primarily based in the country where the project is being developed or constructed.

Disbursements: funds that are actually transferred to a project after a commitment is made. For example, when a funder commits to invest in a project in 2014, but the project can only commence construction in 2015, funds transferred to the projects' builders and consultants in 2015 are classed as disbursements.

Energy access: the ability of the end user to utilize energy supplies; used here to cover both access to electricity and to clean fuels and technologies for cooking.

Finance for energy: investment commitments for specific technologies, assets and market support activities within the energy sector, regardless of the ultimate end user of the energy supply.

Energy infrastructure: any assets used in the generation or transmission of electricity, transportation of clean cooking fuels or cooking itself.

Finance for electricity: the portion of energy finance commitments supporting all grid-connected plants, electricity transmission and distribution infrastructure, and mini-grid and off-grid solutions.

Financial value: the value of something in US Dollar terms at the time of measurement.

High-impact countries: the 20 countries with the highest absolute gaps in access to electricity and/or clean fuels and technologies for cooking, measured by population, as identified in the 2015 Global Tracking Framework (IEA and the World Bank, 2015). For electricity access, the countries are: Afghanistan, Angola, Bangladesh, Burkina Faso, Congo (DR), Ethiopia, India, Kenya, Korea (DPR), Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, the Philippines, Sudan, Tanzania, Uganda and Yemen. For clean cooking access, the countries are: Afghanistan, Bangladesh, China, Congo (DR), Ethiopia, India, Indonesia, Kenya, Korea (DPR), Madagascar, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, the Philippines, Sudan, Tanzania, Uganda and Vietnam. More details about the high-impact countries can be found in Annex 1.

Finance for residential clean cooking access: the estimated portion of finance for clean cooking for which the residential sector is the ultimate end user, i.e., finance that can be considered as increasing residential access to clean and improved fuels and technologies for cooking.

Finance for residential electricity access: the estimated portion of finance for electricity where the residential sector is the ultimate end user, i.e., finance that can be considered as increasing residential access to electricity.

International finance: finance where the funding institution is primarily based outside the country where the project is being developed or constructed.

Multi-Tier Framework (MTF): measures the level of energy access provided by energy finance to residential consumers. Rather than using binary measures of energy access (e.g., having or not having a household electrical connection) that do not consider the quality, regularity, or affordability of service, the MTF instead recognizes that access to electricity is a continuum. Finance is therefore allocated to five "Tiers," from Tier 0 ("no access") to Tier 5 ("very high level of access"), based on the Multi-Tier Framework (MTF) developed by the World Bank (Bhatia and Angelou, 2015) and supported by SEforALL. The MTF is explained in more detail in Chapter 1 and Annex 1.

Non-concessional finance: finance provided on market terms and rates.

Public finance/private finance: whether a finance flow is classed as public or private is determined by who is undertaking a project. In alignment with the OECD (2017), finance qualifies as public if carried out by central, state or local governments and their agencies at their own risk and responsibility.

Residential consumers: all consumers in a country, aside from any business or government consumers. The intention is to broadly capture residential consumption, discounting business consumption where businesses are run from households, where possible.

CHAPTER 1
INTRODUCTION

KEY POINTS

- More than one billion people lack full access to electricity and over three billion lack access to clean cooking globally.
- At least $45 billion in annual investment is needed to 2030 to bridge the gap in electricity access and more than $4.4 billion in annual investment is needed to bridge the shortfall in clean cooking access.
- This report tracks commitments for investments in the energy sector across the high-impact countries, estimating the level of residential access to electricity and clean cooking delivered using the Multi-Tier Framework (MTF).

THE ENERGY ACCESS CHALLENGE

Globally, more than one billion people live without access to electricity and more than three billion lack access to clean fuels and technologies for cooking (IEA and World Bank, 2017). There is growing recognition that universal access to affordable, reliable, sustainable and modern energy by 2030 is key to fulfilling the other 2030 Sustainable Development Goals (SDGs)—including those for health, education, food security, gender equality, poverty reduction, employment and climate change. This report looks at financial commitments in the 20 high-impact countries with the largest electricity and clean cooking access deficits, collectively representing around 80 percent of the global access shortfall (See Figure 1.1).

Figure 1.1 - Energy access in the high-impact countries

	Electricity	Clean cooking
Total global population without access (billion)	1.06	3.04
Population without access in the high-impact countries (billion)	0.84	2.56
Population without access in the high-impact countries as a share of total population without access (%)	80	84

Note: Population and access levels are expressed as averages over 2013-14 using data based on World Bank Indicators.

This report uses the SEforALL (2015) Finance Committee Report quoted figure of $45 billion per annum between 2010 and 2030 globally as the estimated cost to provide universal electrification.

Estimates for required investment in clean cooking vary considerably (Box 1.1); this report uses an annual target investment level of $4.4 billion per year to 2030 (SEforALL, 2015). Other estimates are substantially higher—in the region of $36-41 billion required per annum (IIASA, 2012)—once fuel costs subsidies for cleaner cooking fuels are included.

This report shows quite clearly that investments are not keeping pace with this need. Unless action is taken, predicted population growth and industrialization in developing countries will further intensify energy demand (IEA, 2016), exacerbating the investment gap.

Box 1.1 - A look at the varying estimates of investment needs for energy access

Determining whether financial commitments are close to bridging the energy access gap requires an assessment of the required level of investment, of which there are various estimates for both electricity access and for clean cooking access. Estimates of the required investments vary hugely depending on the timeframe and the countries considered. Some studies also estimate the investment required for specific Tiers of energy access, whereas others do not consider the different types of access provided. Differing assumptions in models running to 2030 on fuel and technology costs will produce very different outcomes.

Because of these differing approaches, there is no definitive figure for energy access investment needs, either globally or in the 20 high-impact countries assessed in this report. To provide indicative figures for comparative purposes, this report used $45 billion per year (SEforALL, 2015) (explained in more detail below) as a proxy for electricity investment needs, and SEforALL's (2015) $4.4 billion per year figure as a proxy for the absolute minimum level required to promote clean cooking access. Neither number maps perfectly to the 20 high-impact countries and, in the case of clean cooking, the estimate could be significantly below the actual level of investment required to deliver universal access to clean cooking. These numbers are instead used as rough guides to the required level of investment. The basis of these and other investment needs estimates is explored below:

Electricity access estimates

- The World Bank's Access Investment Model (AIM) estimates that $1.5 billion a year is required from 2011 to 2030 to deliver Tier 1 electricity access to 15 of the 20 high-impact countries, and up to $50 billion a year to deliver Tier 5 access (IEA and World Bank, 2017).
- The World Bank and IEA (2013) in the Global Tracking Framework estimate that $30 billion a year of additional investment is needed to grant universal electricity access without considering the Tier of energy access above and beyond business-as-usual investment. In total this equates to investments of around $45 billion per year between 2011 and 2030.
- The SEforALL (2015) Finance Committee Report uses a figure of $45 billion per annum between 2010 and 2030 globally, delivering first year consumption of 500kWh per year in urban areas and 250kWh for rural households, rising to 750 kWh per household per year within 20 years.
- The IEA's (2012) New Policies Scenario calculates a need of $14 billion per annum between 2011 and 2030 globally, although electricity access is merely increased rather than provided universally under this scenario.
- Bazilian et al. (2010) estimate electricity access requires anything from $12 billion to $134 billion per year globally between 2010 and 2030, depending on the level of demand.
- Mentis et al. (2017) estimate cumulative investment needs across 44 Sub-Saharan African countries to 2030 between $50 billion and $1,280 billion, depending on the Tier of access granted.
- IIASA (2012) estimate annual electricity investment requirements of $45 billion per year between 2010 and 2030.

Box 1.1 A look at the varying estimates of investment needs for energy access

Clean cooking access estimates

Existing studies appear to focus less on estimating clean cooking investment needs. The numbers that do exist again span a wide range, depending on the timeline, country focus, assumed fuel mix and other variables.

- IEA and World Bank (2013) estimate that an additional $3.8 billion per year between 2011 and 2030 would be required above the forecast business-as-usual investment of $0.7 billion per year to deliver clean cooking access globally.
- In the IEA's Africa Energy Outlook (2014) clean cooking investments in Sub-Saharan Africa are estimated at $4.4 billion over the period 2014-30. However as the report notes, this level of investment is insufficient to bring about universal clean cooking access, either in Sub-Saharan Africa or globally.
- SEforALL (2015) use a $4.4 billion per year figure as the minimum required investment in clean cooking annually. This report uses the $4.4 billion estimate as an indicative figure to highlight the gap between identified investments and the probable needs across the 20 high-impact countries.

Combined energy access estimates

- The IEA's World Energy Outlook (2012) estimates that universal access to both electricity and clean cooking facilities by 2030 would require investments of approximately $49 billion per year between 2011 and 2030.
- Pachauri et al. (2013) estimates the cost of universal access to modern energy, including electricity and clean fuels, at $65-86 billion per year globally over the years 2010-30.

A consistent message is that while estimates of investment needs for energy access vary considerably, the vast majority of estimates are significantly higher than the actual levels of tracked investment.

SUMMARY OF METHODOLOGY

The report approaches finance for energy access commitments in two ways:

1. The first-the global approach- draws on international databases for the 20 high-impact countries. The advantage of this approach is that it paints a broad picture of the global situation and is relatively effective at capturing international public finance for large-scale projects. The main disadvantage is a more limited coverage of domestic finance, which is known to be a significant share of overall financing flows to the sector and could amount to 20-40 percent of the total, based on the case studies in this report. While data on domestic private finance was available in some cases, there was limited information on domestic public finance in international databases. Results are reported on aggregate for these 20 countries and are influenced by flows to larger countries, such as India.

2. The second- country approach- is based on collecting data at the national level for three high-impact countries—Kenya, Ethiopia and Bangladesh—using databases and surveys of governments, utilities and other local institutions. These countries were chosen for their varying levels of economic and energy sector development and to provide a regional contrast between Africa and Asia—and because baseline energy access surveys were underway. The advantage of this approach is that it provides for more precision and is better able to capture domestic public finance, although availability of domestic private finance remains limited. The main disadvantage is the higher cost and longer time frame required, which limited its application to just three countries.

These analyses complement each other by testing different data collection approaches and looking at the same problem from different angles. Future replications should build upon the lessons from this exercise to expand and strengthen the methodology, aligning the global approach with country case studies and deepening the coverage of domestic finance commitments.

To arrive at an estimate of the finance for energy access across the 20 high-impact countries and the subset of that finance relating to residential energy access, the report uses the following approach:

1. Finance commitments in the 20 high-impact countries relevant to clean cooking and electricity access are identified using a variety of data sources over 2013-14. As the period evaluated covers two years, average annual figures are presented throughout the report. If for example $100 million of financial commitments are identified in each high-impact country over 2013-14, this will be presented as an average of $50 million per year. The annual average figure enables meaningful comparisons of estimates throughout the report and with investment estimates from other sources. Using average figures also evens out the effects of large, one-off transactions.

2. Having identified total finance commitments relevant to clean cooking and electricity access in the high-impact countries, a share of those commitments is allocated to residential consumption. For example, a large power plant financed by a tracked commitment is likely to produce electricity consumed by both residential and non-residential consumers (such as businesses, grid exports and government institutions). A proportion of the investment is allocated to residential electricity access, using assumptions around the relative shares of power consumption in the country in question (Box 1.2).

Box 1.2 Attributing financial commitments to the residential sector

Making the assumptions that:

- Investment in grid-connected generation capacity and transmission is shared between exports, industrial, commercial and residential users in proportion to their consumption.
- Investment in distribution and market support only benefits the commercial and residential sector in proportion to their consumption.
- Commitments categorized jointly as "transmission and distribution" can be allocated proportionally to the individual "transmission" and "distribution" categories in accordance to the relative shares for those categories. For example, if distribution commitments are three times as large as transmission commitments, this would be a 75-25 split.

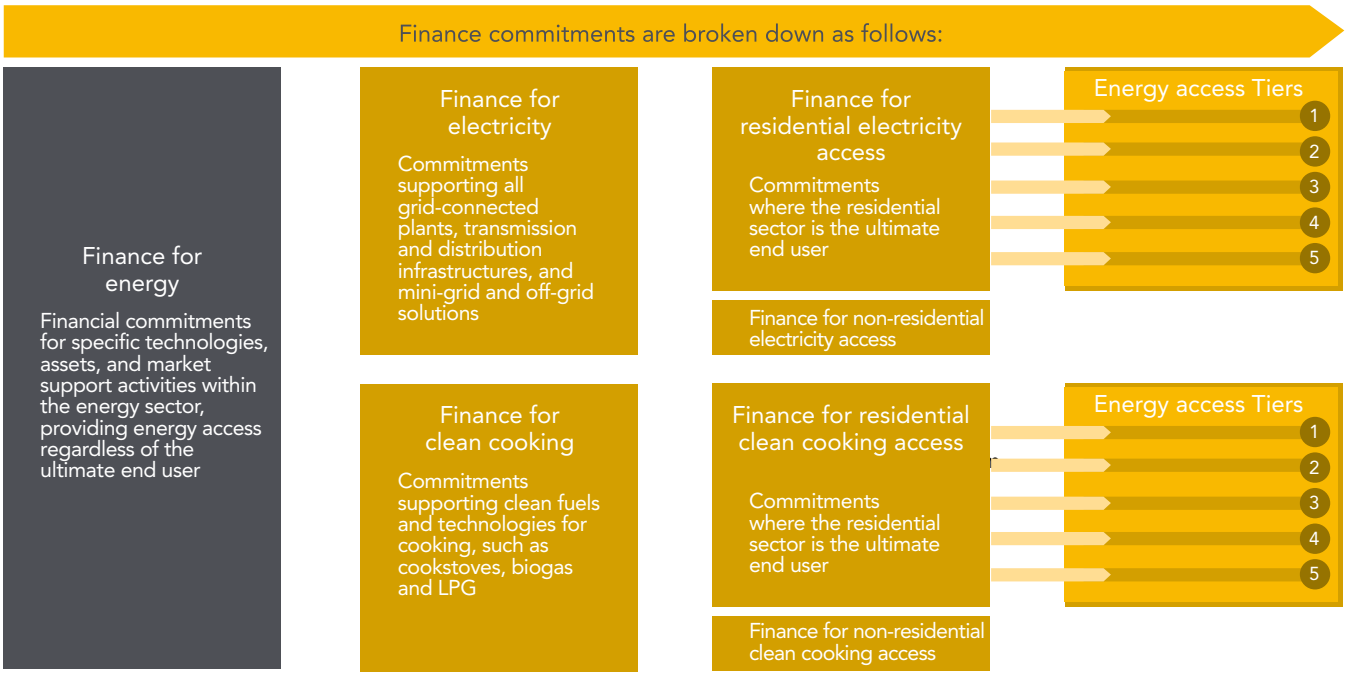
The following formula yields the volume of commitments benefitting a given country's residential sector:

$$= [(1 - I\% - E\%\text{-}C\%) \times (G\text{-}C + T + t\%[T\&D])] + [(1 - C\%) \times (D + MS + (d\%(T\&D))]$$

Where:

I%	=	Industrial share	G-C	=	Investment in grid connections
E%	=	Export share	T	=	Investment in transmission
C%	=	Commercial share	T&D	=	Investment in transmission & distribution
D	=	Investment in distribution	t%	=	Transmission proportion
MS	=	Investment in market support	d%	=	Distribution proportion

Figure 1.2 - A simplified summary of the report methodology



Note: Diagram is not to scale

The steps above yield the total finance commitments relevant for residential electricity and clean cooking access. The final step is to allocate the residential element of the finance commitment to the correct energy access Tier, using the MTF. The MTF—set out in more detail in the section below—attempts to quantify the level of electricity or clean cooking service provided.

The "bottom-up" country cases use the same methodology for defining, measuring and reporting on financial commitments for clean cooking and electricity access as was already reported for the global estimates. In addition to data for the years 2013 and 2014, it was possible to obtain data for 2015 for the country case studies, since the data publication lag is shorter for domestic statistics than international ones. To avoid swings associated with individual large projects, all case study data in Chapter 3 are reported as annual averages for the period 2013-15.

MEASURING THE LEVEL OF RESIDENTIAL ENERGY ACCESS THROUGH THE MULTI-TIER FRAMEWORK

Not all residential energy access is the same. In the case of electricity, for example, some systems may only be available for certain hours of the day or produce limited power. Recognizing the importance of different energy access service levels,[3] the World Bank developed the MTF that measures levels of energy access for electricity and for clean cooking. The MTF considers "the ability to obtain energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy, and safe for all required energy applications across households, productive engagements, and community facilities." This approach rates energy access from Tier 0 (no access) to Tier 5 (very high level of access) (Bhatia and Angelou, 2015).

[3] *Factors which determine the level of energy access could include, in the case of electricity, the wattage available, for how many hours electricity is available, and so on.*

Figure 1.3 Summary of the residential energy access Tiers for electricity
Multi-tier matrix for measuring access to household electricity supply

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
1. Peak capacity	Power capacity ratings (in W or daily Wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	OR Services		Lighting of 1,000 lmhr/ day	Electrical lighting, air circulation, television, and phone charging are possible			
2. Availability (duration)	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration <2 hrs
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability					Cost of a standard consumption package of 365 kWh/year < 5% of household income		
6. Legality						Bill is paid to the utility, pre-paid card seller, or authorized representative	
7. Health & safety						Absence of past accidents and perception of high risk in the future	

Source: Bhatia and Angelou, 2015

Figure 1.4 Summary of the residential energy access Tiers for clean cooking
Multi-tier matrix for measuring access to cooking solutions

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
1. Indoor air quality	PM2.5 ($\mu g/m^3$)		[To be specified by a competent agency, such as WHO, based on health risks]	[To be specified by a competent agency, such as WHO, based on health risks]	[To be specified by a competent agency, such as WHO, based on health risks]	< 35 (WHO IT-1)	< 10 (WHO guideline)
	CO (mg/m^3)					< 7 (WHO guideline)	
2. Cookstove efficiency (not to be applied if cooking solution is also used for space heating)			Primary solution meets Tier 1 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 2 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 3 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 4 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	
3. Convenience	Fuel acquisition and preparation time (hrs/ week)			< 7	< 3	< 1.5	< 0.5
	Stove preparation time (min/ meal)			< 15	< 10	< 5	< 2
4. Safety of primary cookstove	IWA safety tiers		Primary solution meets (provisional) IWA Tier 1 for Safety	Primary solution meets (provisional) IWA Tier 2	Primary solution meets (provisional) IWA Tier 3	Primary solution meets (provisional) IWA Tier 4	
	OR past accidents (burns and unintended fires)					No accidents over the past year that required professional medical attention	
5. Affordability						Levelized cost of cooking solution (inc. cookstove and fuel) < 5% of household income	
6. Quality of primary fuel: variations in heat rate due to fuel quality that affects ease of cooking						No major effect	
7. Availability of primary fuel						Primary fuel is readily available for at least 80% of the year	Primary fuel is readily available throughout the year

Source: Bhatia and Angelou, 2015

This report uses country and technology assumptions to allocate financial commitments to the different Tiers of the MTF. For example, grid-connected electricity capacity typically delivers electricity access between Tier 3 and Tier 5, depending on the grid reliability of the country in question. The report therefore assesses grid reliability based on the frequency of outages and assigns a given finance flow to a Tier on this basis. Separate assumptions exist for mini-grids, solar home systems, fuels and technologies for cooking, and other variables. Some examples of the assumptions used are provided below; for the full methodology and data sources, please refer to Annex 1:

- Grid-connected electricity assets are assumed to generate electricity access between Tier 3 and Tier 5 depending on grid reliability. Similar considerations are applied to transmission and distribution infrastructure. Where real-world information on the existing state of energy access Tiers was available for the country case studies through MTF surveys—for example in Ethiopia—this was used. Data tracking systems do not currently allow a distinction between financing completely new connections (e.g., from no access to Tier 1) and improving or maintaining existing connections (e.g., upgrading Tier 3 access to Tier 4).

- Mini-grids are assumed to generate electricity services between Tier 3 and Tier 4, depending on the hours of energy availability per day.

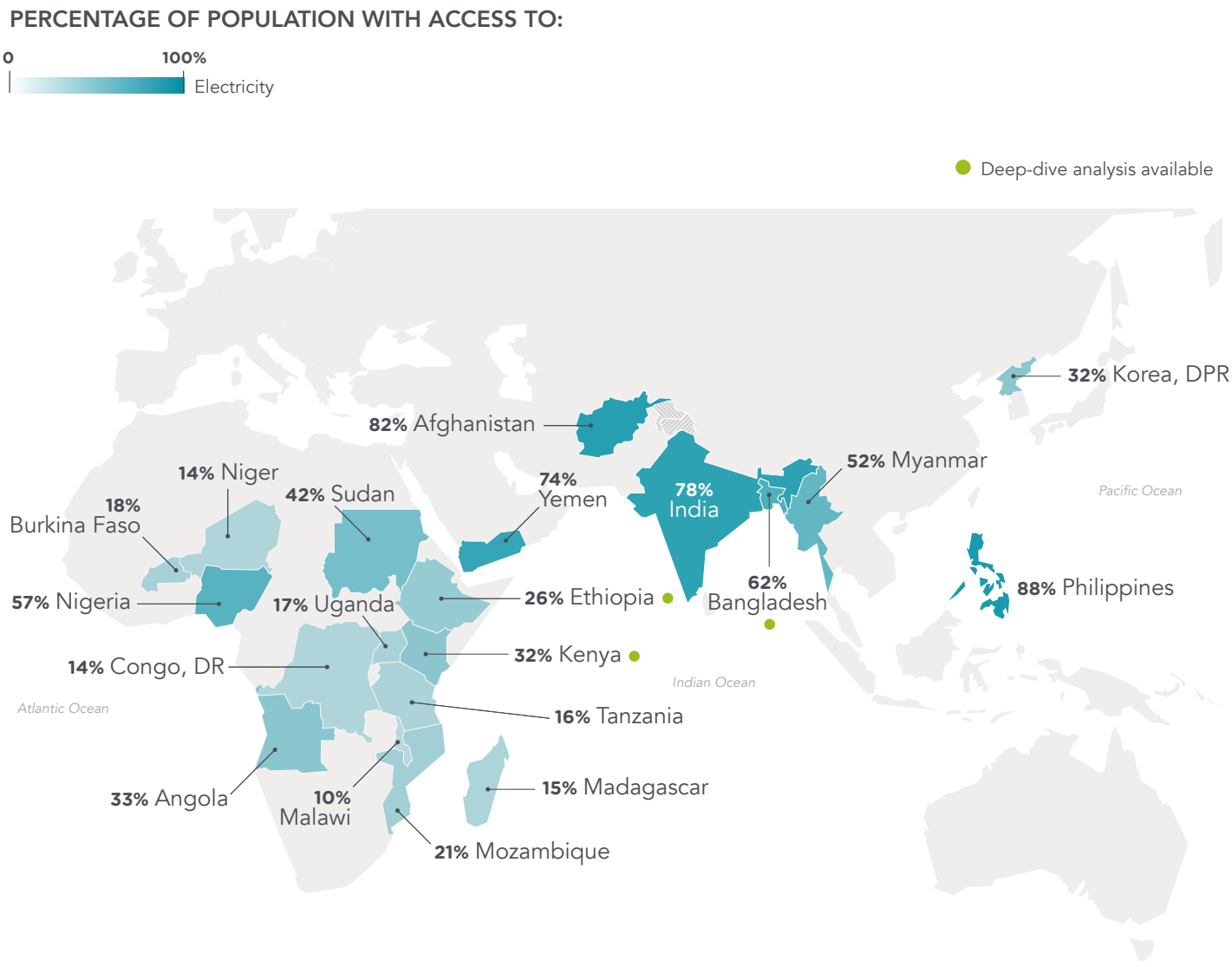
- Biogas digesters for clean cooking are assumed to generate Tier 3 clean cooking access based on efficiency, safety and affordability criteria.

- Using similar metrics to biogas digesters, investments in LPG stoves and fuel infrastructure are assumed to generate Tier 3 access.

- Market support is not allocated to a Tier due to a lack of information. For example, funding to support renewable energy policy development could ultimately indirectly result in a number of different access Tiers. As a result, market support is classed as finance for electricity access but is not allocated to a specific Tier.

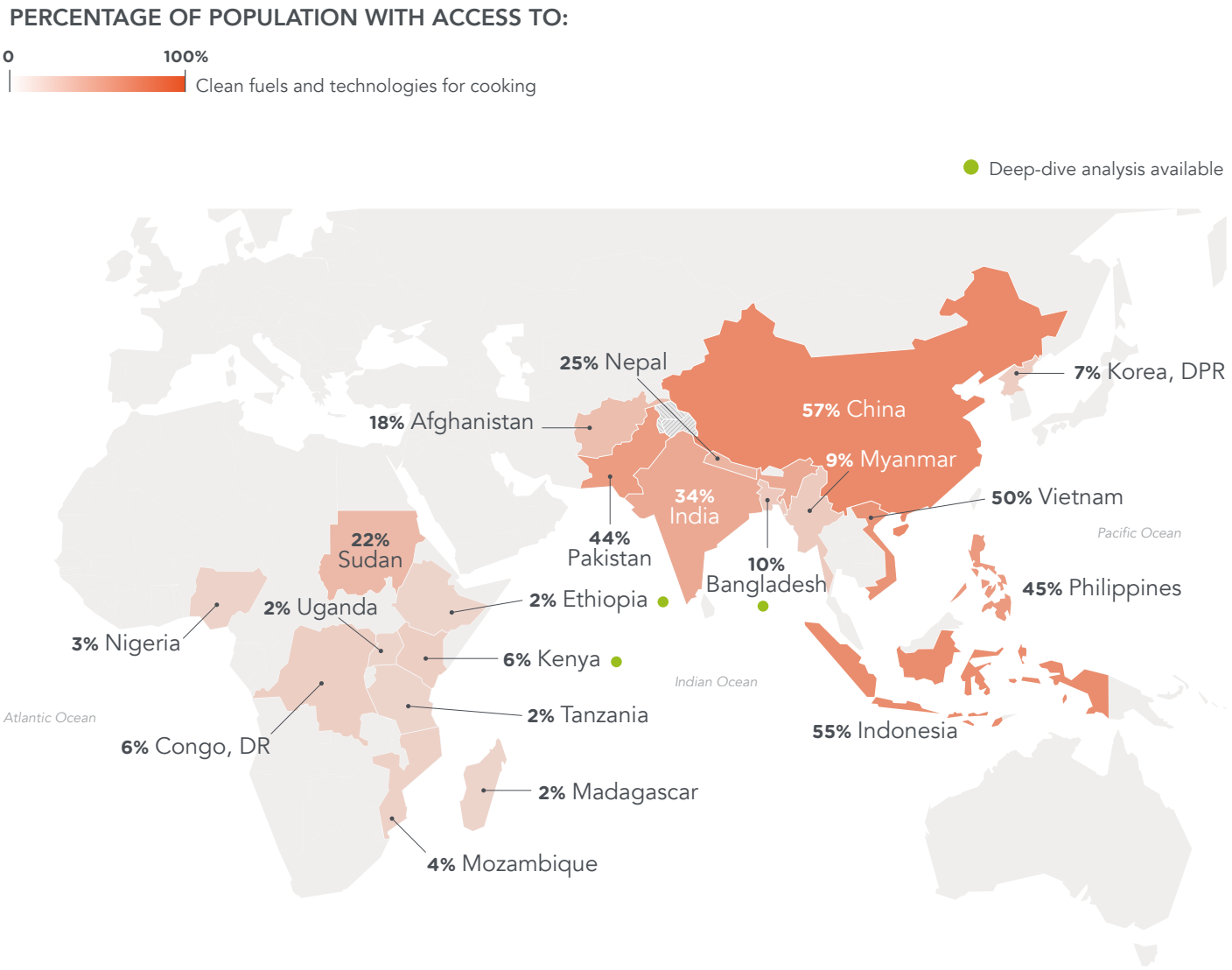
- Allocation of finance to the different access Tiers should be seen as indicative; broad assumptions are often required in the process. The intention is not necessarily to precisely allocate financial commitments to the Tiers but to provide an indication of the level of energy access a given investment is likely to provide. As the MTF surveys are completed across high-impact countries, the resulting data will allow allocations to be more tailored to country contexts in future iterations.

Figure 1.5 - Access to modern energy services in high impact countries



Source: Global Tracking Framework (IEA and World Bank, 2017)

Notes: 1. The dotted line represents approximately the Line of Control in Jammu and Kashmir by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. 2. This map was produced by SEforALL. It is based on the UN Map of the World, which can be found here: http://www.un.org/Depts/Cartographic/map/profile/world.pdf. The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of SEforALL, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries. 3. Data on the percentage of the population with access is averaged over 2013 and 2014.


PERCENTAGE OF POPULATION WITH ACCESS TO:
0
100%
Clean fuels and technologies for cooking
Deep-dive analysis available
25% Nepal
18% Afghanistan
57% China
7% Korea, DPR
9% Myanmar
34% India
50% Vietnam
Pacific Ocean
22% Sudan
44% Pakistan
10% Bangladesh
45% Philippines
2% Uganda
2% Ethiopia
3% Nigeria
6% Kenya
Indian Ocean
Atlantic Ocean
2% Tanzania
55% Indonesia
6% Congo, DR
2% Madagascar
4% Mozambique

STRUCTURE OF THE REPORT

This report provides an overview of finance committed for clean cooking and electricity access in the 20 countries, known as high-impact countries, with the largest populations without access to electricity and clean cooking solutions in the world (Figure 1.5).[4]

Chapter 2 looks at energy finance commitments from international and domestic public and private finance providers between 2013 and 2014 across the 20 high-impact countries. Section 1 looks at finance for electricity and Section 2 looks at finance for clean cooking. Data from several public and private sources was used to analyze more than 2,200 financial commitment transactions over 2013-14, focusing on international commitments and capturing all available information on domestic commitments.[5] The chapter also includes estimates of the portion of finance flowing to residential energy access, as well as the Tier of access generated. By examining commitments, it is possible to identify:

- The main sources and actors involved in financing increased energy access, the instruments they use, and the technologies and geographies they invest in.
- How different technologies are increasing and extending energy access.[5]
- Finance gaps in certain sectors, technologies, instruments, and geographies.

Chapter 3 explores the domestic dimension of finance in greater detail, analyzing over 600 financial commitments over 2013-15 in three selected high-impact countries: Bangladesh, Ethiopia and Kenya. This research captures both domestic and international commitments that are not tracked in global datasets, better illustrates the roles of national governments in energy finance, and sheds light on how both domestic and international finance are allocated to various actors and technologies within countries.

[4] Countries analyzed in the report are identified in the 2015 edition of the Global Tracking Framework (IEA and the World Bank, 2015), which was the latest available when this report was commissioned. The 2017 edition of the report has a slightly amended list of high-impact countries to reflect most recent country progress in energy access. See Annex 1 for details.

[5] Precisely, 2,162 finance commitments for electricity and 119 for clean cooking.

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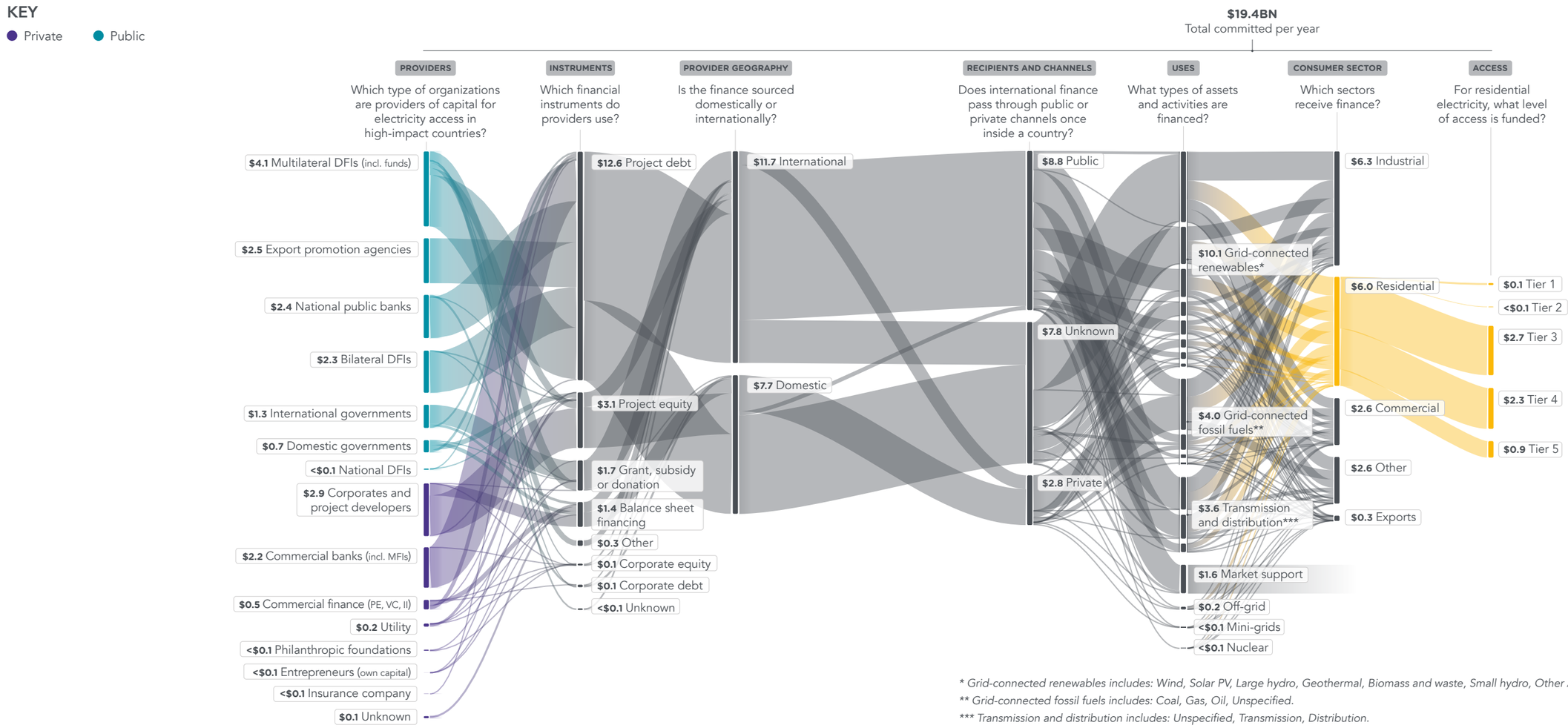
CHAPTER 2
MAPPING FINANCE FOR ENERGY ACCESS

FINANCE FOR ELECTRICITY

Figure 2.1 - Tracked finance for electricity in high-impact countries ($, billion)



** Grid-connected renewables includes: Wind, Solar PV, Large hydro, Geothermal, Biomass and waste, Small hydro, Other / unidentified, Biofuels.*
*** Grid-connected fossil fuels includes: Coal, Gas, Oil, Unspecified.*
**** Transmission and distribution includes: Unspecified, Transmission, Distribution.*

KEY POINTS

- Financial commitments for electricity in the 20 high-impact countries averaged $19.4 billion over 2013 and 2014, of which $6 billion per year related to residential consumption, falling well short of the estimated $45 billion needed annually to achieve universal electricity access by 2030.

- Three of the top five commitment recipients—India, the Philippines and Bangladesh—were in either South Asia or the East Asia and Pacific regions. Together, these three countries received an average of $11.6 billion a year in international and domestic finance for electricity.

- China was the single largest country provider of international finance for electricity in the 20 high-impact countries.

- The majority of financial commitments tracked for electricity access were channeled to centralized electricity technologies, with renewable energy seeing a greater proportion of funding than fossil fuels.

Despite increasing levels of investment, shortfalls persist as annual financial commitments for electricity access remain well below international targets. Between 2013 and 2014, financial commitments for electricity in the high-impact countries totaled $38.8 billion—an average of $19.4 billion a year, increasing from $18.7 billion in 2013 to $20.1 billion in 2014. Of this amount, approximately $6 billion per year increased residential electricity access. This falls short of the estimated $45 billion a year (SEforALL, 2015), as a minimum, needed annually to achieve universal access to electricity by 2030. Closing the gap in all 20 high-impact countries will clearly require even greater investment.

PROVIDERS

International investment, especially from public sources, was the largest source of finance tracked for electricity for the 20 high-impact countries ($11.7 billion per year, Figure 2.2) with combined domestic commitments representing 40 percent of finance for electricity. Domestic finance commitments were identified in just 11 out of 20 high-impact countries in the data. Limited data availability is undoubtedly a factor in the relatively low levels of domestic finance tracked; the data, particularly for domestic private sector finance, is simply not available in some cases. In countries where a material level of private domestic financing does exist, this could be a sign of more mature electricity markets which are less reliant on international donor aid and can attract private investment. Where private domestic finance was tracked as greater than zero, the dataset shows that the majority (61 percent) comes from local private-sector organizations, generally providing equity and debt instruments on commercial terms.

Figure 2.2 - Sources of finance for electricity across the 20 high-impact countries

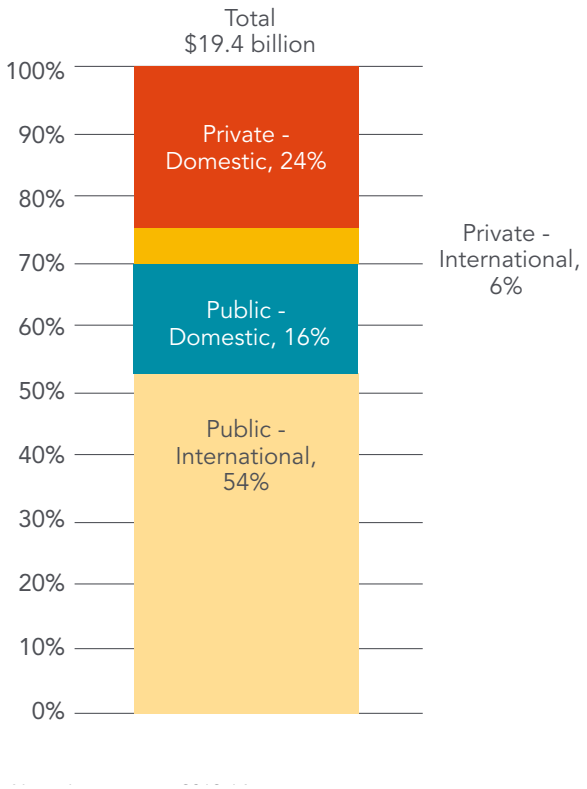


Figure 2.3 Top five Countries providing international finance for electricity ($ billion)

Country	$
China	2.5
Japan	1.5
United States	0.9
Germany	0.8
France	0.4

Note: Average over 2013-14.

The majority (90 percent) of international finance was from public-sector institutions offering concessional finance, while roughly 10 percent represented overseas commercial investment in developing countries from private-sector investors.

Developing countries provided 27 percent of international finance for electricity. Tracked commitments were exclusively from public-sector institutions, 85 percent of which originated in China. China provided more bilateral finance for electricity to the 20 high-impact countries than any other nation (Figure 2.5).

Chinese institutions[6] predominantly financed large hydropower (30 percent) and coal-fired power plants (21 percent), generally in Sub-Saharan Africa (91 percent). Ethiopia, Nigeria and Malawi were the main destinations for these commitments. Around nine percent of Chinese investment flowed to countries in South Asia, specifically to India and Bangladesh. However, these results likely underestimate the full scope of Chinese institutions' financing for electricity projects abroad (Box 2.1).

The report tracked an average of $7.7 billion of domestic commitments towards high-impact countries over 2013-14, 40 percent of the average overall commitments. **These domestic investments were almost entirely concentrated in India and the Philippines and the private sector provided 75 percent of these investments**. India and the Philippines were the recipients of 92 percent of all domestic public and private finance tracked in this report, with commitments largely for grid-connected solar and wind assets.[7] However, it is likely that gaps in data tracking systems mean that domestic finance, particularly private domestic finance, is under-reported across the board, and as a result it should not be inferred that India and the Philippines necessarily enjoy higher levels of domestic and private-sector finance than other high-impact countries.

This chapter's analysis does not capture a country's government-level spending beyond a limited number of data due to inherent limitations in global datasets. Given these limitations, Chapter 3 looks at this question in more detail with a deeper analysis of domestic finance in

Box 2.1 Status of overseas financing from China for power projects

In recent years, China has grown into a major provider of finance for large-scale power infrastructure projects in overseas markets. The report tracked over $2.5 billion of Chinese international finance in the high-impact countries over 2013-14, of which $750 million was for large hydropower, while both coal-fired and geothermal power plants received $500 million.

Although this report has engaged in an extensive review of the most recent information available, understanding the exact magnitude of Chinese international energy financing is challenging. In general, emerging countries are not required to report their activities to international institutions like the OECD. Therefore, the analysis relies on several initiatives and projects tracking Chinese international commitments, but data remains sparsely available or even contradictory. A significant volume of highly uncertain financial commitments were excluded for prudence, but it is possible that international funding from Chinese sources was much higher than reported.

For overseas coal-fired power projects only, CPI (Hervé-Mignucci and Wang, 2015) estimated that $21-38 billion of financial commitments have been made over 2005-15 from China. However, in September 2015, China announced its commitment to controlling public investment flowing into high carbon projects overseas. Prior to the 2015 announcement, a further $35-72 billion had been envisioned for new coal-fired power projects overseas.

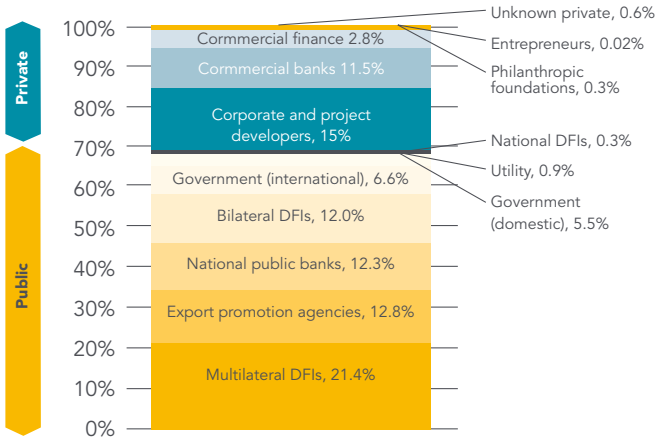
[6] *China Development Bank and China Eximbank, as well as Chinese commercial banks, typically supported by China's export credit insurer, Sinosure.*

[7] *Note that while India constructed significant numbers of coal-fired power stations over the 2013-14 period, financing of these projects will not necessarily be reflected in the commitments tracked over the 2014 period; for example, power stations under construction in 2013-14 may have been based on commitments from an earlier period.*

Bangladesh, Ethiopia and Kenya, suggesting that public finance through domestic budgets provides a larger share of domestic finance commitments than has been possible to identify in analysis of globally available data for the 20 high-impact countries.

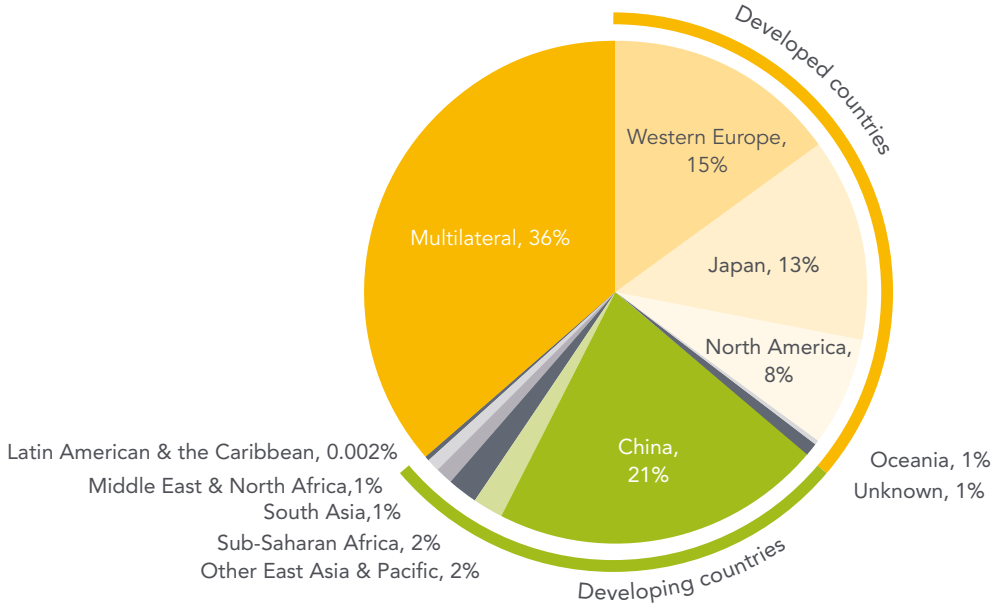
Multilateral institutions were the single largest providers of finance for electricity overall (21.4 percent, Figure 2.4), as well as the single largest providers of international finance for electricity (36 percent or $8.4 billion, Figure 2.5). Export promotion agencies (like ex-

Figure 2.4 - Public and private institutions providing finance for electricity across the 20 high-impact countries



Note: Average over 2013-2014

Figure 2.5 - Sources of international finance commitments for electricity to the 20 high-impact countries



Note: Average international finance commitments (i.e. excluding domestic commitments) over 2013-14. The figure includes both public and private sector sources. A small portion of international finance from developed countries (1% of the total) was not allocated to specific geographies due to a lack of information. All non-multilateral sources are bilateral.

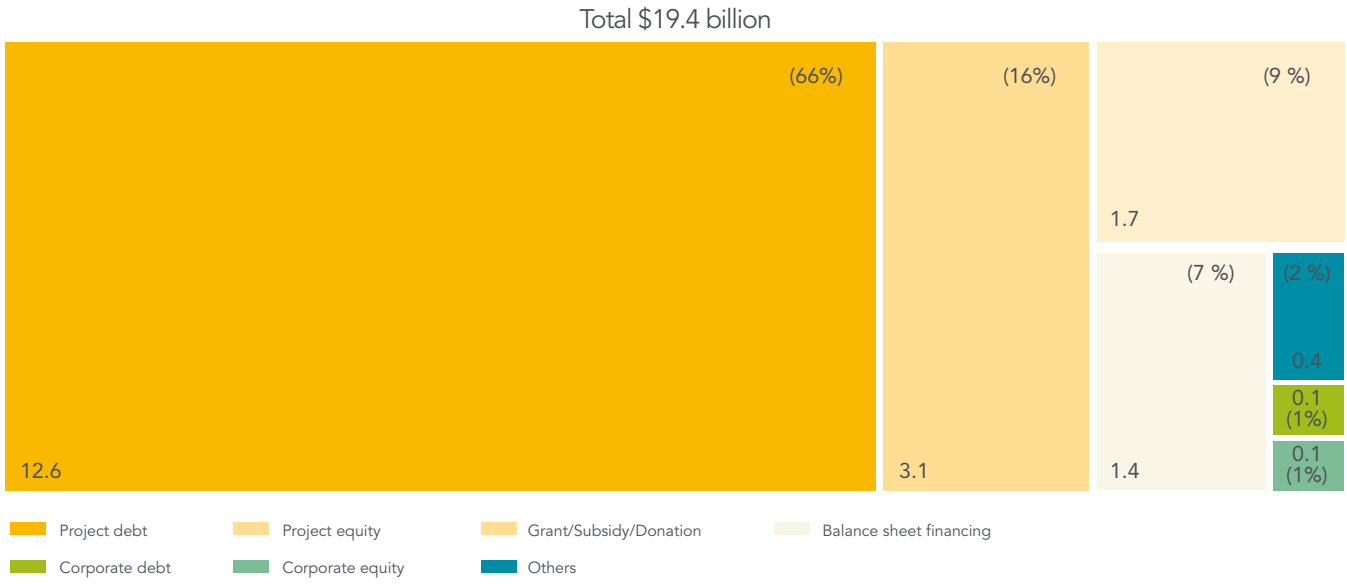
port credit agencies or Exim banks) were the second biggest providers of public finance tracked for electricity in the study, providing almost $2.5 billion a year.

Private-sector companies were generally divided by those who generate and sell electricity (project developers, private utilities and independent power producers) and corporate-like entities that mostly produce electricity for their own consumption (such as a factory consuming electricity from a rooftop solar PV system).[8] These companies invested almost $3 billion (15 percent) in different renewable energy and fossil fuels generation projects. Commercial finance institutions, including banks and international investors (like infrastructure funds, venture capital and private equity funds) provided $2.2 billion, generally through debt instrument or early stage equity. Finally, finance from philanthropic institutions averaged $50 million a year, but it is likely to be understated as no comprehensive data reporting channel exists that tracks their activities.

Among public actors, multilateral institutions mostly financed transmission and distribution projects (45 percent of multilateral commitments) and provided energy market support to local governments (22 percent). One-third of multilateral DFIs' financing went to grid-connected electricity generation, of which renewable energy projects accounted for 70 percent. Multilateral institution support to decentralized solutions was minuscule, commanding less than 0.1 percent of all finance tracked.

Bilateral DFIs and other government bodies tasked with providing international aid also prioritized transmission

Figure 2.6 - Finance for electricity by instrument type



Note: Average over 2013-14. "Others" includes Islamic finance instruments (leasing and Istisna'a), not allocable to other categories. A further annual average of $300 million of guarantees and risk mitigation instruments is not included in the chart.

[8] *As the focus is to understand the impact of energy investment on residential energy access, investment exclusively for captive generation of industrial and commercial players was excluded.*

and distribution projects (38 percent) but with a higher inclination towards rural settings, with projects of electricity distribution and decentralized generation accounting for 11 percent of their investment. Financing from these sources is only slightly higher for grid-connected fossil fuel and nuclear (21 percent) projects than for grid-connected renewable energy (20 percent).

INSTRUMENTS

Public and private actors provide finance for electricity via a range of instruments, predominantly through debt. Of all international public finance tracked, 74 percent had concessional terms in the form of concessional loans (80 percent of tracked commitments) and grants[9]. Bilateral DFIs, export promotion agencies and other governmental agencies and aid providers use almost exclusively concessional instruments for their international activities, while the portfolio of multilateral DFIs is more balanced with approximately half of finance concessional and the other half non-concessional.

While most international finance is concessional, **at the domestic level finance tracked is almost entirely invested with the expectation of earning commercial returns**, particularly through project finance (debt and equity) for grid-connected electricity generation. However, data available offers only an incomplete picture of this dimension of electricity access.

RECIPIENTS

A few high-impact countries received the clear majority of finance for electricity. Between 2013 and 2014, the geographic focus of (international and domestic) finance commitments for electricity was towards countries in Asia: three of the top five recipients—India, the Philippines and Bangladesh—were in either South Asia or the East Asia and Pacific region. Together, these three countries received an average of $11.6 billion a year in international and domestic finance, comprising more than 60 percent of annual finance for electricity.

Most countries reported finance commitments for electricity equivalent to 0.25-2.0 percent of their GDP, and in 12 of the 20 countries total finance for electricity accounted for less than 1 percent of GDP. Malawi and Afghanistan stand out with finance for electricity accounting for almost 8 percent and 5 percent of GDP, respectively, which is consistent with large aid and other commitments to these countries.

The remaining two largest recipients—Nigeria and Ethiopia[10]—were in Sub-Saharan Africa, receiving combined commitments of $2.4 billion a year, or 12 percent of annual finance committed for electricity in the 20 high-impact countries. Finance commitments for electricity in the other 15 high-impact countries stand below $1 billion of annual investment commitments.

When it comes to domestic finance, two countries alone—India and the Philippines—were the recipients of 92 percent of all domestic public and private finance tracked in global datasets, with these commitments largely for grid-connected solar and wind assets.[11] The fact two countries accounted for such a high proportion of finance tracked is undoubtedly in part due to gaps in the global tracking of domestic finance for other countries.

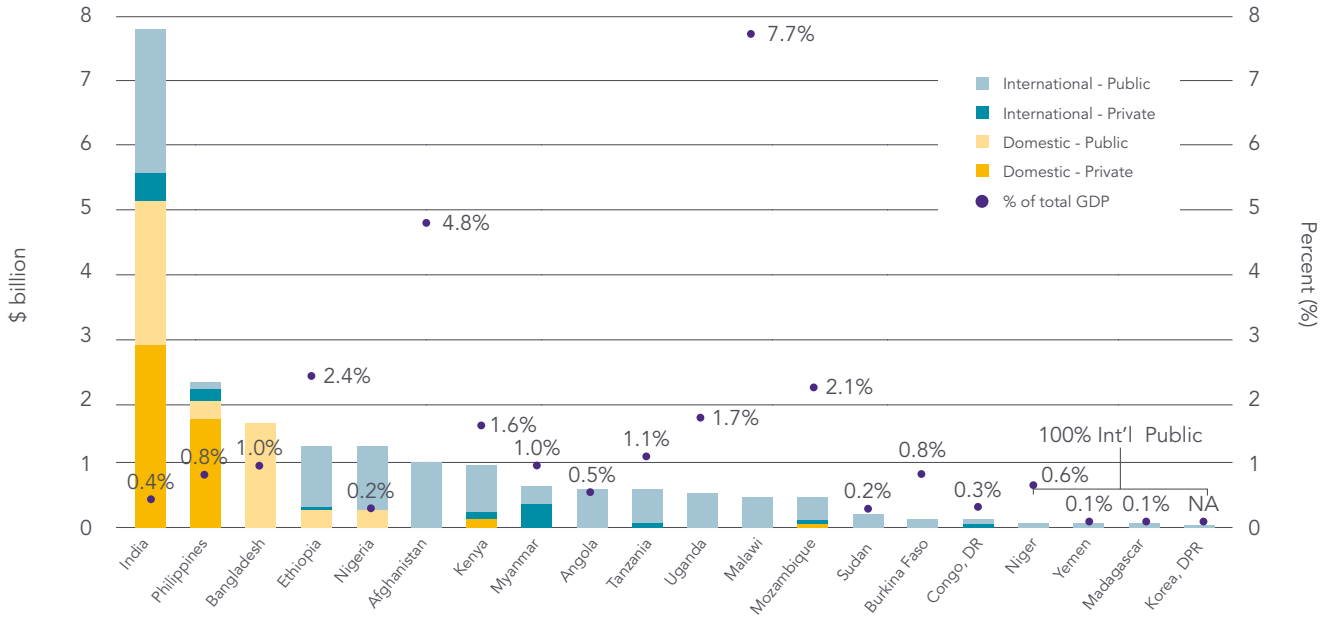
Figure 2.7 demonstrates the mix of financing commitments each high-impact country received across different sources and illustrates the relatively high levels of private

[9] This is likely to be a conservative figure, mostly deriving from information contained in the OECD CRS database. A portion of international financing, especially South-South commitments, is likely to happen on concessional terms, but there are no disclosed details to confirm it.

[10] Ethiopia received a loan of $1.02 billion from the Exim Bank of China in 2013. The project will build two 500 kV double- circuit transmission lines to link the Great Ethiopian Renaissance Dam to the Ethiopian national power grid. This is a relatively large one-off transaction; Ethiopia should therefore not necessarily be seen as consistently among the largest recipients of finance for electricity.

[11] Note that while India constructed significant numbers of coal-fired power stations over the 2013-14 period, financing of these projects will not necessarily be reflected in the commitments tracked over the 2014 period; power stations under construction in 2013-14 may have been based on commitments from an earlier period for example.

Figure 2.7 - Distribution of finance for electricity across the high-impact countries and percentage of their GDP



Note: Average over 2013-14. GDP data taken from World Bank Indicators.

domestic finance in the Philippines and India. However, it is likely that gaps in the tracking of domestic finance mean that actual domestic finance across the 20 high-impact countries was higher than presented here, as seen, for example, in the levels of domestic finance reported in detailed country case studies (See Chapter 3). Among the 20 high-impact countries, those with larger populations[12] receive greater shares of finance commitments in absolute terms. The top three recipients of commitments accounted for 80 percent of the population of all 20 countries.

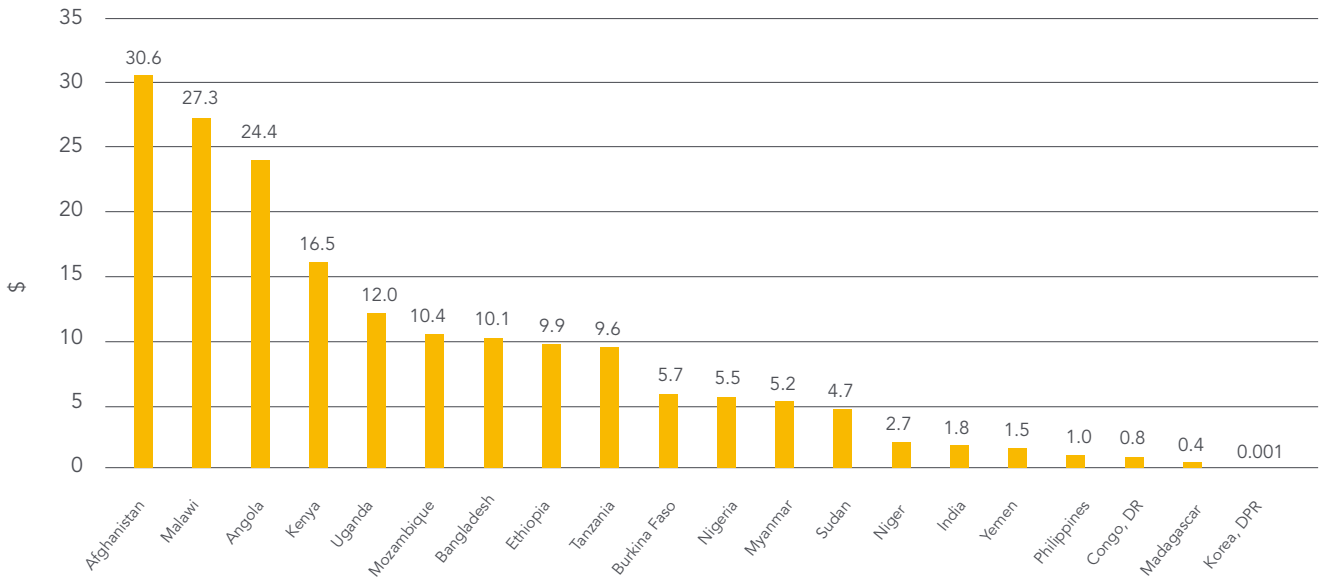
A closer look at international public finance, weighted for the countries' population size, reveals a considerably different distribution (Figure 2.8). For example, India receives a large level of financing commitments in absolute terms, but a relatively low level on a per capita basis. Interestingly, except for Angola, which is the only upper-middle income country in the group, seven recipient countries out of the first 10 are low-income, with the lower-middle countries distributed towards the right tail of the chart.

At least 81 percent of international public finance reached the recipient country through public-sector channels like international organizations, local governmental institutions or through government budgets. The "blending" of international transfers into governments' budgets is complex to track and allocate to specific organizations without counting the same funding twice; Chapter 3 explores the question in more detail.

Around four percent of international finance for electricity was channeled through private organizations, such as local or international non-governmental organizations. Details on recipients are not consistently tracked or reported across data sources. Thus, it was not possible to identify channels for 15 percent of international public finance.

[12] *Total populations, not only those without electricity access.*

Figure 2.8 - Recipients of international public finance for electricity, per capita



Note: Based on World Bank Development Indicators and IEA data (average over 2013-14). The chart includes finance originated from OECD and non-OECD countries.

USES

The majority of finance for electricity was channeled to centralized electricity technologies (Figure 2.9), receiving commitments as follows:

- Grid-connected renewables ($10 billion per year).
- Transmission and distribution ($3.6 billion per year[13]).
- Grid-connected fossil fuel power[14] ($4 billion per year).

Among grid-connected electricity generation, wind power was the technology that received the most finance across 2013-14 ($3.9 billion on average), followed by coal-fired power ($2.8 billion), solar PV, and hydropower ($2.1 and $2 billion respectively). Decentralized electricity—including off-grid and mini-grid technologies—comprised a relatively minor portion of energy finance allocated to high-impact countries, averaging just $200 million per year.

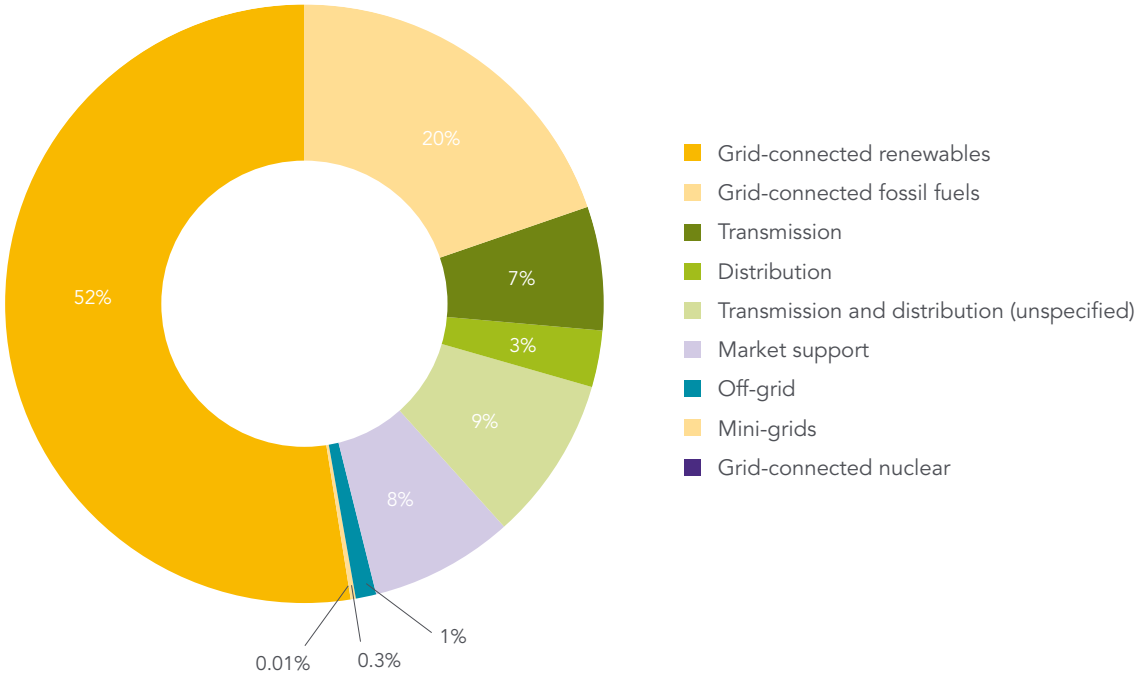
More than $800 million a year of concessional loans was committed by Chinese, German, and Japanese institutions for coal-fired power projects in Sub-Saharan Africa and South Asia. A significant volume of concessional debt was also used to finance large hydropower plants ($800 million a year) and transmission projects ($1.8 billion).

Grant funding primarily went toward market support activities such as capacity building, technical assistance or institutional support for energy reforms, representing 37 percent of all international public sector grants tracked. The balance of grants supported the capital cost of trans-

[13] *Of which $1.3 billion was specifically for transmission lines and $0.48 billion for distribution and line extension. The remaining $1.8 billion either targets a combination or is impossible to allocate among grid sub-projects due to incomplete information.*

[14] *This includes a tiny amount of finance for nuclear power development, in the order of $2.5 million a year.*

Figure 2.9 Share of finance for electricity by technology type across the high-impact countries



Note: Average over 2013-14

mission (25 percent), renewable energy (24 percent) and distribution projects (11 percent).

Additionally, more than $300 million in international guarantees and other risk mitigation instruments—like political risk insurance—was allocated annually between 2013-14, mostly for coal and diesel plants. These instruments have historically played a role in lowering project risks and unlocking overseas private capital.

At the domestic level, 77 percent of all public and private finance for electricity targeted renewable energy, with the 23 percent balance targeting fossil fuel projects. Much of the project finance for wind ($3 billion a year) and coal ($1.5 billion) was made up of equity from project owners (local utilities or independent power producers) and debt from national public banks and DFIs or commercial banks. To a lesser extent, private-sector players financed their projects with their own capital or by raising equity and debt through corporate bonds.

The trackable data showed a much higher incidence of funding for large-scale infrastructure projects— such as hydropower projects, gas-fired power plants and grid extensions—compared to decentralized solutions. This reflects a combination of investor decisions and general data limitations (Box 2.2).

It should be noted that comparing commitments made in 2013-14 with the electricity generation plants constructed in the same period may generate conflicting results. Committed finance is not disbursed immediately; there can be a significant time lag between the commitment date, the disbursement schedule and when the financed asset becomes operational. It typically takes several years for the funds for larger projects to be disbursed; a country's ability to absorb funding can happen for a variety of reasons but be a significant barrier to the disbursement of funds (SEforALL and AfDB, 2017). For example, India put into operation more than 17 GW per year of coal-fired power

Box 2.2 Gaps in the tracking of finance commitments for electricity

This report examined all available data sources to identify primary financial transactions at the project level, but several gaps exist in the tracking of finance commitments for electricity that need strengthening to provide a more comprehensive and granular picture:

- **Grid-connected technologies:** Data on international investment in grid-connected generation, transmission and distribution is generally comprehensive and reliable. This includes public and, to a lesser extent, private financing. However, there is uncertainty over projects solely financed with overseas finance from non-OECD countries (so called "South-South" financing) as these are not systematically tracked by official international systems like the OECD DAC Creditor Reporting System (CRS).

- **Distinguishing between upgrading existing grid-connections and new grid connections:** the data does not typically contain sufficient detail to distinguish between improvements to existing connections (for example, improving Tier 3 access to Tier 4 access) and entirely new connections which could potentially move a residential consumer from Tier 0 access to Tier 4 access. Estimating the number of people affected by the financial commitment tracked is also not possible.

- **Decentralized technologies:** Limited data is available beyond several financing deals for solar companies located in the high-impact countries (available from BNEF and GOGLA) and dedicated international aid programs. Information on the latter is generally available through public data sources (like OECD DAC CRS), which are not designed to allow for a precise distinction between technologies. For example, it is difficult to identify and separate solar off-grid projects from other solar PV projects. Data on private-sector expenditure for diesel generators was also not available. It is inherently difficult to quantify the extent of the gap between data reported here and the actual levels of finance committed to the sector.[15]

- **Market support and domestic policies:** data on international aid supporting energy market reforms is available from OECD DAC CRS, but data on domestic energy budgets is not readily available and has to be collected through in-country efforts (see Chapter 3).

plants over 2013-14 (corresponding to an estimated $15 billion in annual capital cost), roughly five times more than the capacity of renewable energy plants commissioned in the same period.[16] In contrast, commitments made in 2013-14 tell a different story: four times more finance was committed for renewable energy generation than coal fired. The associated power plants will likely be built in subsequent years. This could suggest either a change in investment behavior towards renewables sources—in line with India's ambitious renewable energy targets (MNRE, 2014)—or that data on coal commitments were not tracked in international datasets. The link between commitments and deployed assets is further explored in Box 2.3.

The analysis focuses on 2013 and 2014 and may not reflect more recent market trends. For example, the market for off-grid solar power has accelerated significantly since the beginning of 2014 (GOGLA, 2016). Although the entire sector market remains small, having attracted globally $511 million of investment from 2008 to 2015 (BNEF 2016), companies providing pay-as-you-go solar systems alone raised $223 million of funds in 2016 (BNEF, 2017). More widely, since the period evaluated in this report, the UN agreed on the 2030 Sustainable Development Goals, including Sustainable Development Goal 7 relating to energy, and the Paris Climate Agreement was signed. It is possible that these developments will spur new financial commitments in the period beyond that tracked by this report.

[15] A complementary analysis performed by the authors reveals that the decentralized energy sector in the high-impact countries could be worth $426 million, roughly twice the amount tracked in the report. This approach considers the annual cost of solar home systems and solar lantern units sold on average (380,000 and 5,750,000, respectively) over 2013-15, togethe with the estimated value of mini-grids and other non-solar technologies, such as diesel generators installed over time (on average, 240 MW a year). Data is sourced from GOGLA, PLATTS, BNEF, UNIDO and ICSHP.

[16] Based on S&P Global PLATTS (2017) and Bucklley (2015).

Box 2.3 Financial commitments are not the same as realized investments

It is important to understand that financial commitments do not automatically translate into electricity generation or cooking assets. Because of lags in disbursements, changing currency values and changing project costs, commitments are unlikely to equate directly to realized asset values (SEforALL and AfDB, 2017).

For example, suppose estimates suggest a developing country requires $1 billion to achieve universal energy access based on the projected costs of the energy infrastructure needed (e.g., the power generation equipment, the transmission lines, the clean cooking infrastructure, etc.). Now, suppose a DFI makes a commitment in 2017 to direct $1 billion to increase energy access in the developing country and that the time needed to identify, plan, and cost the electrification and clean-cooking projects means these funds are not disbursed until the beginning of 2018.

The time lag makes it highly unlikely that the initial commitment will correspond to $1 billion in energy infrastructure. In the intervening year, the:

1. Local currency may strengthen against the US dollar, such that the initial commitment is now worth less in the local currency in which project construction is financed.
2. Local installation costs could rise as a result of labor shortages.
3. Costs for consumers to access the energy supply may change. For example, connection costs may increase, and interest rates on loans to purchase a solar asset may rise.
4. Technology costs may fall.

The first three scenarios would mean the initial commitment of $1 billion is no longer sufficient to achieve energy access. The fourth might mean that more capacity is deployed than needed to meet energy access goals. In short, financial commitments will not be the same as realized investments.

CONSUMERS

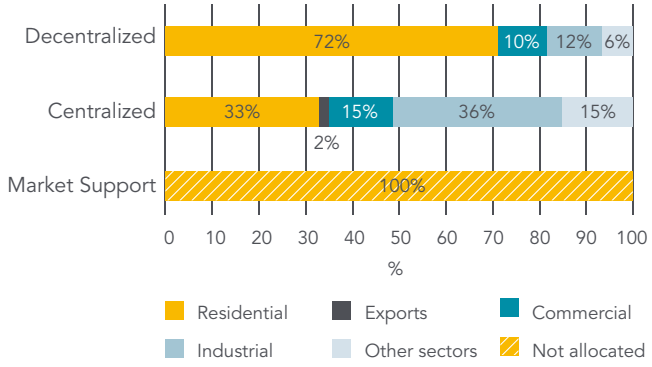
While centralized technologies receive the most funding, their contribution to residential electricity access can be lower per unit of capital invested when compared to decentralized technologies. The residential sector, for example, consumed an average of 33 percent of grid-level electricity produced across the 20 high-impact countries (Figure 2.11). Applying the consumption shares to the finance tracked for electricity (Figure 2.12) suggests that on average $6 billion per year could be defined as increasing residential access to electricity across the 20 high-impact countries.

Commercial and industrial players are estimated to consume more than 50 percent of output (enjoying an average of $11.6 billion in electricity investment per year), while 15 percent is used by other community and economic activities (such as street lighting, hospitals, schools, military) and 2 percent is exported. This is not to discount the role of grid-connected generation and transmission, which benefits a wide range of end users and typically provides higher Tiers of residential electricity access.

Decentralized solutions, such as mini-grid and off-grid assets, see an estimated 72 percent of electricity consumed by residential users, with the remaining balance going to other sectors.[17] However, decentralized electricity solutions accounted for just over $200 million of tracked finance per year across the 20 high-impact countries, around 1% of total commitments for electricity. Decentralized solutions can allow expansion of residential electricity access for

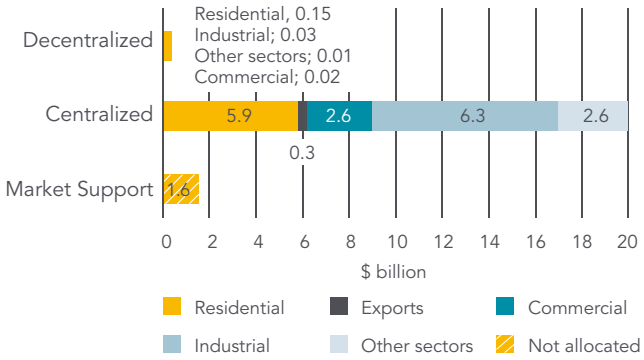
[17] *Estimates of electricity consumption by sector across the high-impact countries is based on analysis including, but not limited to, country-specific grid supply and demand and technology-specific considerations for decentralized technologies. The detailed methodology is in Annex 1.*

Figure 2.10 - Estimated shares of electricity consumption by type of technology across the high-impact countries ($ billion)



Note: Average over 2013-14. Market support, such as international budget support for energy reforms or capacity building, was not allocated because it is considered benefiting the entire energy market and all user types. Full methodology details are available in Annex 1.

Figure 2.11 - Estimated finance for electricity commitments by end user across the 20 high-impact countries ($ billion)



Note: Average over 2013-14.

remote rural populations who reside in mountainous regions or other areas, which make grid extension difficult.

It should also be noted that the urban poor increasingly lack access to electricity for reasons of affordability, even if they are connected to the central grid. Quantifying the extent of this problem is inherently difficult based on commitment data alone, but is an area that requires further attention.

Having identified the proportion of finance committed to electricity that targets residential consumers, this report uses the MTF to allocate financial commitments to the Tiers of electricity access based on the technology and the reliability of the country's grid (Figure 2.13).[18] Limitations in available data mean it was not possible to ascertain whether commitments provide improved electricity access for consumers that already have some access to electricity (e.g., bringing a residential consumer from Tier 2 to Tier 3) or provide entirely new access to electricity (e.g., bringing a residential consumer from Tier 0 to Tier 3). Estimating the number of people affected by the financial commitment tracked is also not possible, given the quality of data available.

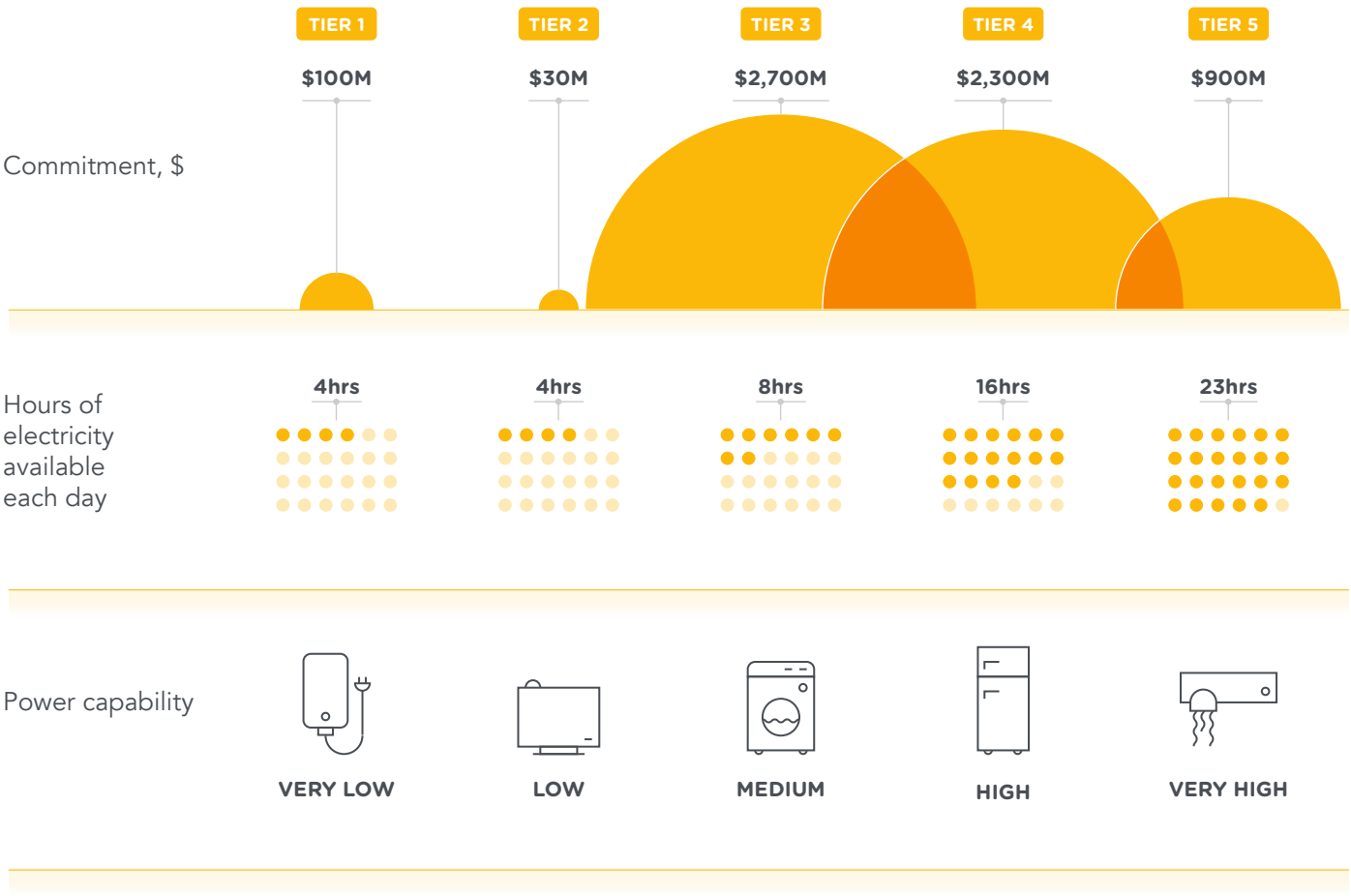
The majority (45 percent) of finance providing residential electricity access (an average of $2.7 billion per year) is estimated to support Tier 3 access. This provides energy services that support medium power appliances and guarantee a minimum of eight hours of electricity supply a day.[19] Tiers 4 and 5 entail greater availability of electricity services: Tier 5, for example, requires electricity access of at least 23 hours a day and no more than three disruptions a week. These Tiers accounted for average financial commitments of $2.3 and $0.9 billion respectively over 2013-2014. Tiers 3, 4 and 5 are usually—though not exclusively—associated with a connection to a central grid, which in most countries—though by no means all—ensures a higher availability, reliability and quality of electricity. However, grid connections often fail to reach populations living without access to electricity in rural areas; those without access to electricity in the high-impact countries live disproportionately in rural areas (IEA and World Bank, 2017).

[18] *Full details about the methodology to allocate finance to Tiers are available in Annex 1.*

[19] *See Figure 1.3 for more details about the Tiers and their attributes.*

[20] *This estimate is based on the IEA's 2016 World Energy Outlook "New Policies Scenario," but falls short of the universal electricity access target.*

Figure 2.12 - Finance commitments supporting residential electricity, by Tiers of energy access (average in 2013-14)



Source: Adapted from IIED (2016), based on IEA and WB 2015: http://pubs.iied.org/pdfs/16623IIED.pdf

A small portion of finance (slightly over $100 million per year) supports access to Tiers 1 and 2, providing critical solutions for hard-to-reach rural communities without access to electricity. The International Energy Agency (IEA) estimates that centralized electricity grids will provide around 60 percent of electricity generated to meet additional access needs by 2030, while decentralized solutions, particularly from renewables, will play a critical role in providing access in remote rural areas of many countries (IEA and the World Bank, 2017).[20]

[20] *This estimate is based on the IEA's 2016 World Energy Outlook "New Policies Scenario," but falls short of the universal electricity access target.*

FINANCE FOR CLEAN COOKING

KEY POINTS

- Financial commitments for residential clean cooking in the high-impact countries tracked in the report averaged $32 million per year over 2013 and 2014, falling well short of the $4.4 billion of annual investment needed as a minimum to achieve universal access to clean fuels and technologies for cooking by 2030.

- Public funding for residential clean cooking accounted for the largest share of commitments, amounting to an annual average of $26 million.

- As a first attempt to collate all financing flows in clean cooking, the analysis is limited by data availability. Insights in this chapter are mostly focused on residential clean cooking financial flows, as opposed to flows that include non-residential and residential applications.

CLARIFYING NOTE ON DATA AND METHODOLOGY

Limitations in the tracking of data for clean cooking hampers any attempt to undertake a comprehensive analysis of financial commitments in the clean cooking sector. Compared to the electricity sector, commitments are generally fewer and smaller for clean cooking projects and companies.[21] Most of these transactions are more than an order of magnitude below the average transaction size of electricity sector commitments. Many of the private transactions in the clean cooking sector are philanthropic grants and early-stage venture financings, for which limited information is available. Infrastructure commitments in LPG and LNG sectors are made in highly competitive environments, for which the sharing of transaction-specific information is uncommon. Public-sector financing can be similarly opaque for the clean cooking sector.

Several specific data exclusions were made given the report's focus on the 20 high-impact countries. For example, in global databases many transactions were identified as regional or global in nature. While important, these were excluded if reasonable country-level allocations could not be made—i.e., to allocate all or a portion of a given transaction to one or more of the high-impact countries. As such, financing for a global market support initiative such as general budget support for the Global Alliance for Clean Cookstoves were excluded from the dataset, as were corporate commitments for stove companies that reportedly operate globally. Domestic public subsidies for liquid fuels used for cooking, valued at tens of billions of dollars globally per year, were excluded from the core data set so as to focus on the capital costs of enhancing access to clean cooking. Carbon finance transactions and the domestic end-user financing of clean cooking solutions such as product-specific lending by multilateral finance institutions were not expressly included in data collection and are thus likely to be only partially represented. A review of gaps in the tracking of clean cooking commitments is included in Box 2.4.

This section adopts a slightly different structure than the approach to the electricity analysis, disclosing financial commitments for residential clean cooking only. There are several projects which are not specifically designed to promote clean cooking, chiefly investments in gas infrastructure, where a proportion of the investment will ultimately benefit clean cooking.

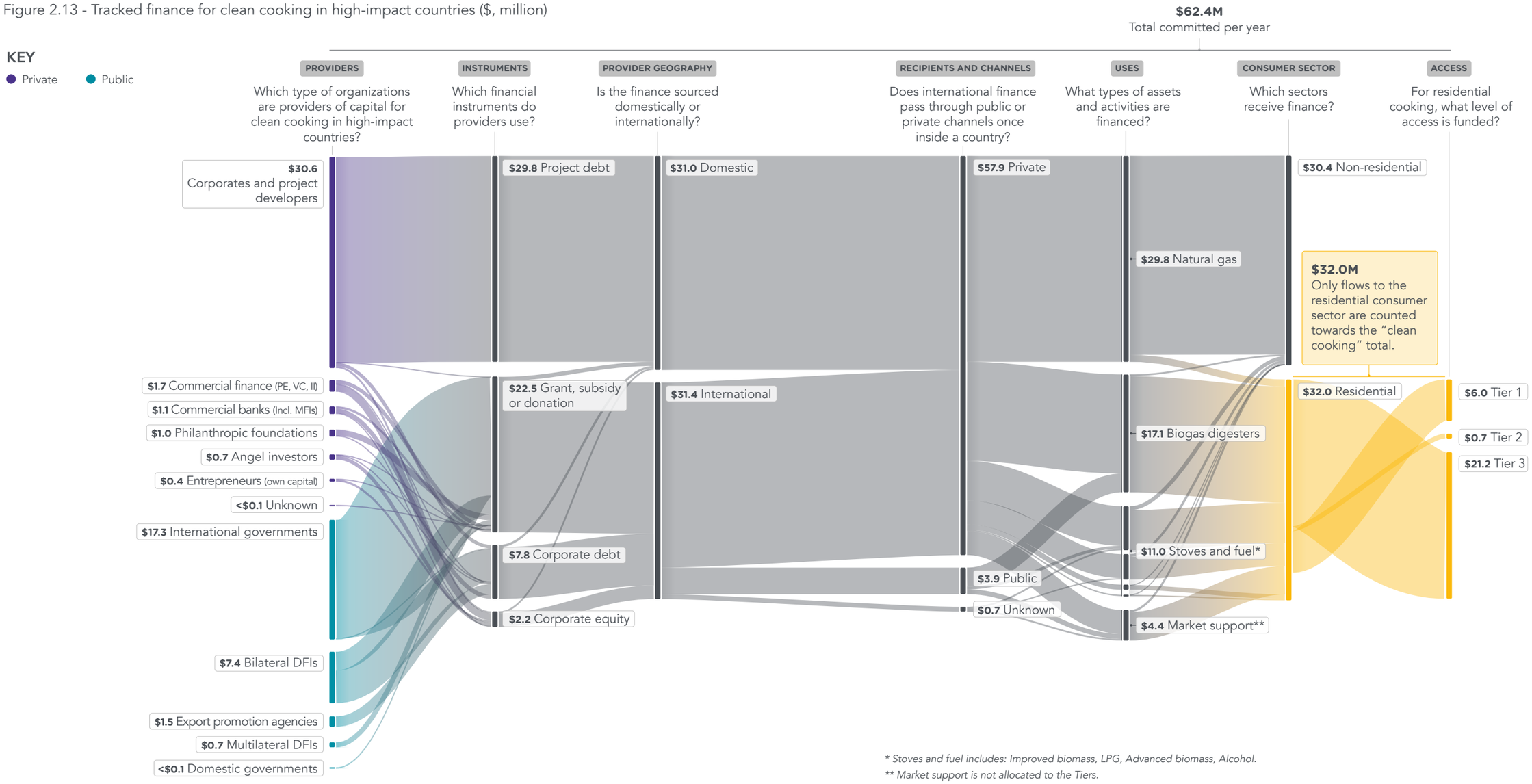
For example, the research identified a single gas distribution project in India worth $59.7 million.[22] Of this project, a small proportion relates to residential clean cooking (based on an estimation of the ultimate use of the gas distributed). The portion which relates to residential clean cooking is included in the final disclosed numbers.

A total of 119 financial commitments for clean cooking were identified over the years 2013 and 2014 in the 20

[21] *Excluding infrastructure transactions in the LPG and LNG sectors.*

[22] *The Allahabad and Chandigarh City Gas Distribution Project.*

Figure 2.13 - Tracked finance for clean cooking in high-impact countries ($, million)



** Stoves and fuel includes: Improved biomass, LPG, Advanced biomass, Alcohol.*
*** Market support is not allocated to the Tiers.*

Box 2.4 Gaps in the tracking of financial commitments for access to clean cooking

Market shares and market structure: Aggregate, country-level data describing allocations of residential and non-residential uses of specific cooking technologies is sparse. Assumptions were used throughout the analysis and are defined in Annex 1.

Piped Natural Gas and LPG cooking data: Generally, less transaction and market information was available for these technology segments.

Country data quality: Varying amounts and qualities of country-level data exist in global databases. Country data on financial commitments for Congo, DR, Korea, DPR, Myanmar, and the Philippines was absent.

OECD DAC CRS data: Entries in the OECD DAC CRS database contain only limited project descriptions. Conservative assumptions were used throughout the analysis to identify and allocate activities in clean cooking.

high-impact countries, across public and private sector financing. Given this limited data set, the insights in this chapter should be considered as indicative of sector activity but not wholly representative.

A summary of the methodology informing the analysis of financial commitments in the clean cooking sector is provided below. Additional details related to the data and methodology informing this chapter are provided in Annex 1.

1. **Scope**: The following clean and improved fuels and technologies were included in the analysis of transactions in the 20 high-impact countries:

- Advanced biomass stoves and fuel infrastructure
- Alcohol stoves and fuel infrastructure
- Biogas digesters
- Electric stoves
- Improved biomass stoves
- LPG stoves and fuel infrastructure
- Natural gas stoves and fuel infrastructure
- Solar cookers

2. **Data sources**: Data sources included datasets provided by the Global Alliance for Clean Cookstoves (GACC), OECD DAC CRS and IJ Global.

3. **Transaction data**: Transactions were detailed using secondary data to describe the source location, asset being financed, instrument and recipient of financing.

4. **Sectoral allocations of financial commitments**: Financial commitments were allocated to residential and non-residential sectors based on the best available data. For certain technologies, the allocation to the residential sector is unambiguous—clean cookstoves for example, are largely used in residential cooking applications. In the case of gas distribution infrastructure, assumptions must be made about the relative consumption shares for residential cooking and other purposes such as industrial use and power. For certain transactions, sectoral allocations were explicitly detailed in reference data. For most, secondary data and sector expertise guided sectoral allocations.

5. **Tier allocations**: Given the scarcity of country-specific MTF data, technology-specific Tiers were assigned using the attributes of the MTF Tiers for clean cooking (Bhatia and Angelou, 2015) as shown in Figure 1.4 in Chapter 1. As specified by Bhatia and Angelou (2015), each attribute was assessed separately (i.e., scored across Tiers 1 to 5) for each cooking so-

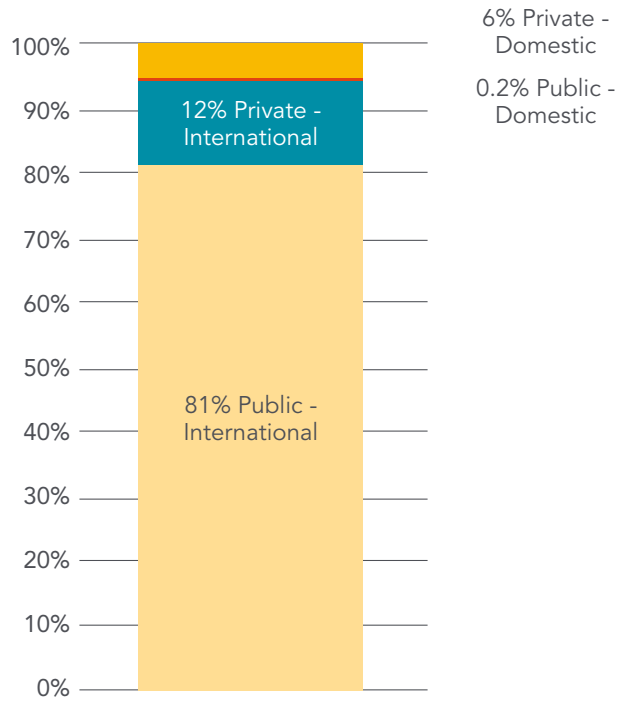
lution. The overall Tier for a given solution was obtained by applying the lowest Tier provided among any one attribute. While this is notably a modified application of the MTF, it enables a first analysis of how financing for clean cooking is translating to the delivery of varying levels of cooking energy services.

TOTAL FINANCIAL COMMITMENTS TRACKED IN CLEAN COOKING

Finance for clean cooking falls well below the annual investment targets to achieve universal access to clean cooking by 2030. Between 2013 and 2014, residential clean cooking commitments in the high-impact countries averaged $32 million per year. While the 20 high-impact countries represent 84 percent of the global access deficit in clean cooking, financial commitments tracked represented less than 1 percent of the estimated indicative minimum of $4.4 billion of annual investment required to achieve universal access by 2030.

It is likely that the commitments tracked in clean cooking are conservative because of the data limitations described above. However, limited data coverage cannot wholly explain the gap between tracked commitments and estimated levels of required annual investment. As reference points, the 2013 Annual Report of the Global Alliance for Clean Cookstoves (GACC, 2014) indicates that over $240 million in commitments were made for clean cooking globally in 2013 alone. Putti et al. (2015) estimate that total global funding for clean and improved cooking is "unlikely to exceed the range of $500 million to $1 billion." These estimates suggest that, at best, current levels of finance for clean cooking are approximately 25 percent of the required annual investment, as previously modeled by the IEA.

Figure 2.14 - Sources of finance for residential clean cooking access to the high-impact countries



Note: Average over 2013-14

PROVIDERS

International finance for residential clean cooking access totaled nearly 15 times that of domestically sourced finance. Over the years 2013 and 2014, international commitments averaged $30 million per year (94 percent), as compared with a $2.08 million annual average for domestic financings (Figure 2.14). Only six of the tracked commitments were sourced domestically, supporting transactions in LPG, improved biomass, biogas and natural gas infrastructure. All domestic transactions but one were non-concessional and sourced from project developers or commercial financial institutions. It is likely that there are domestic and South-South financial commitments which have not been captured in the data, either due to gaps in the tracking of financial commitments or in commitments to high-impact countries, or both.[23] For example, China's Exim Bank has provided financing for improved cookstoves in the past, however no commitments were identified in the database informing this analysis.

International public finance was the largest source of

[23] *See Chapter 3 for additional insights on domestic finance for clean cooking access.*

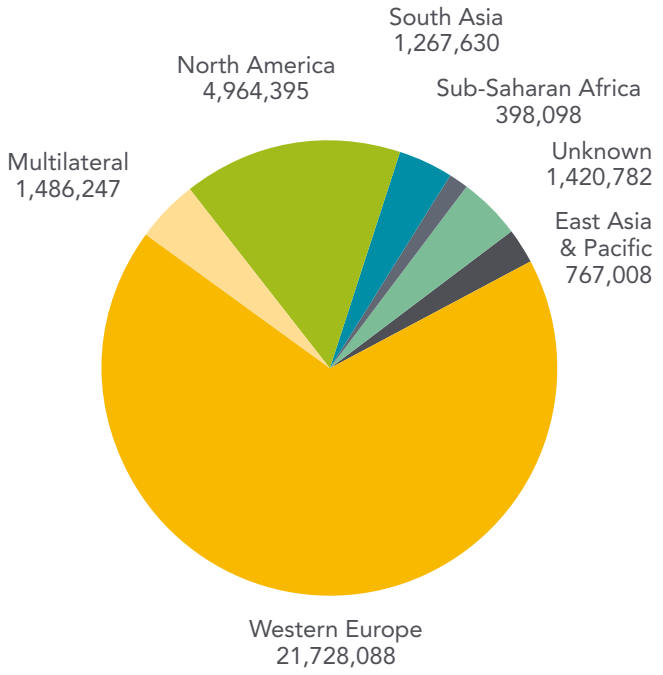
finance for clean cooking. International public funding for residential clean cooking activities represented 80 percent of the overall tracked financial commitment, averaging $26 million per year. International public finance decreased from $43 million in 2013 to $9.1 million in 2014.[24]

By comparison, private finance for residential clean cooking access totaled $3.5 million in 2013 and $8.5 million in 2014, averaging $6 million. Two-thirds of private finance tracked originated in a different country, while one-third was domestic.

The majority of tracked international commitments originated in Europe, followed by North America. Of the 119 commitments tracked, 41 originated in Europe, an annual average of $21.7 million or 68 percent of the total finance tracked for residential clean cooking access (Figure 2.15). This compares with an annual average of $5 million (17 percent of all tracked finance for residential clean cooking) that originated in North America. While most European commitments originated from the public sector, most North American commitments originated from private funders, with 40 percent provided by philanthropic foundations. European commitments averaged approximately $1 million per project, while those originating in North America approximately $0.3 million.

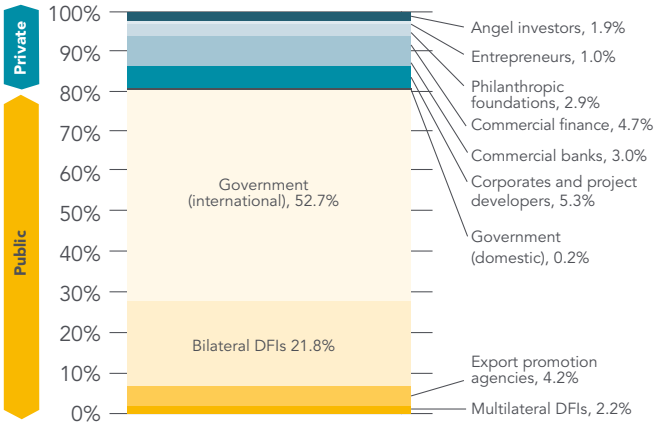
The majority of international public finance originated from governments (Figure 2.16). Most international public finance was provided by governments, followed by bilateral DFIs. While private funding is nearly evenly split between Asia and Sub-Saharan Africa, public funding is strongly focused on Sub-Saharan Africa. Nearly all inter-

Figure 2.15 - International sources of finance for residential clean cooking access to the high-impact countries ($)



Note: Annual Average 2013-14

Figure 2.16 - Public and private providers of finance for residential clean cooking access to the high-impact countries



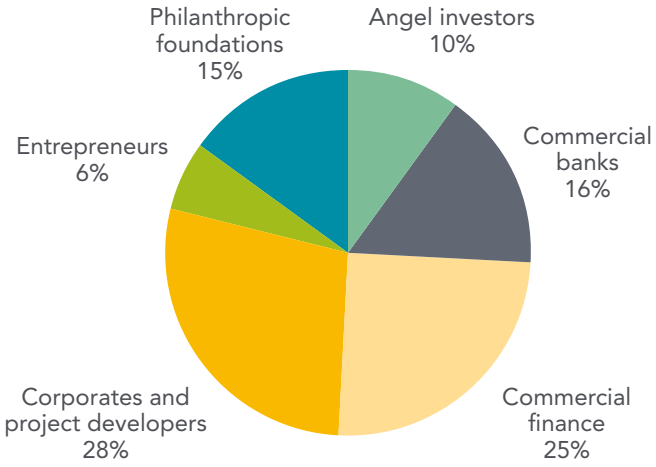
Note: Average over 2013-14

[24] *Given the data gaps on domestic public finance previously described, international public finance represents 99.8 percent of all public finance tracked.*

national public finance was provided in the form of grants. The predominance of public grant finance tracked in the sector was highly influenced by transactions supporting the Africa Biogas Partnership Programme (ABPP).

The largest amount of private finance was sourced from corporations and developers. Corporates and project developers increasingly engaged the clean cooking sector, though their total tracked commitments remain relatively minor, averaging $1.7 million (Figure 2.17). These include both international corporates providing support through innovation competitions as well as corporates seeking to make small investments in clean cooking enterprises. Domestic companies and established businesses are also investing in the growth of new clean cooking enterprises, providing approximately $2 million per year. While several philanthropic transactions have been tracked ($0.9 million a year on average), it is likely that contributions from philanthropic foundations are underrepresented, as these transactions are not always reported. The relatively substantial contribution of commercial banks to the sector, 16 percent of all private finance tracked, suggests that at least certain opportunities in the clean cooking sector be viewed as viable for commercial lending. For example, through the provision of micro-finance to local distributors, or the provision of working capital loans to national level importers.

Figure 2.17 - Private providers of finance for residential clean cooking access to the high-impact countries

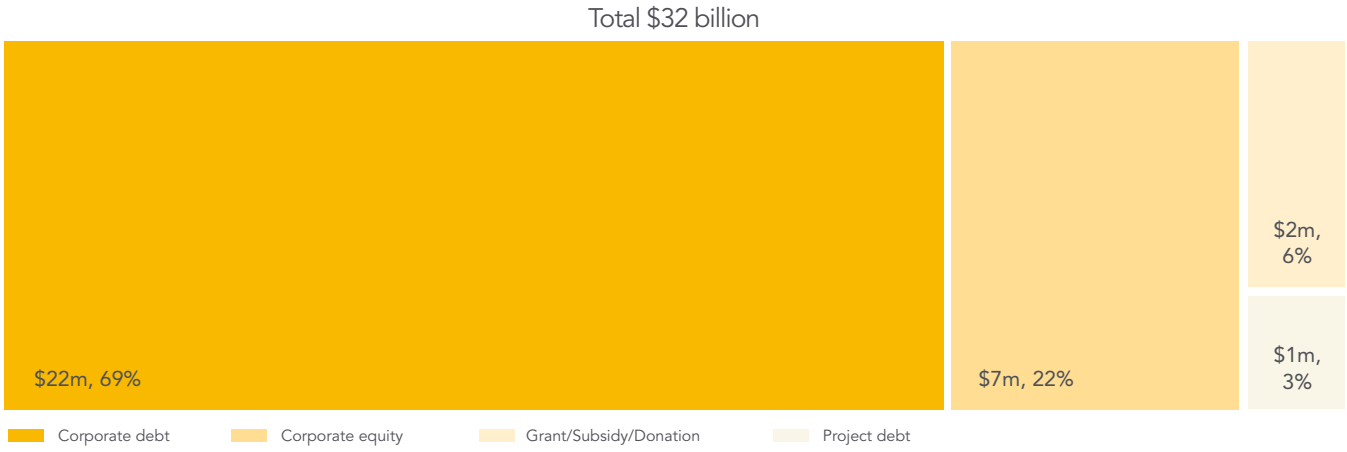


Note: Average 2013-14

INSTRUMENTS

The majority of commitments tracked for residential clean cooking access was through grants and concessional finance. Nearly 70 percent, an annual average of $22 million, of residential commitments were provided as grants (Figure 2.18), mostly from donor governments and DFIs (92 percent), with a minor portion from philanthropic institutions and angel investors (4 percent). Most grant funding was channeled through non-governmental organizations with an annual average of $17.4 million committed (80 percent). A quarter of all finance for residential clean cooking was provided through debt instruments ($8 million), largely provided by international public actors (70 percent).

Figure 2.18 Finance for residential clean cooking access by instrument to the high-impact countries



Note: Average over 2013-14

Most grants supported the distribution of biogas digesters, while corporate finance was split evenly between LPG and improved biomass cookstoves. Grant-financed activities were predominantly noted, by volume, as supporting the dissemination of biogas digesters, averaging $16.3 million over 2013-14, while improved cookstoves received $3 million. Most corporate debt and equity supported the distribution of LPG, which averaged $3.1 million per year, and improved biomass cookstove solutions, which averaged $2.8 million, indicating that commercial investments may be tenable for certain types of clean cooking enterprises.

Only 13 equity investment transactions were noted in 2013 and 2014. Average equity investments totaled $2.2 million per year, with most transactions attributable to angel investor and founder investments. Only one equity investment above $1 million was tracked, followed by four between $0.5 million and $1 million.

RECIPIENTS

Most finance for residential clean cooking access targets Sub-Saharan Africa. Seventy-eight of the 119 transactions tracked targeted activities in Sub-Saharan Africa, representing an annual average of nearly $24.8 million of finance for residential clean cooking access across 2013 and 2014. Commitments in Asia (averaging an annual level of approximately $7.2 million) were driven by activities in India and Vietnam, with only half a million dollars in commitments identified in China on average. Considering the Government of China's commitment to clean cooking and its large-scale domestic biogas digester program it is

Box 2.5 Considering the role of cooking fuels in the clean cooking financing landscape

While the majority of transactions tracked in this report include clean and improved stove and biogas digester technologies, it is important to consider the importance of enterprises delivering clean cooking fuels. There are notable differences between financial commitments that support the "social enterprise" spectrum of the clean cooking sector and those that support infrastructure-like investments in organizations actively building new ecosystems for the distribution of clean fuels (i.e., ethanol, LPG, and natural gas) for cooking. While both types of opportunities demonstrate strong potential to deliver positive social, economic and environmental impact, the two demonstrate substantively different investment and transaction profiles, with the latter often underrepresented in tracked data.

Transactions supporting clean cooking social enterprises may be generalized as typically small, in the order of a few hundred thousand dollars to a few million. Few cooking enterprises have raised eight-figure sums and finance is sourced predominantly from highly philanthropic impact investors and specialized clean technology funds in the public and private sectors. These financiers may be willing to take risks on unproven teams, new products, and innovative business models, to grow retail, fast-moving consumer goods businesses. Financiers often use grants in addition to other forms of concessional capital to help grow specific clean cooking businesses.

Transactions in the ethanol, LPG and natural gas clean cooking fuel sectors, on the other hand, require developers and financiers to adopt long-term, "industry building" perspectives. Transactions may be sized in the tens if not hundreds of millions of dollars, with long-tenor debt and a variety of risk mitigation instruments. The regulatory interactions, financial and professional service providers and organizations driving ethanol, LPG, and natural gas cooking fuel opportunities are substantively different to the rest of the sector. Financing for clean cooking fuels development must be systemic by nature. From a physical assets and operations perspective, these opportunities require a combination of refining, bulk fuel storage, bulk fuel transport and distribution, refilling, and consumer appliance development. The more challenging, time-intensive, and critical components of developing new clean cooking fuel industries require general market development support and programming. This can range from the creation and approval of technical standards to the development of regulatory frameworks, the creation of fit-for-purpose financing facilities and support for stakeholder awareness campaigns – in addition to several additional enabling environment initiatives.

When considering the data in this report, readers are encouraged to remain aware of the varied landscape that represents clean cooking comprises and bear in mind the diversity of capital, instruments and recipients needed to achieve of universal access to clean cooking solutions.

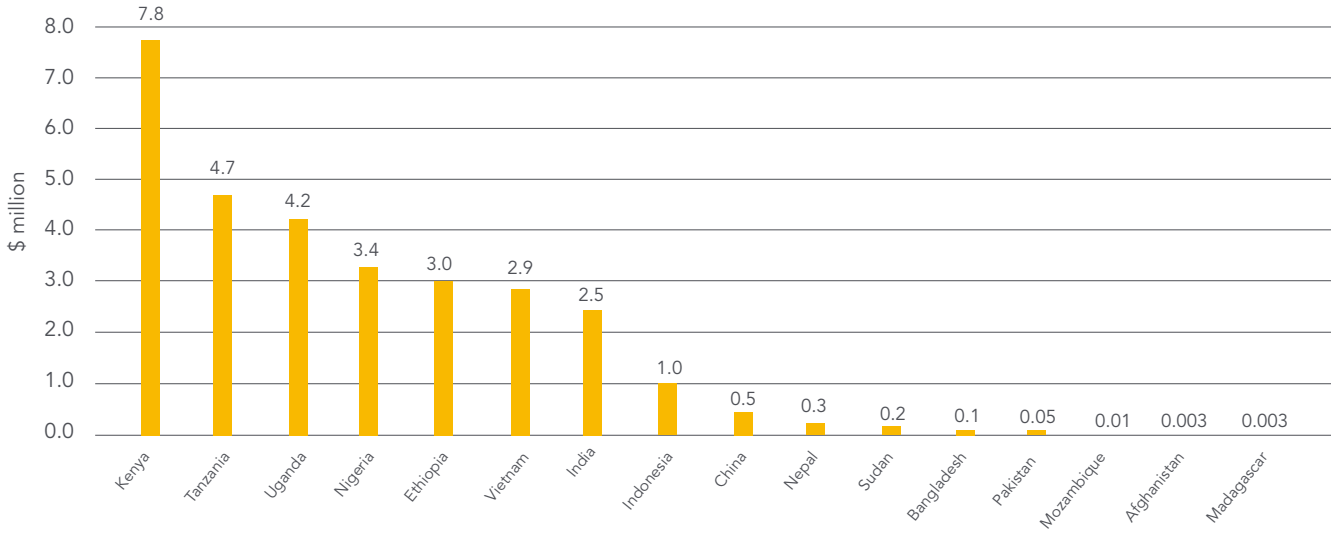
likely that this is indicative of a gap in the tracking of clean cooking data.

Markets in Eastern Africa accounted for nearly 70 percent of tracked commitments at $20.1 million per year. An annual average of $7.9 million of financing targeted activities in Kenya, $4.7 million for Tanzania, $4.2 million for Uganda and $3 million supporting activities in Ethiopia (Figure 2.19). This regional concentration of the tracked financial commitments can largely be attributed to the support provided to the ABPP within each of these countries in 2013. As shown below, East African markets also received the greatest levels of clean cooking financing per capita, likely attributed to the scale of the ABPP.

TYPE OF ASSET

Most financing for clean cooking was channeled to biogas digesters (an annual average of $16.8 million), followed by improved biomass stoves (averaging $5.8 million per year) and advanced biomass stoves ($0.7 million per year) over 2013-14. The major determinant of this allocation is likely the role of public finance and the project designs typically supported by ODA in the clean cooking sector. Several publicly funded biogas initiatives were designed as "market development" programs, which are necessarily capital intensive. These programs are often multi-year and broad in scope, providing resources for capital subsidies, credit lines and a range of enabling

Figure 2.19 - Recipients of finance for residential clean cooking access across the high-impact countries ($million)



Note: Average over 2013-14. The graph does not show $1.4 million targeting multiple high impact countries in Sub-Saharan Africa, due to a lack of detail in country destinations. No data was found for Congo DR, Korea DPR, Myanmar, Philippines.

environment initiatives, including but not limited to national awareness raising, entrepreneur capacity building and regulatory strengthening. Improved biomass cookstoves are favored by public and private finance, despite providing the lowest Tiers of access to cooking services. This can likely be attributed to familiarity with the technology, as well as its relative affordability compared with other cooking solutions (Figure 2.20).

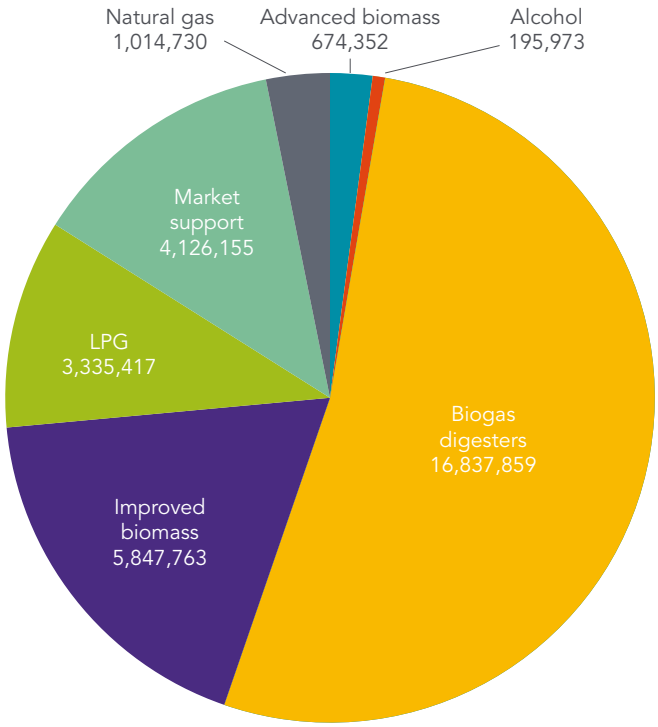
TIERS OF ACCESS DELIVERED

Most financial commitments tracked are anticipated to deliver Tier 3 levels of access to cooking services. While several types of clean cooking solutions exist, a variety of factors can limit the Tier of energy services that may be delivered by even technically excellent solutions. Cooking solutions—including those provided by LPG-, natural gas-, biogas- and electricity-based technologies—are generally considered to be clean and efficient (as defined by PM 2.5 mg/min and thermal efficiency scales, respectively). However, factors including affordability, the availability of energy carriers and personal safety may ultimately result in a lower Tier of cooking service—as defined by the MTF. As an example, users of electric stoves may be limited by load-shedding, while LPG network disruptions can cause temporary reversions to charcoal-based cooking.[25]

Nearly 70 percent of all tracked commitments in 2013 and 2014 (an annual average of $21.2 million) was estimated to deliver Tier 3 levels of cooking access (Figure 2.21). This was largely due to the disproportionate commitments attributed to a few large, publicly financed biogas dissemination projects, as well as commitments made in LPG, and the Allahabad and Chandigarh City Gas Distribution Project mentioned previously. Approximately $6 million, or 22 percent of total commitments flowing to the residential sector, is estimated to deliver Tier 1 levels of access, largely driven by the dissemination of improved biomass stoves.

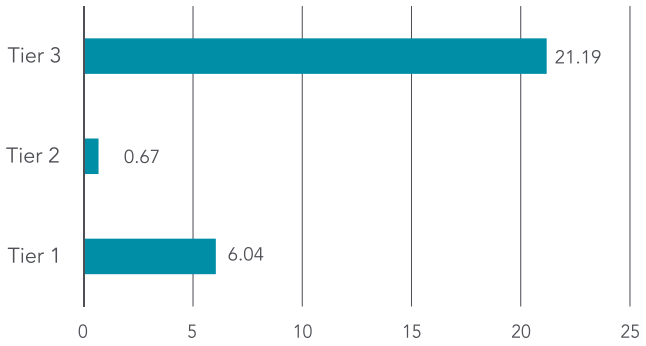
[25] *Or, more precisely, a temporary increase of charcoal in a given household's cooking fuel stack.*

Figure 2.20 - Finance for residential clean cooking access per asset type across the high-impact countries ($)



Note: Average over 2013-14

Figure 2.21 - Finance for residential clean cooking access by Tiers of access ($ million)



Note: Average over 2013-14

CHAPTER 3

BOTTOM-UP CASE STUDIES ON ENERGY FINANCE FOR KENYA, BANGLADESH AND ETHIOPIA

To complement the overview of financing flows to the high-impact countries, this chapter provides a more detailed analysis of estimated domestic finance commitments for energy in three of the high-impact countries—Kenya, Bangladesh, and Ethiopia. These three "deep dives" are based on primary data collection in each country. This "bottom-up" approach makes it possible to provide a more detailed and disaggregated measurement of domestic finance for both electricity and cooking. It also sheds light on additional issues such as the institutional pathways through which finance is committed at the country level for energy and the financial instruments used to pass financing commitments to the investing entities.

In addition, piloting this method at the country level allows greater insights into domestic finance that is not tracked in international datasets. This will allow improvement of the granularity and scope of data in future iterations by connecting global and country analysis and extending country coverage.

The three countries were selected for several reasons. First, they all belong to the high-impact countries group, making it possible to compare country-level results against the global approach for the same countries. Second, they are at different stages of economic and energy sector development and provide regional contrast between Africa and Asia. Third, they had relatively good availability of data at the country level, for both cooking and electrification. Current MTF access surveys are being carried out in the three "deep-dive" countries, allowing application of some of the most up-to-date information.

METHODOLOGY

The "bottom-up" country cases use the same methodology for defining, measuring and reporting on finance commitments for electricity as was already reported for the global estimates. In addition to data for the years 2013 and 2014, it was possible to obtain data for 2015 for the country case studies since the data publication lag is shorter for domestic statistics than international ones. To avoid swings associated with individual large projects, all data in the chapter are reported as annual averages for the period 2013-15.

Data was collected by local energy experts in each country who reviewed all published sources of information and conducted visits to the main institutional actors in each country. These actors included energy ministries and their associated agencies, as well as public utilities and private service providers. The collected data then went through a detailed quality control and review process by government counterparts and local World Bank energy specialists.

It is important to note that the country case studies also captured international flows into the countries, in addition to their own domestic flows. However, the international flows reported from the global approach need not necessarily coincide with those in the "bottom-up" methodology. Data availability may differ in each case. Moreover, there can be delays before finance committed by international actors is disbursed at the domestic level. Considering that neither method captured all flows, estimates provided by the bottom-up and top-down approaches complement and supplement each other.

In addition to public finance, every effort was made to cover domestic private finance, such as corporate and project debt from commercial banks and small-scaled decentralized service providers for off-grid electricity and cooking. However, this proved to be a difficult task due to the atomized and dispersed nature of this sector, together with the commercial confidentiality of much of the relevant data given the competitive market context. Thus, the limited data that could be obtained was duly anonymized. Consultations with knowledgeable local energy experts were undertaken to gauge their insights regarding what proportion of the industry "universe" was represented by the limited data that could be collected and how representative a view of the sector was being provided.

Once data collection was completed, energy finance patterns were analyzed by source country, source institution, financial instrument, financing channel and infrastructure type. Financing was then allocated to residential energy access based on the methodology described in Chapter 1 and Annex 1. Finally, finance was allocated to individual access Tiers based on the methodology described in Chapter 1 and Annex 1. The one exception was Ethiopia, for which preliminary data from MTF surveys in-country were available; the Tier allocation from the MTF survey was applied for Ethiopia. Completion of MTF baseline surveys for 15 of the high-impact countries in the study will allow this methodology to be refined and better aligned with a given local context in future.

This chapter presents the results of each of the country case studies sequentially. It concludes with a brief comparison between the country cases and between the global and country-level evidence for each case.

KENYA CASE STUDY

COUNTRY SECTOR CONTEXT

In 2008, the Government of Kenya launched its Vision 2030 national development plan. Electricity access is a priority under Vision 2030, with a goal for universal coverage by 2020. The "Roadmap for Fast Tracking Power Generation" aims to increase capacity threefold over 2013 levels (1664 MW) to 5000 MW by 2017. With this buy-in, Kenya's grid-connected and off-grid markets are active and growing. The government is also focusing on renewable energy diversification: it is working to phase out fossil fuels and reduce dependence on hydropower. Thus, geothermal energy has been rapidly increasing its share of the generation mix in recent years. Moreover, Kenya has one of the most developed off-grid private-sector driven solar markets in the world. Kenya is also actively engaged with a number of African regional cookstove initiatives.

Kenya's electricity sector has been fully restructured with separate public utilities responsible for generation (KenGen), transmission (KETRACO) and distribution (KPLC). KenGen is partially privatized following an initial public offering of 30 percent of its equity on the Nairobi Stock Exchange and generates power alongside several Independent Power Producers. In addition, the sector has two specialized public agencies—the Rural Electrification Agency (REA) and the Geothermal Development Corporation (GDC). It is regulated by the Energy Regulatory Commission (ERC); formerly the Electricity Regulatory Board).

Relevant entity names		
KETRACO	Kenya Electricity Transmission Company	State-owned transmission utility
KENGEN	Kenya Electricity Generation Company	Generation utility, 70% owned by the GoK (KENGEN, 2017)
KPLC	Kenya Power and Lighting Company	Distribution utility, 50.1% owned by the GoK (KPLC, 2016)
KNEB	Kenya Nuclear Electricity Board	National nuclear power agency
GDC	Geothermal Development Company	State-owned exploration SPV
REA	Rural Electrification Authority	State-owned grid extension agency
MOEP	Ministry of Energy and Petroleum	

Finance data for energy in Kenya was collected from public institutions, including utilities, and interviews with private-sector actors. One of the key challenges for Kenya was to obtain information on the vibrant private sector engaged in off-grid solar energy services. The same problem was also experienced in the cooking sector. Thus, the information on decentralized private provision of energy services is not fully complete or even representative. Moreover, given that the information obtained relates to turnover rather than finance per se, these results are incompatible with the bulk of the financing commitments data and are therefore reported as a separate box rather than integrated with the overall results for the country. In any case, the values appear to be so small as to not materially affect the overall narrative for the country case (See Box 3.1).

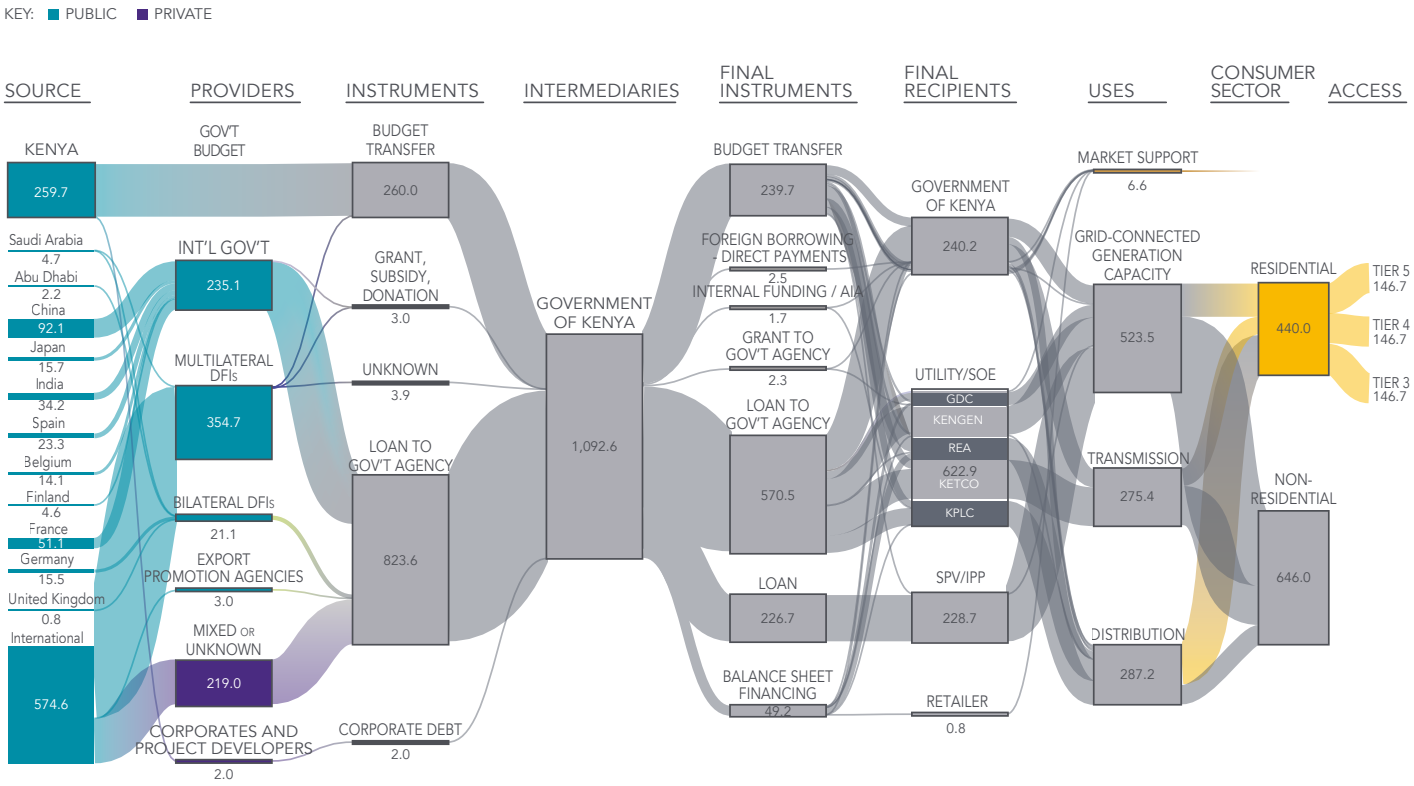
Box 3.1 Indicative figures on domestic private finance for electricity in Kenya

As mentioned above, despite Kenya's leadership in the off-grid and mini-grid sector with companies like M-Kopa, BBOXX and PowerGen, it was difficult to obtain domestic data on how much the private sector received in financing commitments.

Another approach is to examine the sector by reported enterprise revenue. Eleven companies included in a survey of enterprises in Kenya reported figures of $5.8 million for mini-grids and $13.5 million for solar energy in 2015 (SEforALL, Practical Action Consulting and E3 Analytics, 2017). Although it is unknown what percent or proportion of the industry these data represent, they give some insight into the order of magnitude of company size.

Figure 3.1 - Kenya finance flows for electricity 2013-15

Average finance flows for electricity in Kenya from 2013-15: $1,092.6 million per year



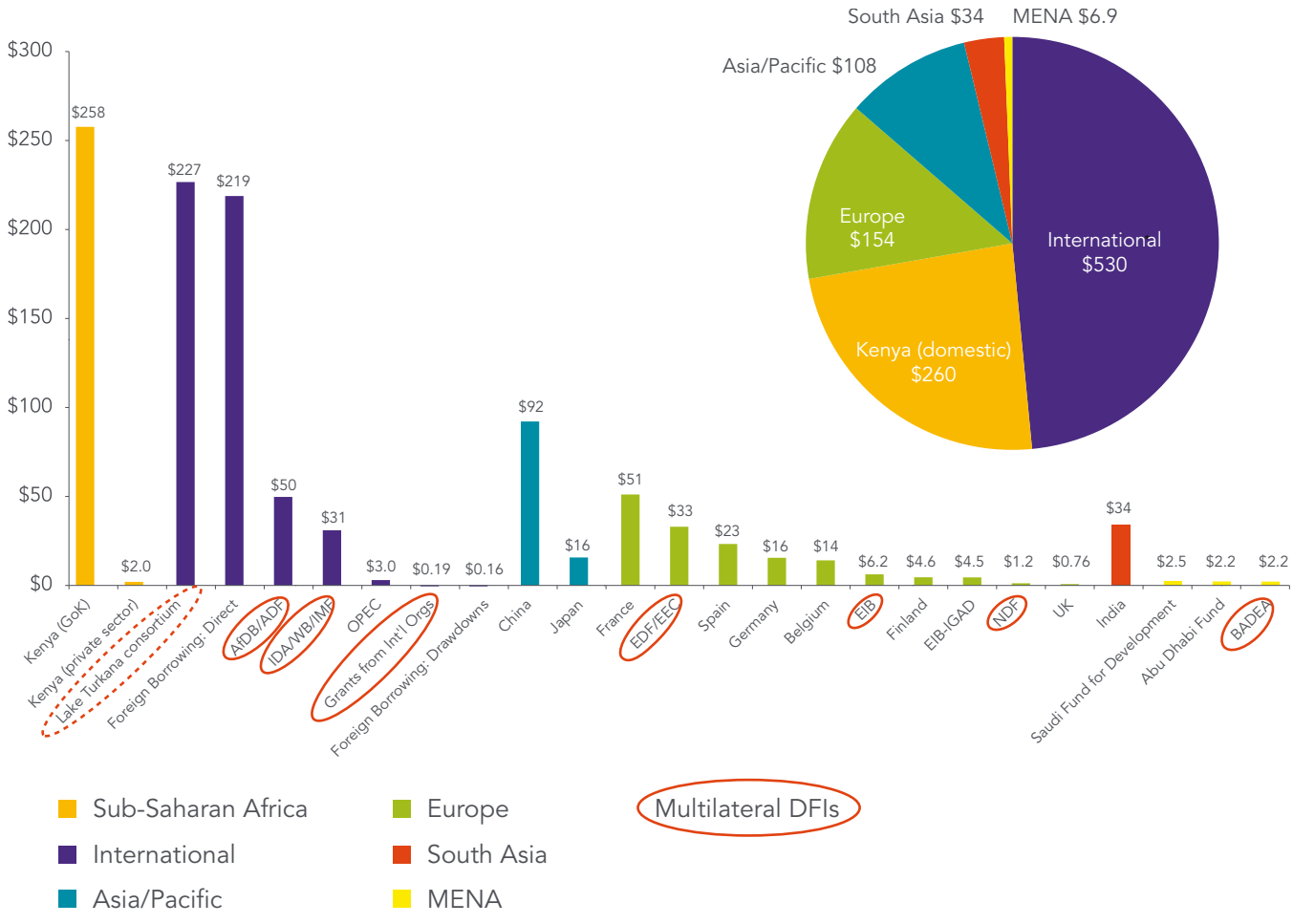
Note: Totals are an average of commitments made between 2013 and 2015.

FINANCE FOR ELECTRICITY

The bottom-up approach estimated the average annual value of finance commitments for electricity in Kenya over 2013-15 to be $1.093 billion. The available data was spread over a total of 180 separate energy projects and is equivalent to a flow of $24 per capita or 1.8 percent of GDP.

While the bulk of identified finance for electricity originates outside Kenya, domestic finance from the government budget was found to be the single largest source of funding (Figure 3.2). About half of Kenya's finance commitments for electricity come from international financiers and a further quarter from specific foreign countries. The largest international source identified is the consortium of agencies supporting the Lake Turkana Wind Project, followed by the foreign borrowings of the Government of Kenya. Among multilateral institutions, the African Development Bank and World Bank stand out with $50 and $31 million a year respectively. Considering foreign government sources, China is the largest single financier, averaging an estimated $92 million annually, compared with $155 million per year from all European sources combined. India was also a notable contributor with $34 million annually. Nevertheless, finance originating from Kenya's own government budget was found to be larger than any other single source and represents about 25 percent of the total, or around $258 million per year.

Figure 3.2 - Kenya: Finance commitments for electricity, by source ($ millions)

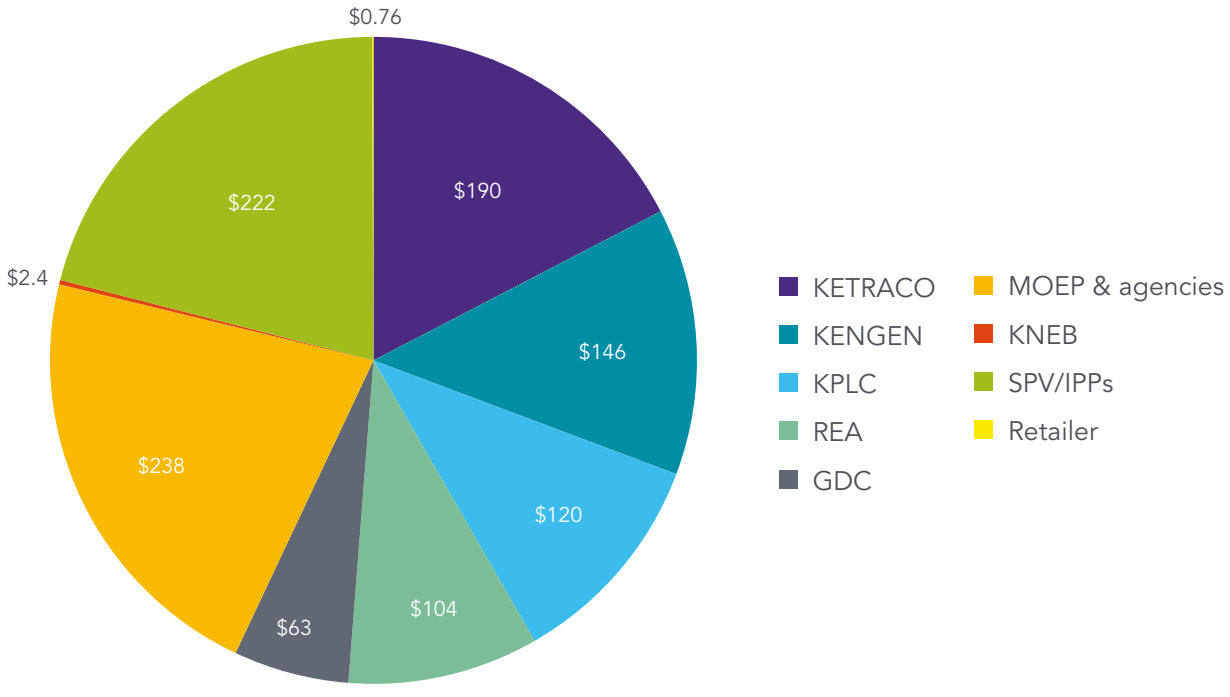


The Government of Kenya acted as a financial intermediary for the entirety of international capital flows identified in the research: $832.9 million or 76 percent of the total annual average commitments. Concessional loans were the main financing mechanism used to provide international finance for electricity to the Government of Kenya, with grants accounting for less than one percent (around $6.1 million). The average size of a loan in this dataset was around $30 million, compared with $5 million for the average size of a grant. The government passes on the loans it receives to a variety of energy service providers, almost always in the form of loans, although it is not known whether the terms of on-lending match those at which the government originally borrowed. The small volume of grants received is almost entirely transferred also as grants.

Kenya's electricity parastatals are the primary recipients of finance for electricity on-lent by the government (Figure 3.3). Considering the $833 million per year in international capital flows to the Government of Kenya, about 70 percent are passed on as loans to electricity sector parastatals; KETRACO is the largest recipient followed by KenGen and KPLC. Another 26 percent of the international finance is on-lent to Special Purpose Vehicles/ Independent Power Producers (SPV/IPPs). One is the Lake Turkana Wind Power project, which will provide 310 MW of capacity to the national grid that will be purchased by KPLC at a fixed price over a 20-year period. The other is a grid-connected biogas plant operated by the Tropical Power Company, which will generate 2.2 MW using flower waste feedstock. Tropical Power is 50 percent owned by the family-run VP Group. A further approximated $238 million of largely international (85 percent) finance is retained by the line ministry for its own programs.

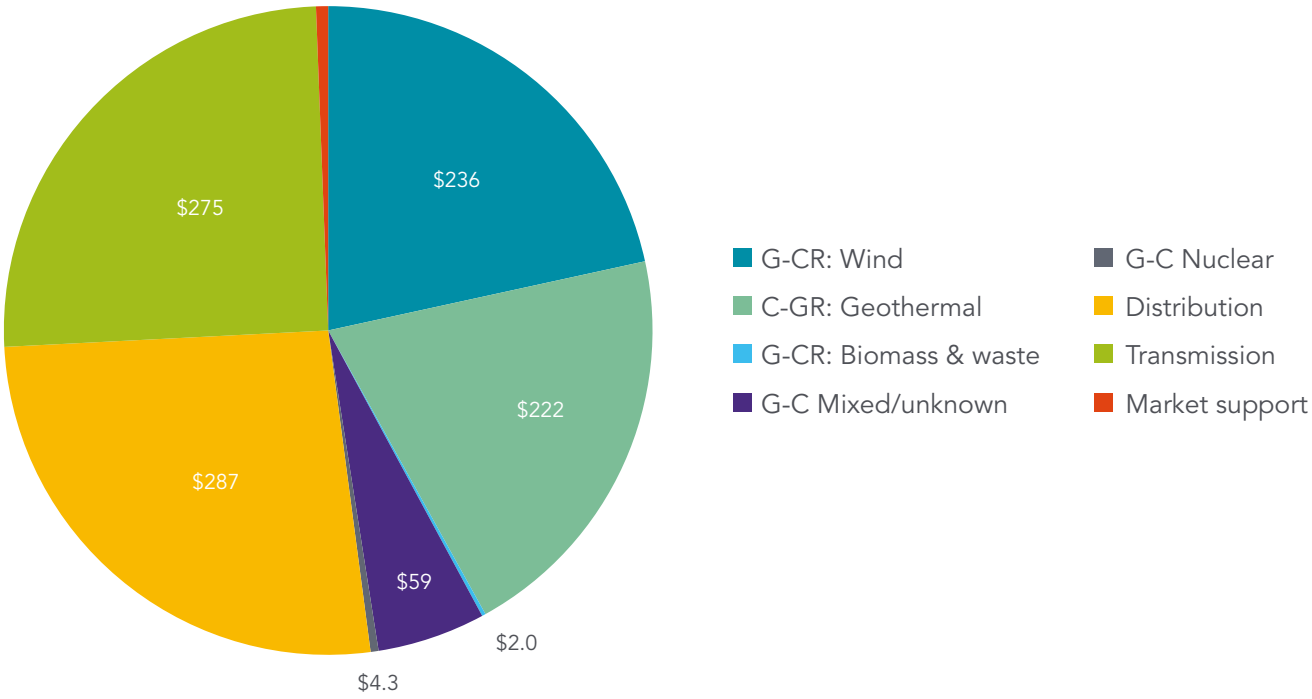
Overall, Kenya's state-owned utilities were found to be the ultimate recipients of $622.9 million in financial commitments, or 57 percent of the nation's total finance for electricity. Data indicated that about two-thirds of utility finance comes from international sources and the remaining third from domestic sources.

Figure 3.3 Kenya - Distribution of finance for electricity, by ultimate recipient ($ millions)



Almost the entirety of funding for electricity access in Kenya identified by the bottom-up approach went to power grid infrastructure (Figure 3.4). This research methodology found that less than 1 percent of funding was earmarked for market development and only a small part of this was channeled to off-grid electricity solutions. Just over half of the finance for electricity was channeled to transmission and distribution projects in roughly equal shares. Just under half of this went to grid-connected generation capacity, almost all of it for wind and geothermal projects.

Figure 3.4. Kenya - Commitments supporting grid-connected capacity, by sector ($ millions)



It is estimated that 41 percent of finance for electricity benefits residential access, divided equally between Tiers 3, 4, and 5 (Figure 3.5). Using the methodology described above, The overall finance commitments for electricity are apportioned between residential and non-residential consumers to estimate the share that can be attributed to residential access, which comes to 41 percent for Kenya, or $440 million. An indicative allocation across Tiers, based on 2017 MTF survey data for Ethiopia, suggests that this funding is split approximately equally between Tiers 3, 4 and 5. Due to the heavy focus on grid-connected capacity, the allocations to Tiers 1 and 2 is negligible.

Figure 3.5: Kenya: Allocation of finance for electricity to access by Tier ($ millions)

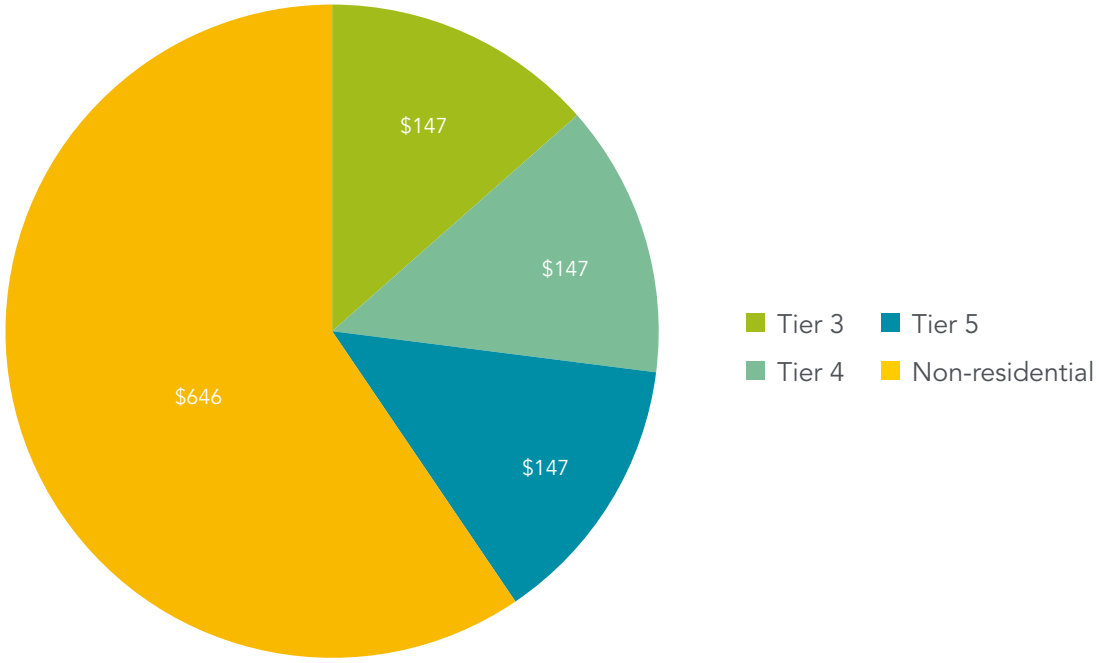
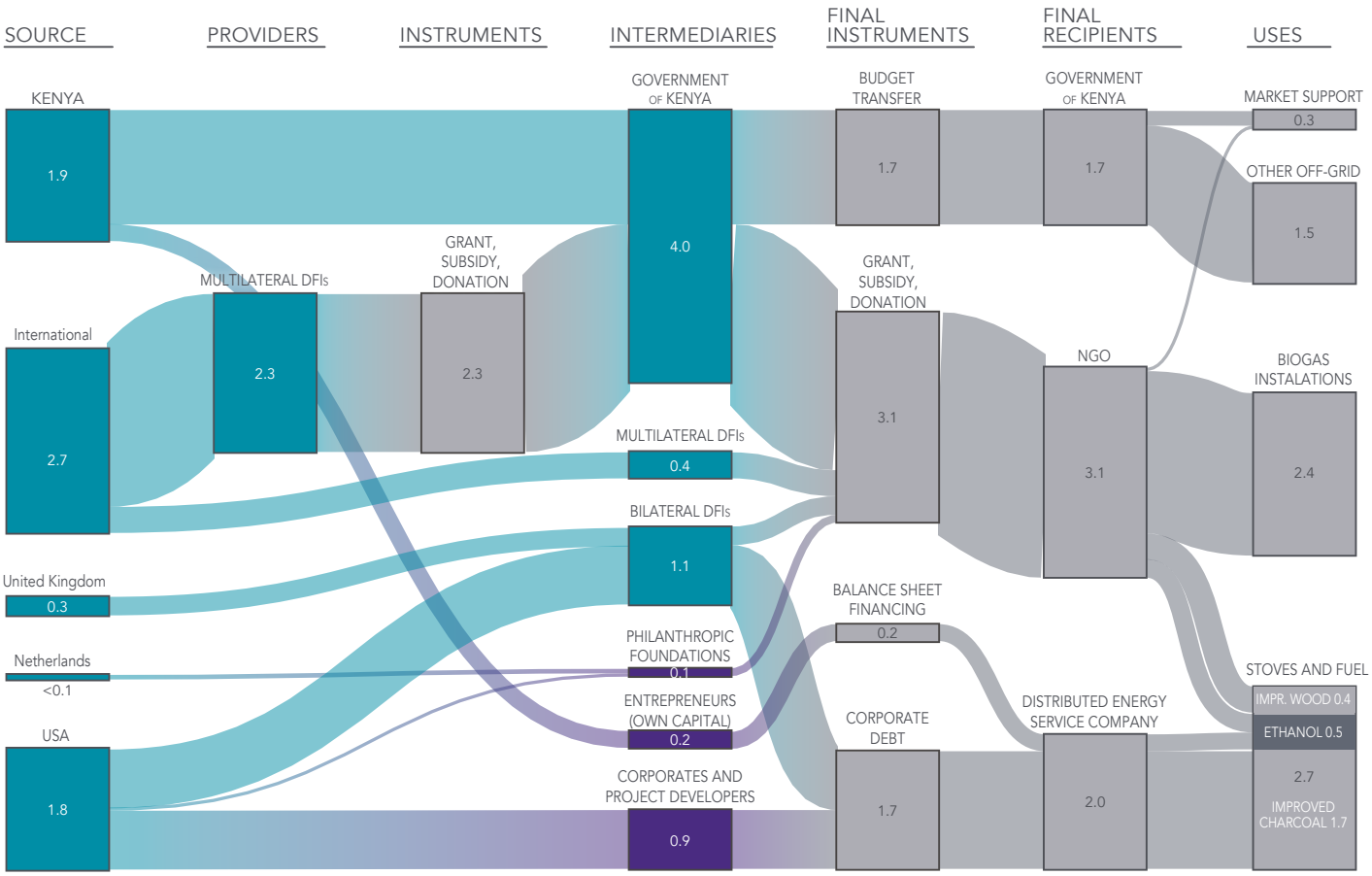


Figure 3.6 - Clean cooking finance flows in Kenya 2013-15 ($, million)

Average of finance flows for clean cooking in Kenya from 2013-15: $6.8 million per year

KEY: PUBLIC PRIVATE



Note: Totals are an average of commitments made between 2013 and 2015.

FINANCE FOR CLEAN COOKING

Among countries in Sub-Saharan Africa, Kenya is relatively engaged with the clean cooking agenda. The country has active projects with each of the following international clean cooking initiatives: World Bank (WB) Africa Clean Cooking Energy Solutions (ACCES); Global Alliance for Clean Cookstoves (GACC); Energizing Development Program (EnDev); Global LPG Partnership (GLPGP); Africa Biogas Partnership Programme (ABPP); and Biomass Energy Initiative for Africa (BEIA); and Global Village Energy Partnership (GVEP) - Developing Energy Enterprises Program (DEEP).

Nonetheless, the average annual value of clean cooking finance in Kenya between 2013 and 2015 was found to be just $6.74 million by the bottom-up approach, although apparently on an upward trend (Figure 3.6). This is equivalent to just $0.15 per capita, or one one-hundredth of a percent of GDP. Although it is difficult to derive trends from such a short period, Kenya had a 13 percent compound annual growth rate of financing commitments for clean cooking between 2013 and 2015, which could be indicative that this small sector is growing.

Some 70 percent of finance commitments for cooking was found to come from international sources (Figures 3.7 and 3.8). Multilateral institutions accounted for about 40 percent of total finance identified, or $2.72 million. North America was by far the largest bilateral source of funds at $1.79 million, with Europe a distant second. Flows from North America were a mixture of resources from private foundations, export credit and private corporations (notably General Electric). The balancing 30 percent of finance for cooking comes from domestic sources, primarily $1.69 million from the Government of Kenya's budget, as well as a small but significant slice of $0.25 million from local entrepreneurs. Nearly all funding was concessional, except for that provided by private entrepreneurs.

Figure 3.7. - Kenya: Average annual commitments for cooking, 2013-15 by source region, country ($ millions)

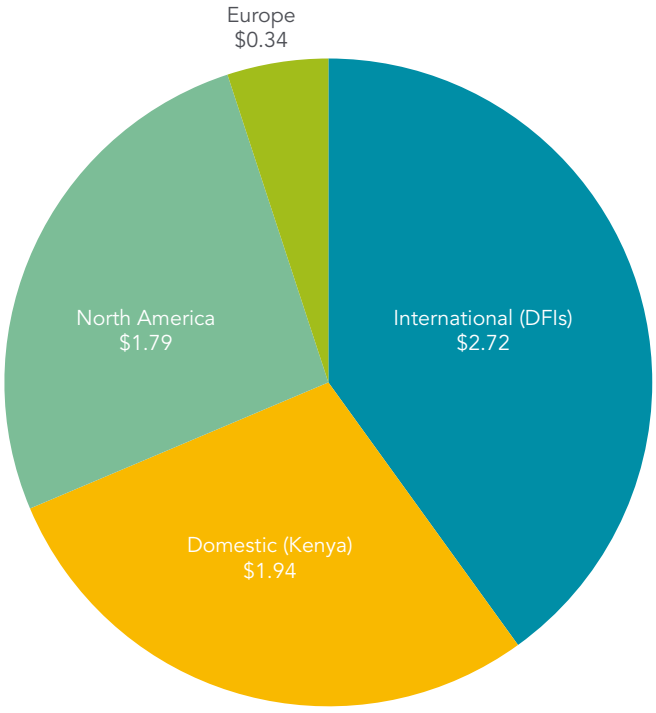
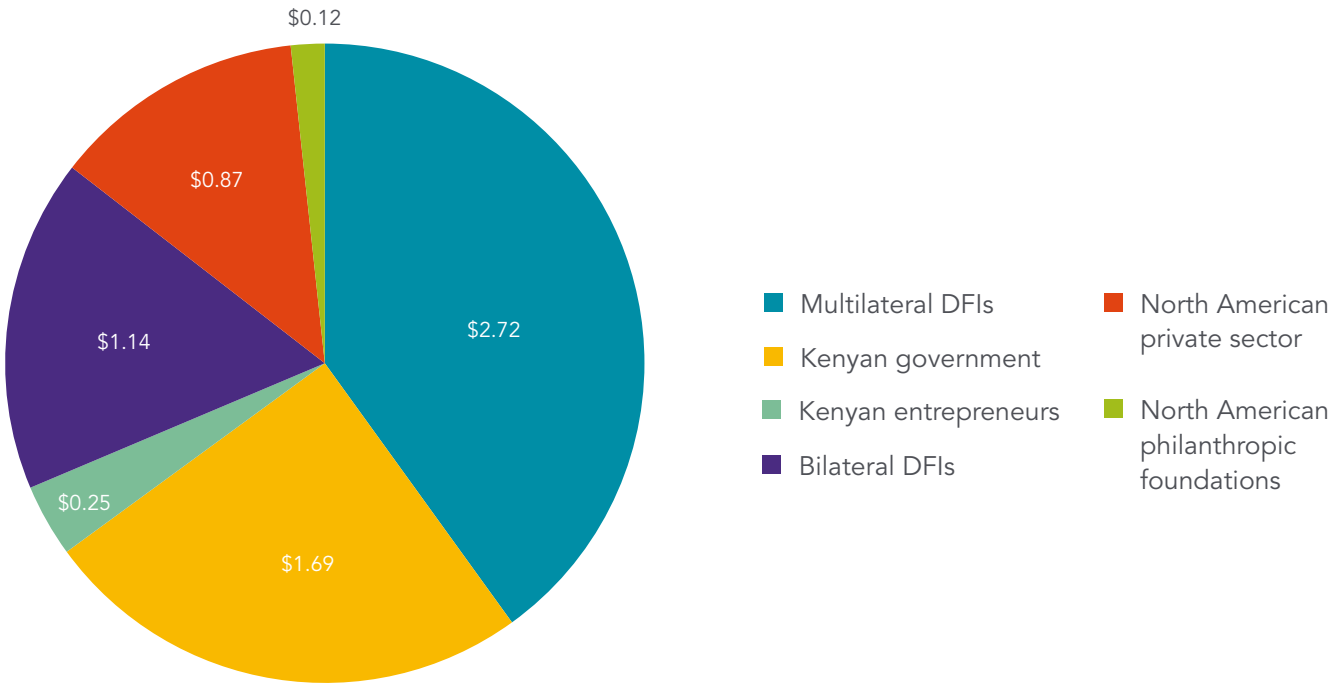
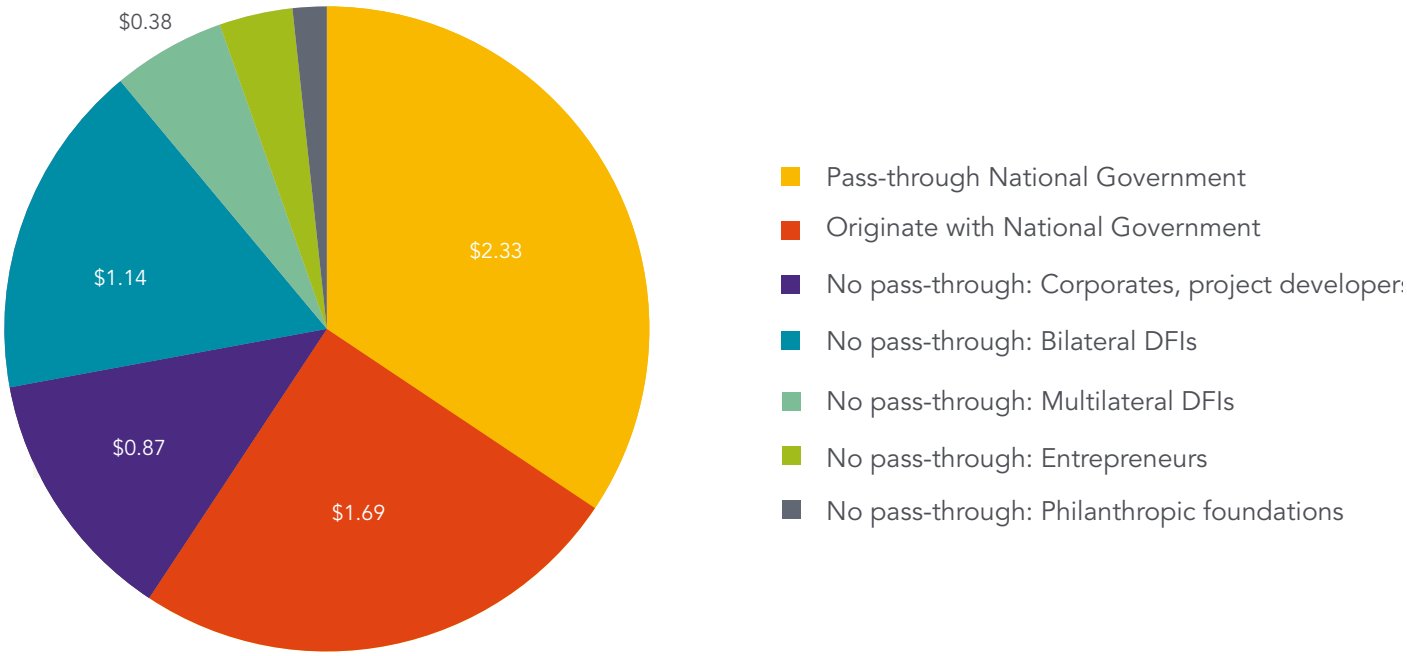


Figure 3.8 - Kenya: Committed flows by upstream contributing institution ($ millions)



In contrast to electricity, more than half of the international finance for cooking was found to go directly to recipient institutions without passing through the Government of Kenya as an intermediary. The Government of Kenya is an intermediary for an estimated $2.3 million or just under half of the international finance for cooking (Figure 3.9). The flows that pass through the Government of Kenya are either grants to non-governmental organizations or budget transfers to the Ministry of Energy and Petroleum (Figure 3.10). Of the remainder that does not pass through the Government of Kenya—but is committed directly to final recipients—the largest portion by volume was corporate debt (around $1.74 million). This corporate debt was, in fact, one concessional flow from General Electric and the Overseas Private Investment Corporation (OPIC), a US development finance agency (although the split between the two was unknown).

Figure 3.9 - Kenya: Pass-through to Kenyan Government ($ millions)



The main institutional players are NGOs, distributed service companies and the line ministry. Nearly half of all commitments over 2013-15 were delivered to NGOs, a share that has been increasing in recent years. Altogether, an estimated $3.11 million is committed to NGOs annually. Another third of the funding goes to distributed energy service companies; namely BURN Manufacturing (a Nairobi-based clean cookstove manufacturer) and Mumias Sugar Company (which produces ethanol from sugarcane).

The highest volume of this financing was then found to be channeled to biogas installations ($2.4 million per year, or 35 percent), followed by improved charcoal stoves ($1.74 million per year, or 26 percent) (Figure 3.11). Flows to biogas installations are in fact two large flows, one from the World Bank and the other from Dutch non-governmental organization HIVOS. Both projects focus on supplying clean cooking technology to rural households in Kenya. The improved charcoal stoves financing was just one flow: GE/OPIC corporate debt financing for a private company called BURN Manufacturing. The third-largest volume of financing went to "Other off-grid technologies" to support the Ministry of Energy and Petroleum's Woodfuel Resources Development project.

Figure 3.10 - Kenya: Ultimate recipient ($ millions)

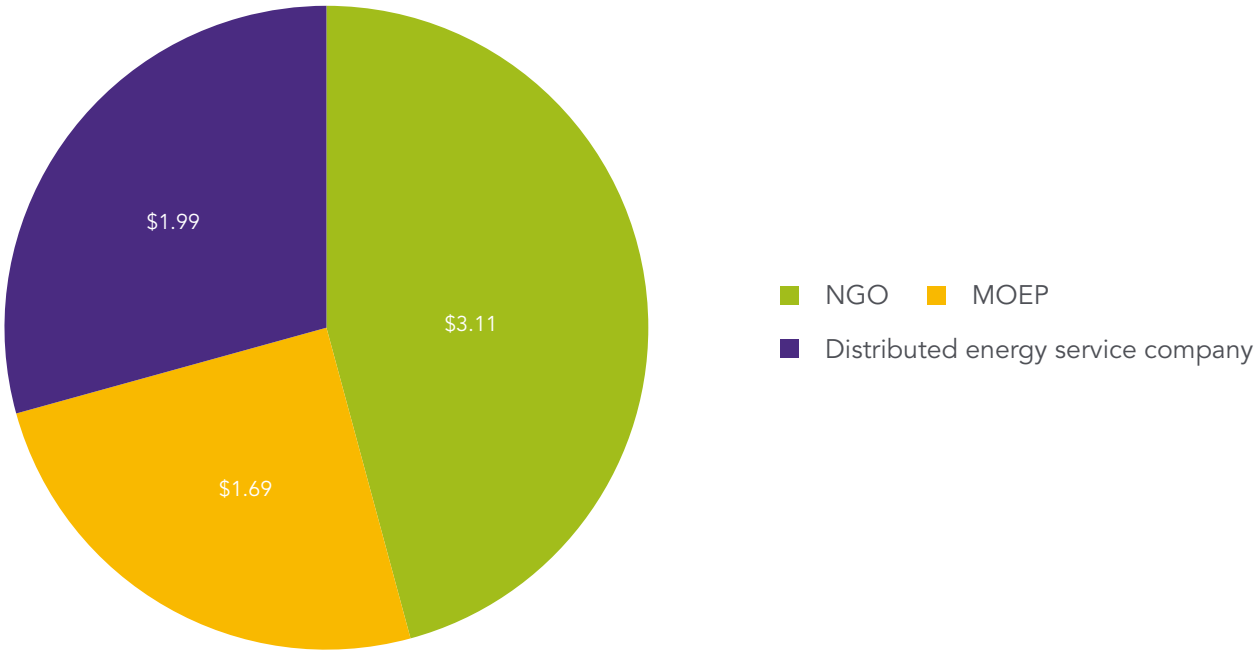
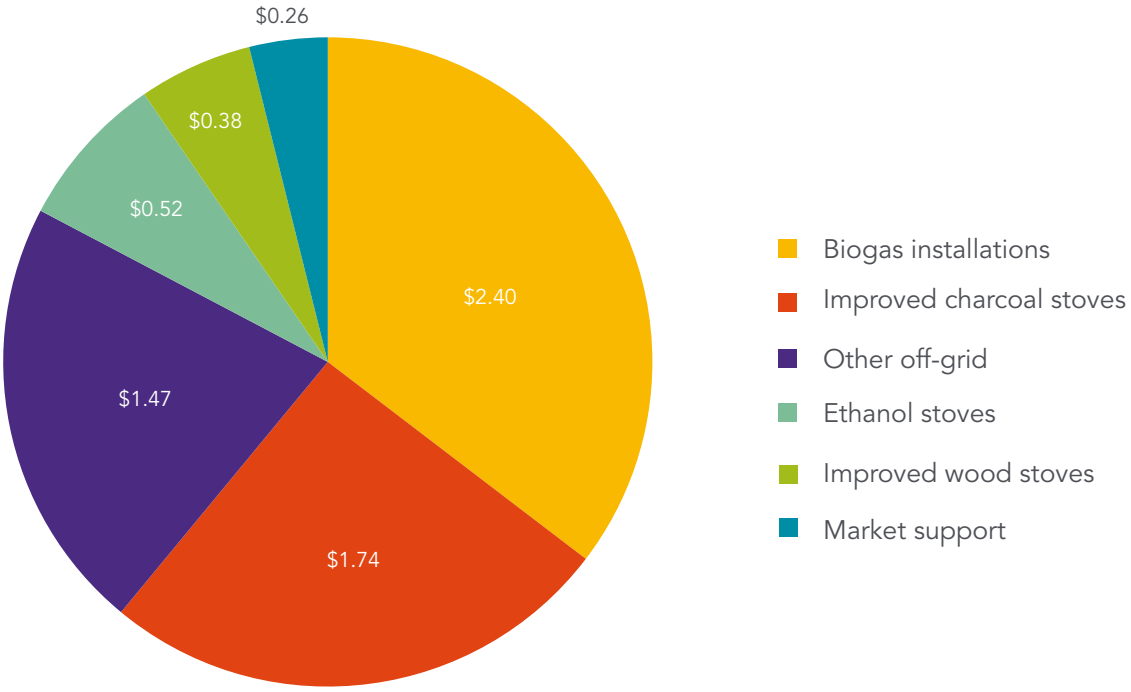


Figure 3.11 Kenya: Clean cooking by technology ($ millions)



ETHIOPIA CASE STUDY

COUNTRY SECTOR CONTEXT

Ethiopia's 2016 National Electrification Strategy states that electrification is a critical component of the country's development agenda, in support of targets for both economic growth and human development. Ethiopia's first Growth and Transformation Plan (2010-15, GTP I) targeted universal electricity access "in the medium term," as well as aiming to establish Ethiopia as an East African power hub; hydropower is an important means of meeting these goals. The country's most recent Second Growth and Transformation Plan (2015-20, GTP II) aims to reach 7 million customers by 2020.

To support these efforts, Ethiopian Electric Power Corporation (EEPCo) was restructured in 2013. Thus, generation and transmission functions for projects 66 kV and higher would be the purview of the newly formed Ethiopian Electric Power (EEP). This includes the work of Ethiopia's Universal Electricity Access Project (UEAP), an initiative for nationwide access, which seeks to connect rural areas to the national grid. Grid-connected power distribution of less than 66 kV (including rural electrification and customer service), would be carried out by the Ethiopian Electric Utility (EEU).

Administratively, most of Ethiopia's energy sector falls under the rubric of the Ministry of Water, Irrigation and Electricity (MOWIE). The Alternative Energy Technology Promotion and Dissemination Directorate is involved in the off-grid energy sector, including off-grid electrification (through the Rural Electrification Secretariat) and the National Biogas Program. The National Improved Cook Stove (NICS) program was administered by MOWIE/AETPD until early 2017, when it was moved to the Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) Department within the Ministry of Environment, Forest and Climate Change.

It should be noted that—in contrast to Bangladesh and Kenya—no data for finance commitments to energy were publicly available, either from the government or the national utilities. Researchers therefore estimated government and utility finance from their contributions to projects funded by bilateral and multilateral donors (if MOWIE had indicated GOE financing involvement). They otherwise used a variety of primary and secondary sources to estimate financing flows based on available information (Box 3.2). Thus, cost estimates obtained for the Gilgel Gibe III hydropower plant and the Great Ethiopian Renaissance Dam (GERD), for example, were not from official government sources.

Box 3.2 Indicative figures on domestic private finance for electricity in Ethiopia

There are three main actors in Ethiopia's small off-grid sector: the GOE through the Rural Electrification Fund (REF) and the Development Bank of Ethiopia (DBE), private sector companies, and non-govenmental organizations.

It was difficult to obtain domestic data on how much finance flowed to private sector actors for off-grid electrification. An alternative approach is to look at reported enterprise turnover. While this is not equivalent to finance, it does help to gauge the scale of the sector. Such data were available for a subset of seven companies; although it is unknown what proportion of the industry these seven companies represent (SEforALL, Practical Action Consulting and E3 Analytics, 2017). They reported sales of $8.9 million for solar home systems (SHS) and solar lanterns in 2014, and $6.0 million in 2015, which can be taken as an indicative lower bound on the size of the market.

FINANCE FOR ELECTRICITY

Bottom-up approach estimates found the average annual value of finance committed for the electricity sector in Ethiopia over the period between 2013 and 2015 was $1.212 billion (Figure 3.12). This was spread over a total of 29 separate energy projects and is equivalent to a flow of $13 per capita, or 2.2% of GDP.

Research indicated that an estimated 80 percent of finance for electricity came from international sources, the lion's share of it from China (Figure 3.13). Ethiopia received an annual average of $960 million of finance for electricity from international sources. As much as $740 million of this was from China, sourced from several different institutions. These included a large transaction with Chinese State Utility Electric Power Equipment and Technology Company (known as "CET"), as well as loans from China Exim and the Industrial and Commercial Bank of China (ICBC). A distant second, multilateral DFIs—notably the World Bank and the African Development Bank—provided a total of $187 million a year. The remaining 20 percent of finance commitments for electricity came from domestic sources, primarily the national budget of the Government of Ethiopia.

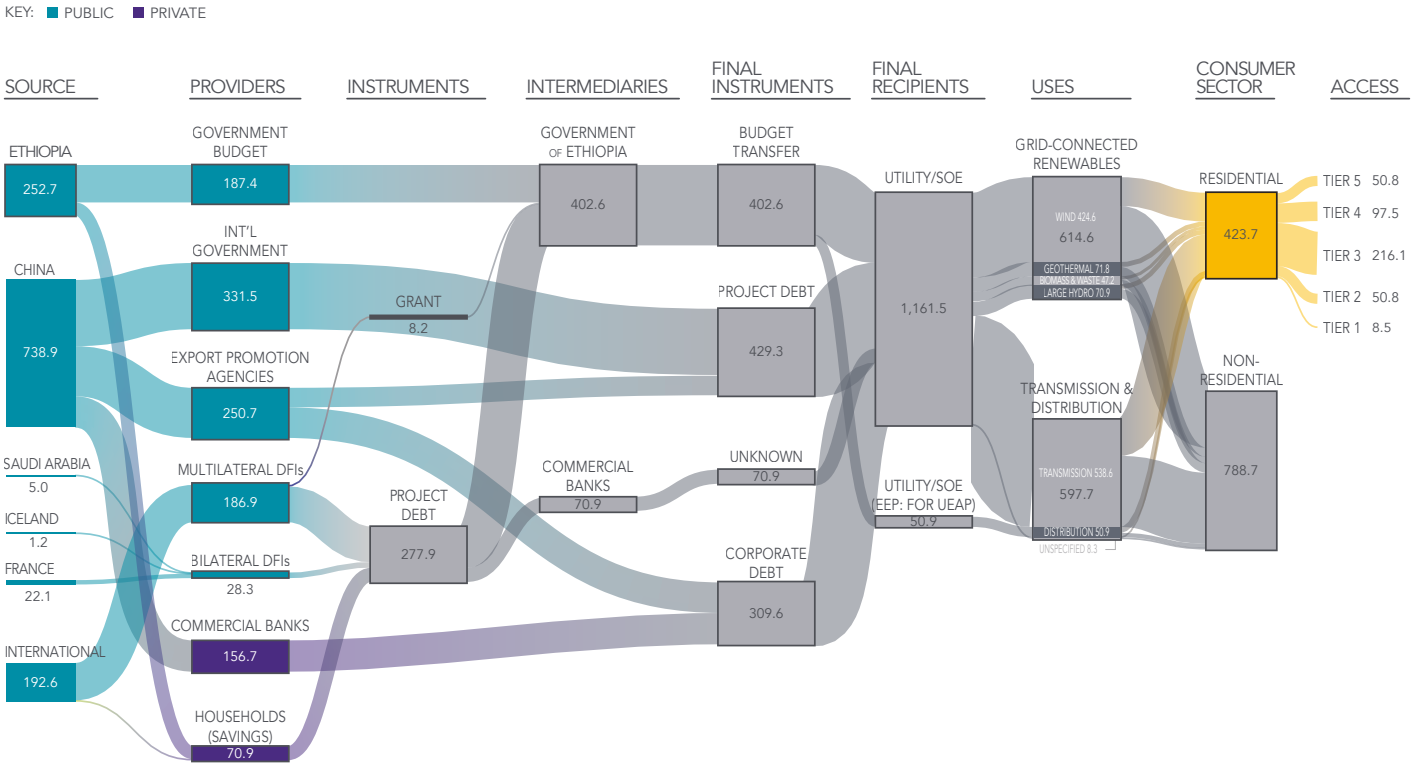
By far the largest electricity project in Ethiopia during this period was the Grand Ethiopian Renaissance Dam (GERD). Of the finance reported during the 2013-15 period, $390 million relates to the construction of two 500 kV transmission lines needed to connect the dam to the national grid at two new substations (Dedesa and Holeta). This project was largely financed by the Chinese enterprise CET, with some co-finance from the Government of Ethiopia. Additional finance was also identified for the dam itself, coming from earmarked government bonds branded specifically for the GERD and placed both domestically and internationally, the latter to target diaspora communities. It is estimated that as much as $70 million of capital was raised for the dam from household savings through this mechanism, over 90 percent of which was domestic.

Some 60 percent of finance for electricity was non-concessional in nature. However, 60 percent of finance provided by China was on non-concessional terms; this was comprised of project debt and commercial debt from Chinese institutions. This can be considered a mix of bilateral export credit (CET) and export promotion (mainly China Exim).

Almost the entirety of finance for electricity in Ethiopia was channeled—directly or indirectly—to the national utility EEP. The various flows of non-concessional debt from China were assumed directly by the Ethiopian Electric Power Corporation (EEP). Funding from Multilateral DFIs was channeled through the Government of Ethiopia and on-lent to EEP. EEP was also the main beneficiary of government budget transfers to the sector, receiving $137 million to fund activities including geothermal development and a biomass plant. These also included the Ethiopian government's 15 percent support of the Adama wind farm (the remainder financed by China Exim) and 15 percent support of the GERD Dedesa-Holeta project (CET). The remaining government budget transfers of $50 million were channeled to Ethiopia's Universal Electricity Access Project (UEAP), an initiative aimed at extending the grid to rural areas. A further $8 million per year flowed to rural electrification from a variety of Arab donors (Saudi Fund, OPEC Fund and BADEA).

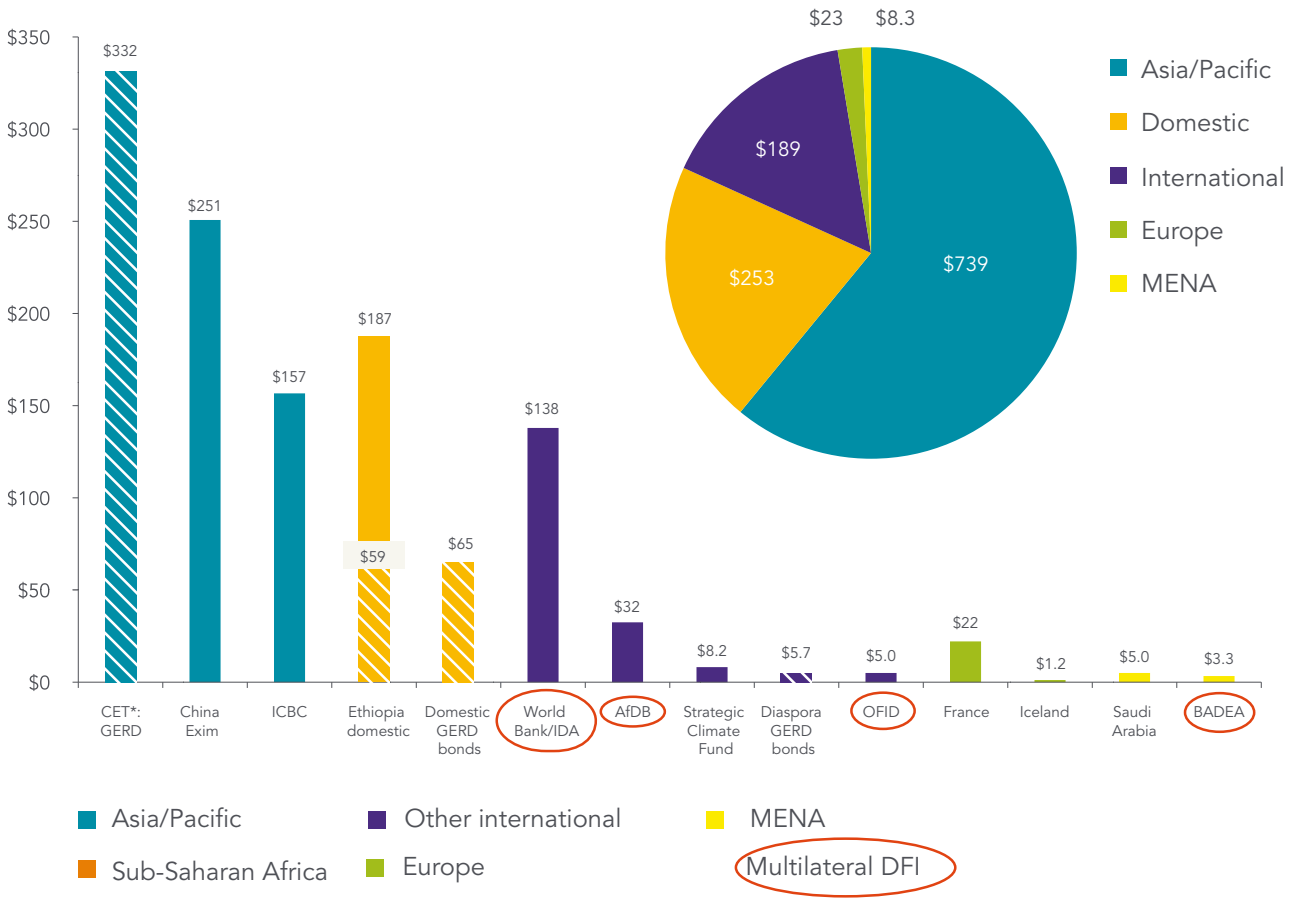
Figure 3.12 - Finance for electricity access in Ethiopia, 2013-15

Average finance flows for electricity in Ethiopia from 2013-15: $1,212.4 million per year



Note: Totals are an average of commitments made between 2013 and 2015.

Figure 3.13: Ethiopia: Committed flows by source region and country/ entity ($ millions)



The data showed that just over half of finance for electricity in Ethiopia was channeled to large-scale grid-connected power generation projects and almost all the remainder to transmission (Figure 3.14). This is consistent with the fact that all recorded flows were channeled to EEP, which has responsibility for only generation and transmission. No flows were recorded for the national distribution utility, EEU, although this may reflect the fact that only data tracked from secondary sources was available. The $615 million per year on average directed towards power generation projects encompassed a large allocation of $425 million to wind farms (financed by China EXIM and ICBC), as well as a geothermal development project supported by the World Bank, and part of the funding for the Grand Ethiopian Renaissance Dam. The substantial allocation of $539 million per year on transmission infrastructure was dominated by the Chinese funded transmission line to the GERD. The Ethiopia-Kenya interconnector proceeding under the East Africa Power Pool was another significant item.

It is estimated that 35 percent of finance for electricity benefits residential access, primarily in Tiers 3-4 (Figure 3.15). The overall finance commitments for electricity are apportioned between residential and non-residential consumers to estimate the share that can be attributed to residential access. This comes to $424 million, or 35 percent, for Ethiopia. An indicative allocation across Tiers, based on 2017 MTF survey data for Ethiopia, suggests that almost all the finance for residential electricity access contributes to service at Tiers 3-4—although the contribution to access at Tier 2 is not insignificant.

Figure 3.14 - Ethiopia: Flows by technology ($ millions)

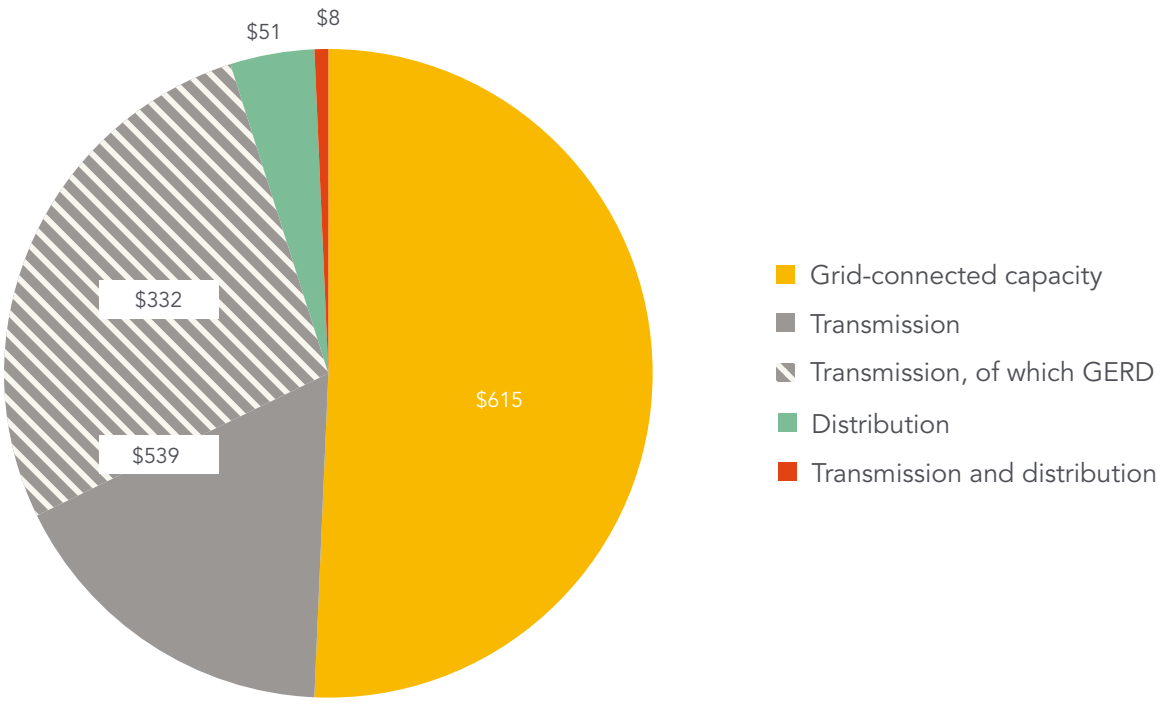


Figure 3.15 - Ethiopia: Allocation of finance for electricity to access by Tier ($ millions)

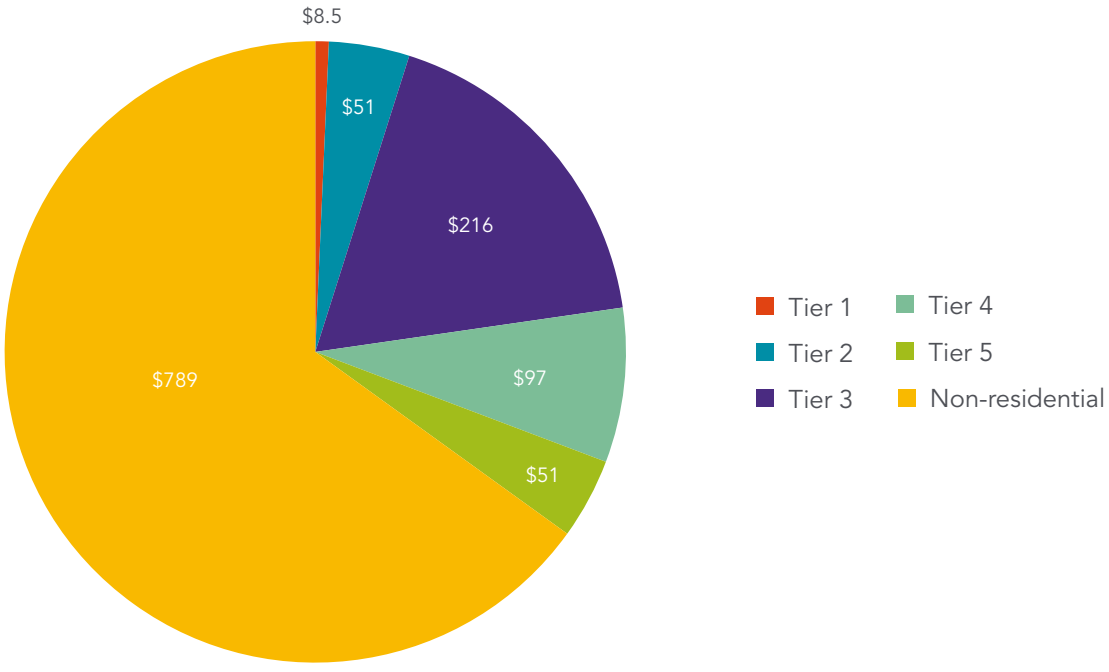
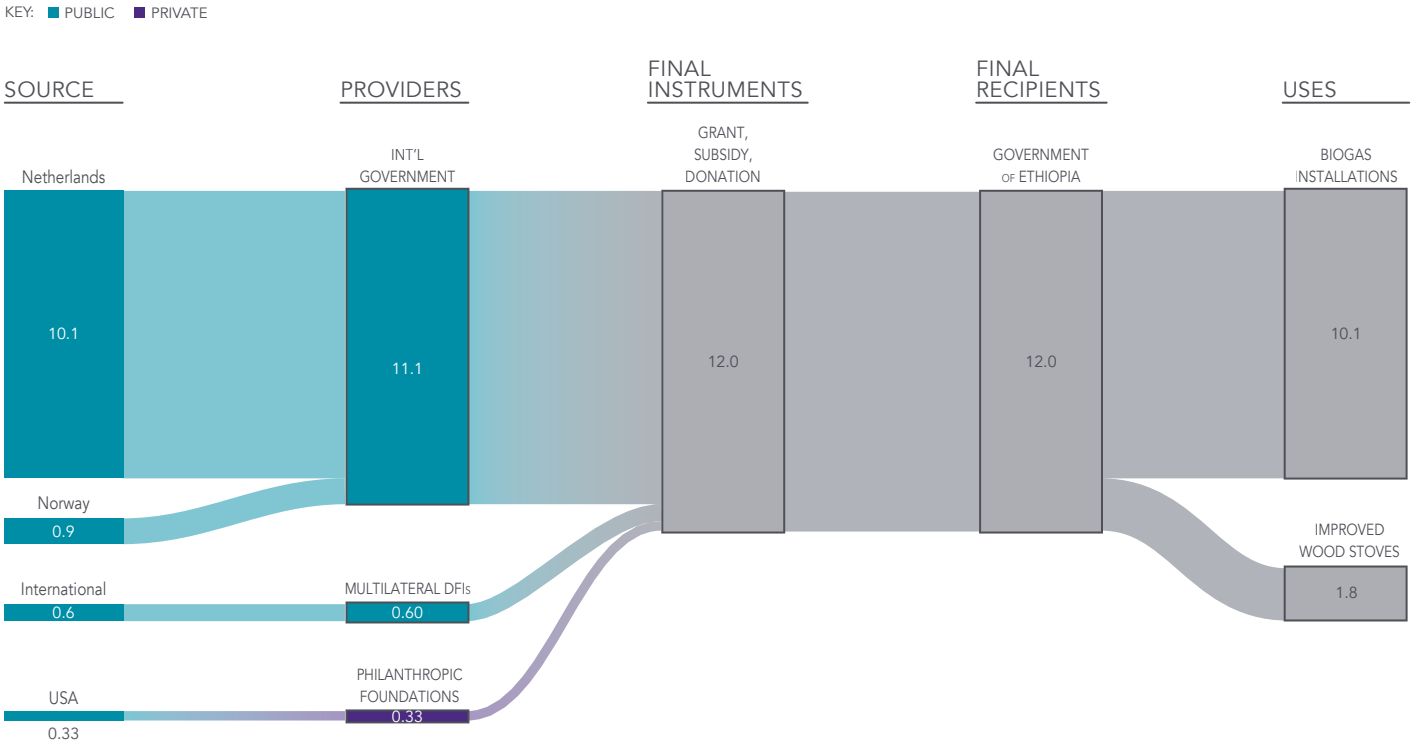


Figure 3.16 – Finance flows for clean cooking in Ethiopia 2013-15

Average finance flows for clean cooking in Ethiopia from 2013-15: $12.0 million per year



Note: Totals are an average of commitments made between 2013 and 2015.

FINANCE FOR CLEAN COOKING

The bottom-up approach found the average annual value of assets committed for clean fuels and technologies for cooking in Ethiopia between 2013 and 2015 was $11.9 million (Figure 3.16). This was equivalent to just $0.12 per capita or a mere 0.02 percent of GDP.

Financing for clean fuels and technologies for cooking in Ethiopia was found to be exclusively from overseas (Figure 3.17). There were just four commitments identified over the research period, by far the largest one being a bilateral contribution from the Netherlands.

All flows took the form of grants channeled to the Government of Ethiopia and subsequently allocated to one of two national cooking programs. By far the largest was the National Biogas Program of Ethiopia (NBPE), which promotes use of biogas for cooking and lighting and captured over 80 percent of resources (Figure 3.18). The remainder went to the National Improved Cook Stove program (NICS), which focuses on improved wood stoves for rural households.

Box 3.3 Ethiopia's small, private clean cooking sector by enterprise revenue

Ethiopia is known to have a small private sector active in the clean cooking space. However, data on this market segment was difficult to obtain. While it was not possible to secure information on financing flows, enterprise turnover was obtained for a handful of companies surveyed (SEforALL, Practical Action Consulting and E3 Analytics, 2017); although it is not known what percentage of the market they represent. These data suggest an average annual turnover of around $650,000 for the four companies that reported data.

Figure 3.17: Ethiopia: Committed flows for cooking by source region ($ millions)

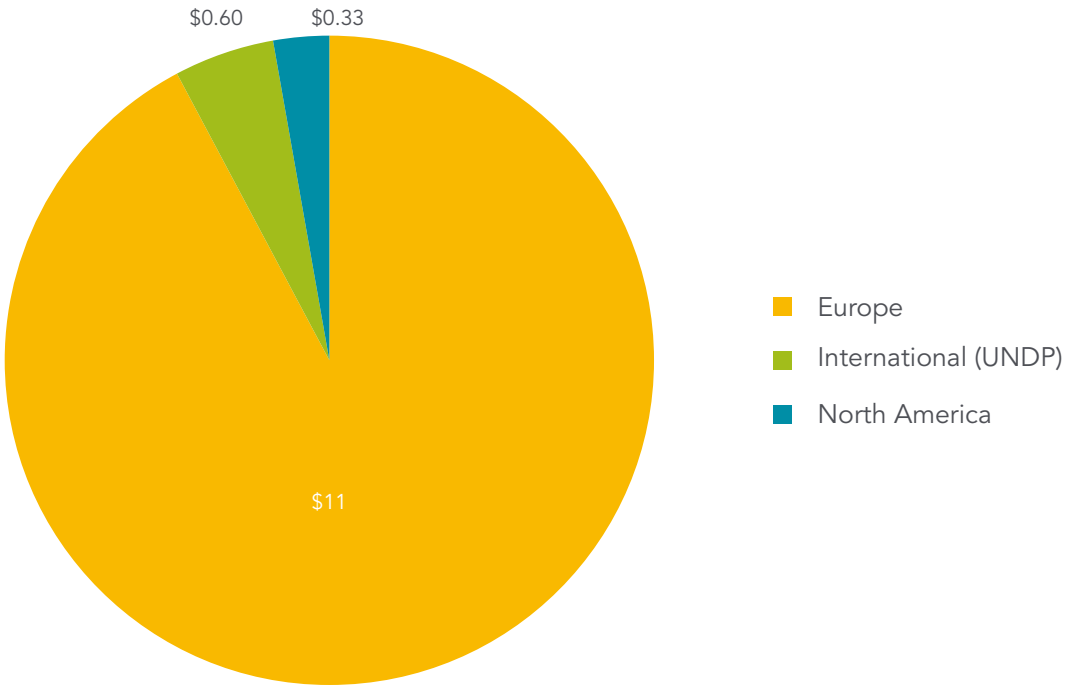
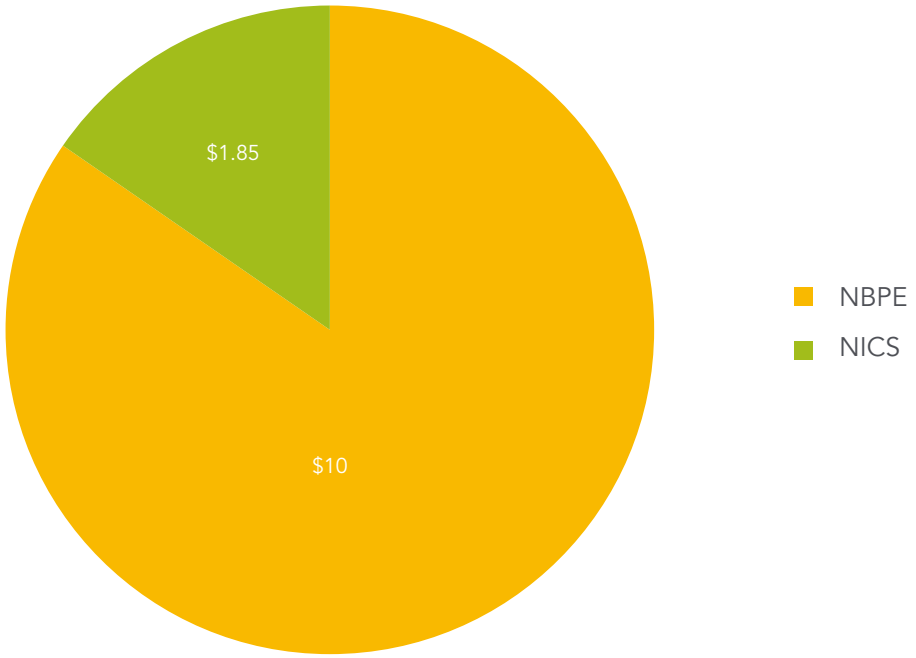


Figure 3.18 - Ethiopia: Commitments to government clean cooking programs ($ millions)



BANGLADESH CASE STUDY

COUNTRY SECTOR CONTEXT

Bangladesh's Vision 2021 Plan was launched in 2012 and seeks to expand power generation capacity from 15 GW to 20 GW between 2015 and 2021 (Government of Bangladesh, 2012). This will help the country meet the objectives of: universal access to electricity, and sustained GDP growth at an annual rate of 10 percent. The Government of Bangladesh (GoB) seeks a least-cost diversified energy mix balancing hydrocarbons and renewable energy resources, which—per the 2008 Renewable Energy Policy—should gradually become commercially viable without subsidy.

Bangladesh's electricity sector is overseen by the Power Division of the Ministry of Power, Energy and Mineral Resources (MPEMR) and its various agencies. The Bangladesh Power Development Board (BPDB) is the statutory authority responsible for state-owned power generation, and urban distribution outside of greater Dhaka. It also serves as the single buyer, functioning as off-taker for all Independent Power Producers (IPPs) and state generators, and has numerous subsidiaries. In addition, six distribution companies are responsible for the provision of electricity in Bangladesh's main urban centers. The Power Grid Company of Bangladesh (PGCB) administers transmission. The Rural Electrification Board (REB) distributes power in rural areas through its electric cooperatives, while off-grid projects are financed mainly by the Infrastructure Development Company Limited (IDCOL)—a government-owned financial institution that also operates the main improved cookstove program in Bangladesh.

Relevant entity names		
ASPCL	Ashuganj Power Supply Company Ltd.	BPDP subsidiary: power plant operator
BGFCL	Bangladesh Gas Fields Company Ltd.	PetroBangla subsidiary
BMOGC /PetroBangla	Bangladesh Oil, Gas and Minerals Corporation	Oil and gas parastatal
BPDB	Bangladesh Power Development Board	Statutory authority responsible for state-owned power generation and urban distribution outside of greater Dhaka
CPGL	Coal Power Generation Ltd.	GoB state-owned electricity generation utiltiy
CZPDC	Central Zone Power Distribution Company	Urban distribution: Mymensingh Zone and Sylhet Zone, once fully established
DESCO	Dhaka Electric Supply Company Ltd.	Urban distribution: Dhaka Metropolitan and Naryanganj
DPDC	Dhaka Power Distribution Company Ltd.	Urban distribution: Dhaka Metropolitan and Naryanganj
EGCB	Electricity Generation Company of Bangladesh	BPDP subsidiary: power plant operator
GTCL	Gas Transmission Company Ltd.	PetroBangla subsidiary
IDCOL	Infrastructure Development Company Limited	Government-owned development financial institution
KGDCL	Karnaphuli Gas Distribution Company Ltd.	PetroBangla subsidiary
NWPGCL	Northwest Power Generation Company Ltd.	BPDP subsidiary: power plant operator
NWZPDC	Northwest Zone Power Distribution Company	Urban distribution: Rangpur Zone and Rajshahi Zone, once fully established
PGCB	Power Grid Company of Bangladesh Ltd.	Nation-wide system operation and transmission
REB	Rural Electrification Board	Rural power distributor
RPCL	Rural Power Company Ltd.	BPDP subsidiary: power plant operator
SZPDC	South Zone Power Distribution Company	Urban distribution: Chittagong Zone and Comilla Zone, once fully established
TGTDCL	Titas Gas Transmission and Distribution Company Ltd.	PetroBangla subsidiary
WZPDCL	West Zone Power Distribution Company Ltd.	Urban distribution: Khulna and Barisal Divisions

Finance data for energy in Bangladesh was collected from primary interviews with government officials and private actors in the energy sector. The main obstacle to data collection was the reluctance of private companies, IPPs, and private sector capital contributors to share funding information; this was true both for electrification and cooking. Thus, private sector data is neither complete nor representative. Given that the information obtained relates to turnover rather than finance per se, these results are reported as a separate box rather than integrated with the overall results for the country. In any case, the values are so small as to not materially affect the overall narrative (See Box 3.4).

Box 3.4 Indicative figures on domestic private electricity finance in Bangladesh

Little data was available on what was known to be very active private mini- and off-grid sector in Bangladesh. In terms of turnover, and based only on a survey of 21 companies, reported figures of $29.3 million for mini-grids and $51.7 million for solar energy in 2015 (SEforALL, Practical Action Consulting and E3 Analytics, 2017). Although it is unknown exactly what percentage of the industry these data represent, they already testify to the substantial scale of the private off-grid electricity sector in Bangladesh. However, turnover is not the same as finance. Due to confidentiality concerns, data on finance was essentially unobtainable, and so this significant sector could not be integrated into the overall analysis of financial flows.

Finance data for energy for Bangladesh's off-grid sector manifested itself in disbursements data alone. These flows were substantial, and revealed the important role played by IDCOL. Therefore, in contrast to the other two deep-dive countries, this data is presented alongside the commitments data to give a fuller picture of this activity.

FINANCE FOR ELECTRICITY

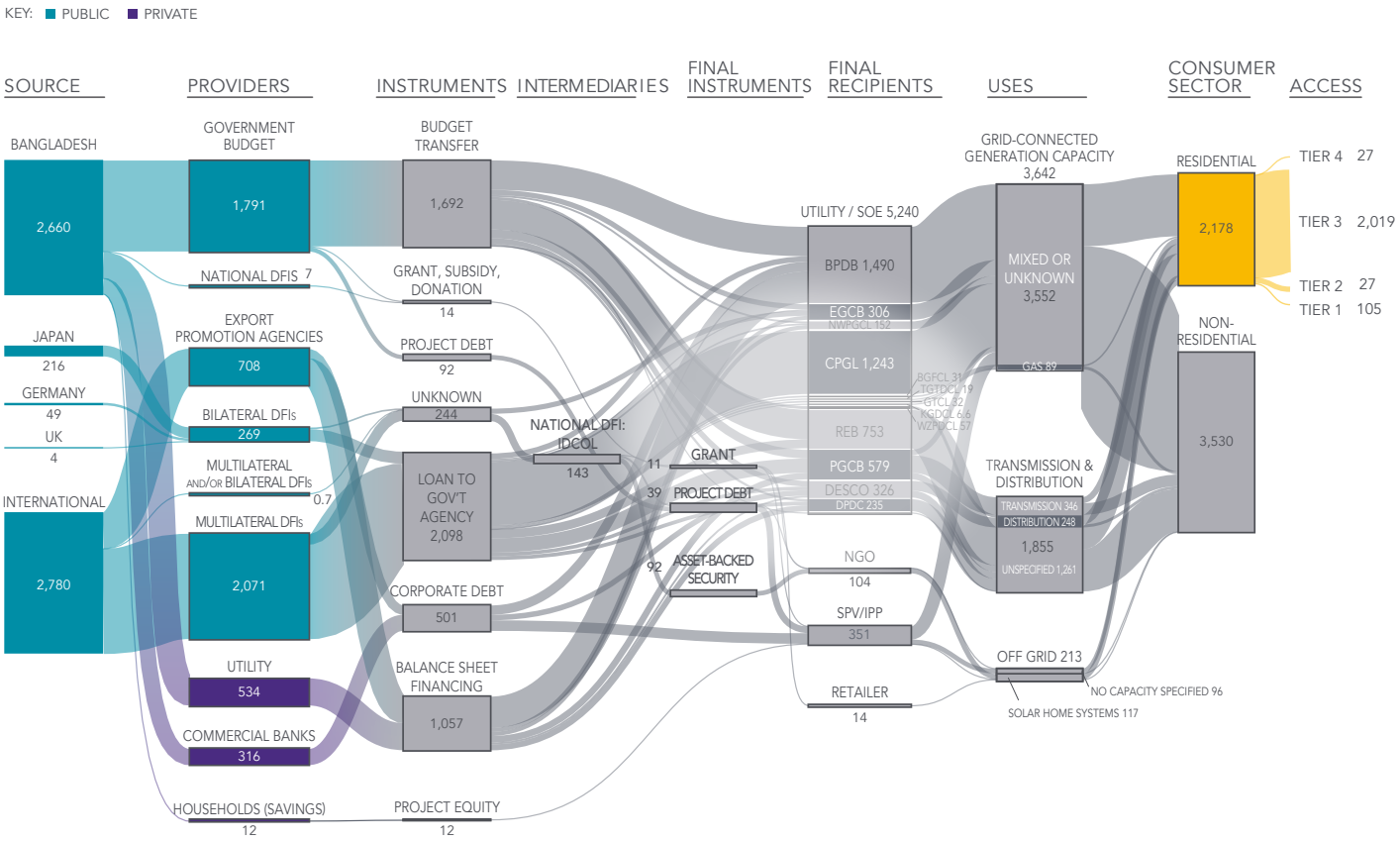
The bottom-up approach found that the average annual value of financial flows committed for Bangladesh's electricity sector was $5.231 billion during 2013 to 2015 (Figure 3.19). This was spread over a total of 152 separate energy projects and is equivalent to a flow of $33 per capita, or 3.0 percent of GDP. The research also identified additional financing flows averaging $479 million per year for 2013 to 2015. These were also captured in the form of disbursements by a different set of institutional actors. While commitments and disbursements are distinct measures of financing flows that strictly speaking should not be added together, consideration of these disbursements would bring the average annual financing flows to $5.710 billion or 3.3 percent of GDP.

Just under half of these financing flows were found to originate within Bangladesh, while the remainder come from international sources (Figure 3.20). Domestic finance, averaging an estimated $2.3 billion per year, accounted for 44 percent of total commitments. The single largest source of finance overall was the government's budget, which provided $1.7 billion per year, on average. More modest amounts of capital were also raised by internal cash generation from several electric utilities and from domestic commercial banks. International finance, identified by the bottom-up approach and averaging $2.9 billion per year, accounted for the remaining 56 percent of total commitments. The World Bank, with $1.4 billion per year, was by far the single largest international source of finance. The Asian Development Bank was also significant at $0.5 billion annually. Bilateral financing flows to Bangladesh's electricity sector were found to come primarily through export promotion agencies rather than development finance institutions.

Research indicates that about 60 percent of Bangladesh's committed finance flows for electricity were concessional in nature. The international finance is split

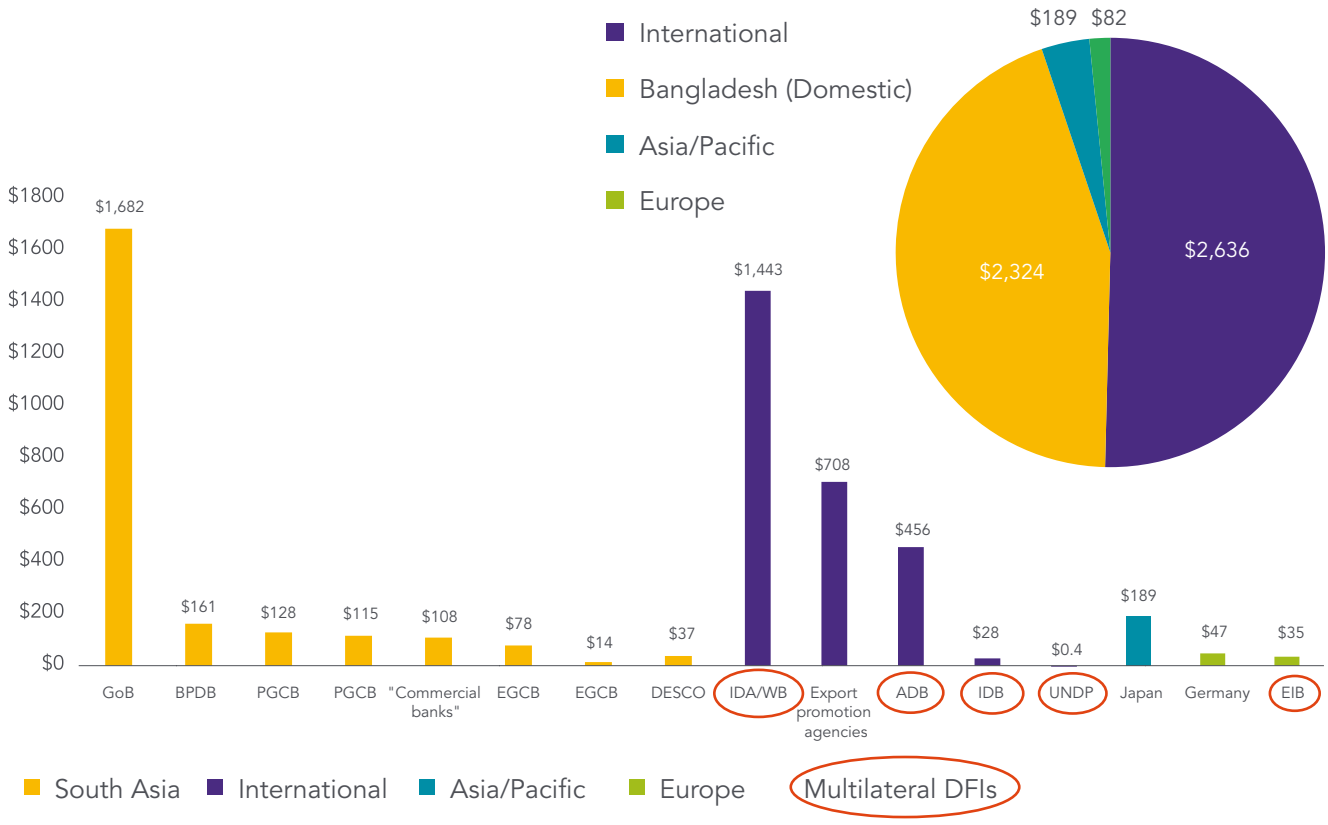
Figure 3.19 - Finance flows for electricity in Bangladesh 2013-15

Average finance flows for electricity in Bangladesh from 2013-15: $5,709.3 million per year



Note: Totals are an average of commitments made between 2013 and 2015.

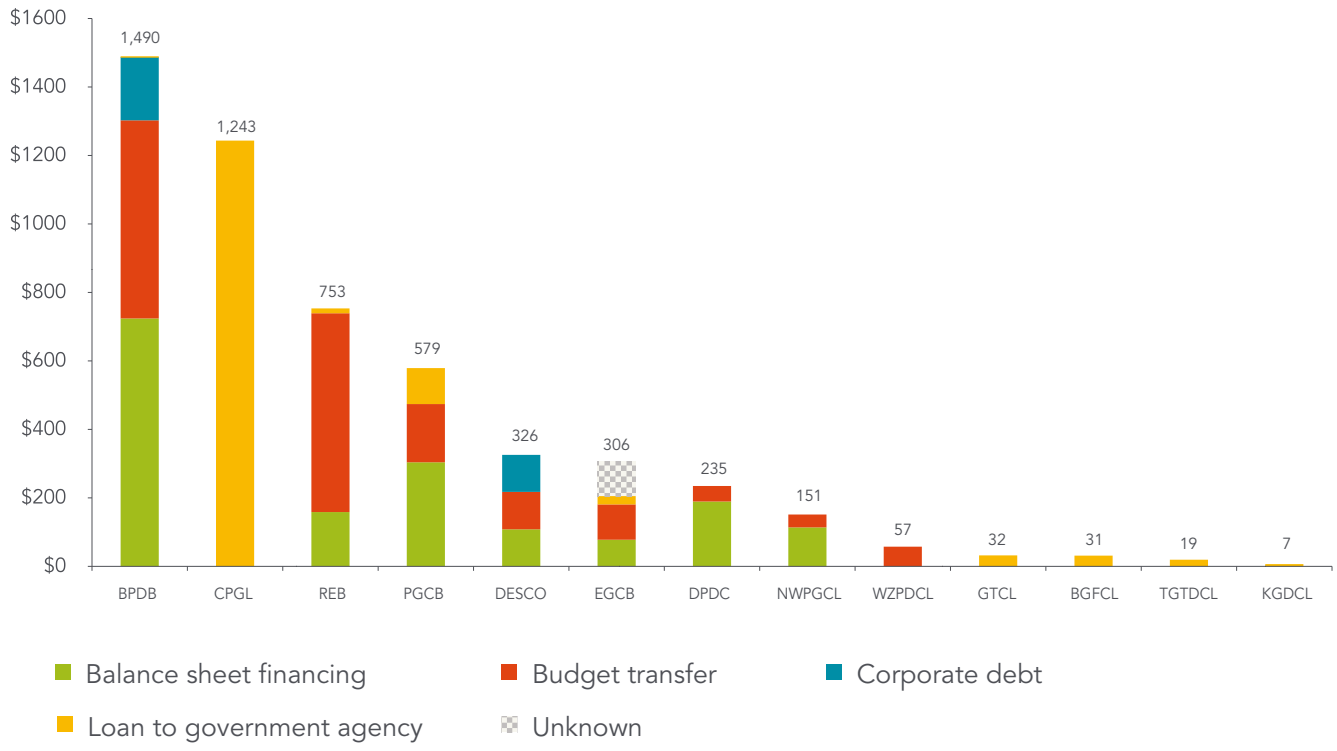
Figure 3.20 - Bangladesh: Committed flows by source ($ millions)



quite evenly between concessional and non-concessional loans. The international concessional finance mainly goes directly from multilateral DFIs to the government. The international non-concessional flows are a mixture of Export Credit Agency finance and multilateral DFI loans made directly to power utilities. Turning to domestic finance, a higher share of around 70 percent is concessional, reflecting the large contribution of the Government of Bangladesh. The remaining 30 percent of non-concessional domestic flows mainly took the form of balance sheet financing from utilities.

All committed flows listed in the dataset ultimately went to one of Bangladesh's numerous state-owned power utilities via a combination of financing mechanisms (Figure 3.21). The Bangladesh Power Development Board (BPDB)—the agency overseeing state-owned power generation, and urban distribution outside of greater Dhaka—received the most financing, amounting to an estimated annual average of $1.5 billion or 29 percent of the total. Coal Power Generation Ltd. (CPGL) was the next-largest recipient, with $1.2 billion, followed by the Rural Electrification Board (REB) with $0.75 billion. By far the largest recipients of government budget transfers (or grants) were BPDB and REB. This indicates an apparent strong focus on rural electrification with regards to the latter. Budget transfers to BPDB cover the high cost of liquid fuel from rental plants; this keeps the bulk supply tariff low so that consumer costs in both urban and rural areas also remain lower. All other utilities relied much more heavily on balance sheet financing and corporate debt. In addition, domestic commercial banks disbursed an estimated $208 million to a variety of implementing agencies, including the utilities.

Figure 3.21 - Bangladesh: Financial instrument and ultimate recipient ($ millions)



The bottom-up approach found that nearly two-thirds of financial commitments for electricity went to power generation projects, around $3.4 billion annually (Figure 3.22). Bangladesh's utilities have been the largest investors in power generation projects, amounting to around $850 million annually. The remaining one-third of finance for electricity was channeled to transmission and distribution infrastructure on the national grid, amounting to an estimated $1.1 billion annually. The bulk of this, $0.7 billion annually, went to REB for rural electrification projects, reflecting Vision 2021 priorities. If disbursement data is also considered, some additional $213 million were channeled to off-grid electricity projects; around half of this was through IDCOL.

It is estimated that 36 percent of finance for electricity benefits residential access, primarily in Tier 3 (Figure 3.23). The overall flows of finance for electricity are apportioned between residential and non-residential consumers to estimate the share that can be attributed to residential access. Given a relatively strong industrial base, the share allocated to residential electricity access comes to $1.9 billion, or 36 percent. An indicative allocation across Tiers, based on the reliability of electricity supply in Bangladesh, suggests that these resources are largely providing Tier 3 access. If disbursements are also considered, a not insignificant percentage of finance also goes to off-grid projects, thereby benefiting access at lower Tiers 1-2.

Figure 3.22 - Bangladesh: Commitments and off-grid disbursements, by sector ($ millions)

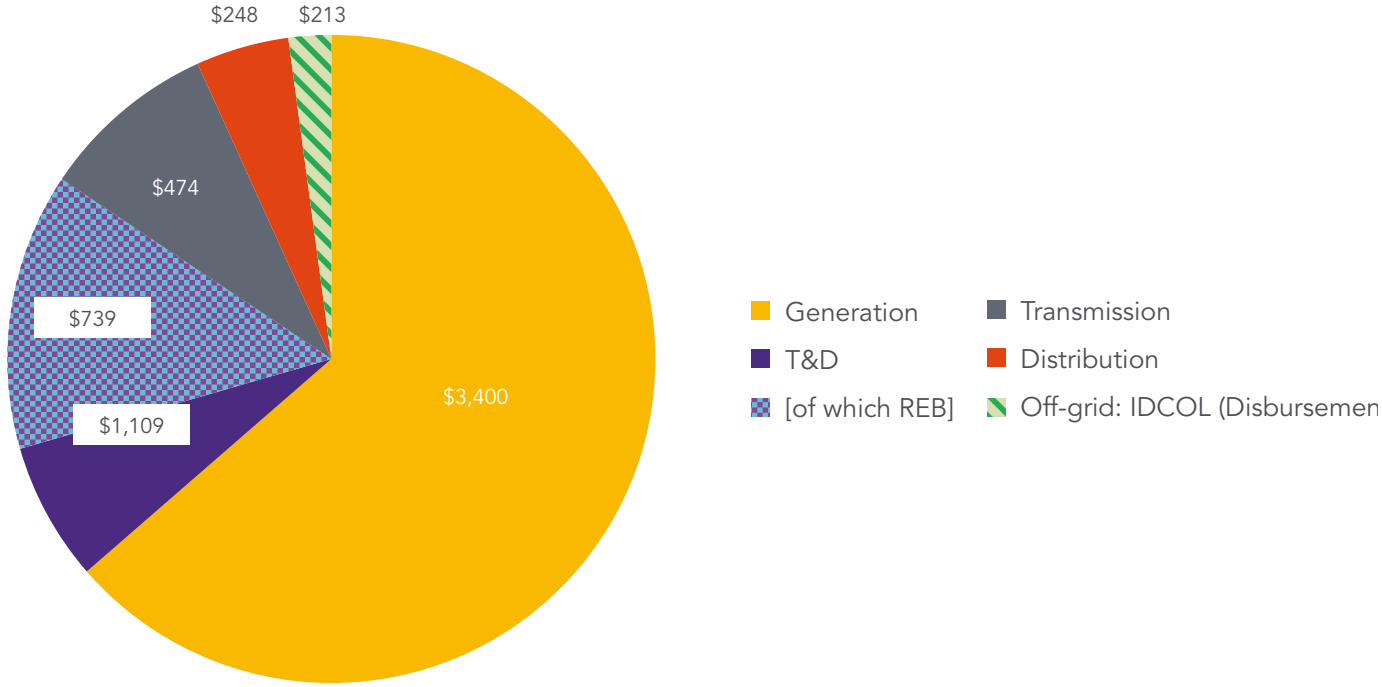
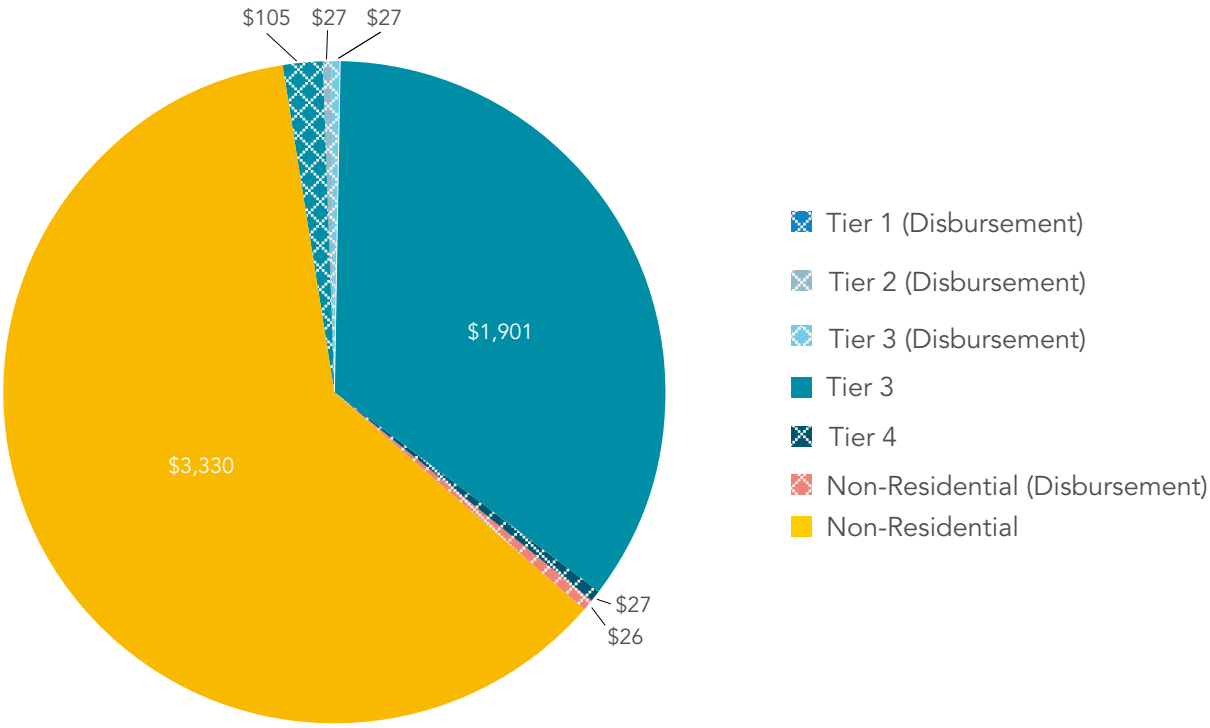


Figure 3.23 - Bangladesh: Allocation of finance for electricity to access by Tier ($ millions)



FINANCE FOR CLEAN COOKING

Country-level research on finance for clean fuels and technologies for cooking in Bangladesh was unable to identify data on financial commitments, only data on disbursements and expenditures (that is, cost of goods sold). Therefore, it is not possible to make strict comparisons between cooking finance results for Bangladesh and those for Ethiopia and Kenya, which are based on commitments. Nevertheless, an overview of the available disbursement data is presented here.

This data indicated that the average annual value of financial flows disbursed and spent on Bangladesh's cooking sector was $305,860 during 2013 to 2015 (Figure 3.24). This was spread over a total of 42 separate projects and translates into an insignificant amount per capita or as a share of GDP.

The Government of Bangladesh, through its domestic development finance institution, IDCOL, is an important player in the improved cook stove space. Disbursed funds averaging $155,000 annually were provided to IDCOL in the form of World Bank credits.[26] These funds—which make up the majority of clean cooking disbursements—are then disbursed as grants to Bangladeshi partner NGOs and organizations that implement IDCOL's Improved Cook Stove (ICS) project.

Box 3.5 Indicative figures on domestic private improved finance for cooking in Bangladesh

Little data was available on what was known to be very active private mini- and off-grid sector in Bangladesh. In terms of turnover, and based only on a survey of 21 companies, reported figures for enterprise revenue (SEforALL, Practical Action Consulting and E3 Analytics, 2017). Based on a subset of just three companies, $157,000 was reported of clean cooking revenue in 2015.

In addition, a handful of modest disbursements were reported for private companies. One company, Filament Engineering, received non-concessional project debt of $38,670 from a domestic commercial bank for its improved wood stoves business. Stated as an annual average over the 2013-15, this disbursement amounted to $12,890, while Filament Engineering and Luxur Green Energy reported raising a combined annual average of $81,000 from friends and family for their improved wood stoves businesses.

COMPARISON OF RESULTS

This section concludes the three "deep dive" country case studies on finance for energy access by making two sets of comparisons to put the results in broader perspective. First, the three country cases are compared across each other to look for overall patterns. Second, the results from country case studies are compared with those obtained for the same countries from the global approach.

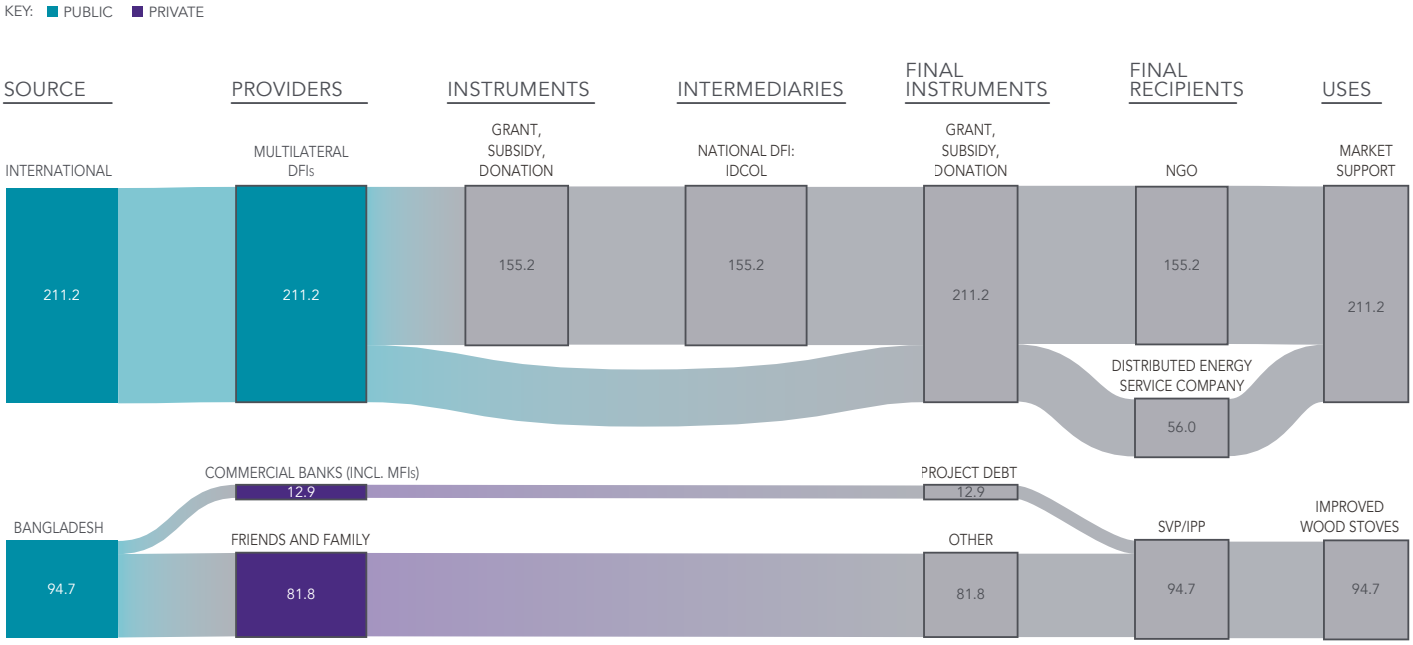
COMPARING ACROSS COUNTRY CASES

Comparisons of the overall magnitude of finance for electricity are best done by normalizing flows, either against population or GDP (Figure 3.25). These normalized indicators show that financing levels for the two African case studies were of the order of two percent of GDP, while that for Bangladesh was substantially higher at three percent of GDP. In the case of electricity, the finance structures also differed markedly between Bangladesh and the two African cases. While in all countries domestic finance—

[26] *The World Bank program with IDCOL began in 2015, and has ramped up rapidly in 2016-17 with $7 million already disbursed at the time of writing. The program disburses around $250,000 each month, supporting around 60,000-70,000 stoves per month. Therefore, annual averages from 2013-15 reflect the figures in the first year of the program.*

Figure 3.24 - Finance flows for clean cooking in Bangladesh 2013-15

Average finance flows for clean cooking in Bangladesh from 2013-15: $305.9 thousand per year



Note: Totals are an average of commitments made between 2013 and 2015. Due to data limitations, this visualization depicts average disbursments and Cost of Goods Sold (COGS) instead of commitments over the time frame.

Figure 3.25 Comparison across country case studies of finance for electricity

	Bangladesh	Ethiopia	Kenya
Average annual finance for electricity			
Absolute financing volume ($ million)	5,231	1,212	1,093
Finance per capita ($ per capita)	33	13	24
Finance as a share of GDP (% of GDP)	3.0	2.2	1.8
Structure of finance for electricity			
Share coming from international sources (%)	56	79	76
Share coming from domestic sources (%)	44	21	24
Share that is concessional (%)	65	65	100
Share that is non-concessional (%)	65	35	0
Share going to off-grid electricity (%)	4*	<1	<1
Share going to transmission and distribution (%)	35	49	51
Share going to residential access (%)	36	35	40
Share going to Tiers 1-2 (%)	6*	14	0
Share going to Tiers 3-5 (%)	94	86	100

* This figure represents off-grid disbursements, the only data available, rather than commitments.

and, in particular, the government budget—was a substantial source of funding, Ethiopia and Kenya remain much more reliant on international sources of finance than Bangladesh. Around two-thirds of financing commitments were concessional in nature, though substantially higher in Kenya. Capturing financing to off-grid electricity was challenging in all countries, but the limited data available suggest that these were well below one percent of the total, in most cases. Generally, the African countries dedicated higher shares of finance to electricity transmission and distribution, reflecting less developed grids. The share of resources going to residential electricity access was fairly consistent at 35-40 percent across countries. The share of financing benefiting higher Tiers 3-5 of access ranges from 86 percent in Ethiopia (based on preliminary MTF survey data) to 100 percent in Kenya (based on estimates).

In all three country cases, the volume of finance going to the cooking sector was tiny, amounting to well under $1 per capita and negligible in relation to finance for electricity (Figure 3.26). Across the board, the bulk of finance for cooking seems to be directed primarily to the development of biomass cookstoves, followed by improved biogas facilities.

COMPARING GLOBAL AND COUNTRY APPROACHES

In addition to the "deep-dive" country case studies, these three countries—Bangladesh, Ethiopia and Kenya—were also covered under the global approach. Data was examined using both approaches, with a view to how this data could be integrated and aligned for future iterations of research, producing a more robust dataset. An interesting question to understand is the extent to which these two

Figure 3.26 Comparison across country case studies of finance for cooking

	Bangladesh	Ethiopia	Kenya
Average annual finance for cooking			
Absolute financing volume ($ million)	0.25*	12	6.7
Finance per capita ($ per capita)	<0.01*	0.12	0.15
Structure of finance for cooking			
Share coming from domestic sources (%)	31*	0	29
Share going to biomass cookstoves (%)	31*	15	31
Share going to biogas facilities (%)	0*	85	35

**These figures represent disbursement and spend, not commitments.*

Figure 3.27 - Comparison between global and country approaches for estimating financing commitments, 2013 and 2014 combined totals

$ billion	Bangladesh		Ethiopia		Kenya	
	Country	Global	Country	Global	Country	Global
Grand total	11.57	3.20	3.52	2.45	2.44	1.93
Close match	0.62	0.40	0.27	0.27	0.74	0.69
No overlap	10.94	2.80	3.25	2.18	1.70	1.23
• International	6.22	2.80	2.61	1.75	1.23	1.18
• Domestic	4.72	-	0.64	0.43	0.47	0.05

different methodological approaches provide similar or consistent results. There are plenty of reasons why these results may be expected to differ, including different data sources, more thorough coverage of international flows using the global method, and more thorough coverage of domestic flows using the country-based method. In addition, lags between funds being committed by international agencies and funds appearing as disbursements in country budgets might also be expected.

The comparison was conducted on a line-by-line basis, examining all flows individually and trying to match them up by financier, destination project and magnitude. This line-by-line examination succeeded in identifying and eliminating double counting to the greatest extent possible. Results were then aggregated to establish the overall total finance commitments to energy access from each exercise, the extent to which there was overlap between the two, and the nature of any flows that did not overlap

between the two. To make the databases as comparable as possible, data for 2013 and 2014 were considered jointly and the results were summed across the two years. The data for 2015, which were available for the country case studies, was not included in this comparison since the same was not available under the global approach.

The results of the comparison are quite striking in several ways.

First, as might be expected, the total magnitude of financing commitments captured in the country case studies is substantially higher than under the global approach. For the two African cases, the total financing commitments are about 30 percent higher than under the global approach. However, in the case of Bangladesh, the difference is enormous, with the financing commitments from the country case study being over 3.5 times larger than for the global case: the bottom-up approach found $10.9 billion in flows which did not appear in the top-down dataset, while the top-down approach found $2.8 billion which did not appear in the bottom-up dataset.

Second, the degree of overlap between the two estimates is surprisingly small. Only about one-third of the financing commitments identified in the global approach could be matched with the country case study for Kenya; this figure shrunk to less than 10 percent for Ethiopia and Bangladesh. The vast majority of the commitments identified under the country cases could not be matched to the estimates from the global exercise. While an important part of the difference lies in the greater ability of the country case method to capture domestic flows, this is not the whole story. The two methods also differ substantially in the international flows that they capture, with one set of international sources (of all institution types) being picked-up by one method and another by the other approach.

In view of these findings, the two approaches appear to be complements rather than substitutes. Indeed, a key recommendation would be to harvest both global databases and country-level evidence for all countries, analyze the degree of overlap, and then provide an aggregated estimate that draws upon the strengths of each.

ANNEX 1
DATA AND DETAILED METHODOLOGY

This methodology explains the approach taken to map commitments intended to increase access to electricity and to clean cooking solutions across the 20 high-impact countries. The methodology clarifies how the report tracked finance commitments for energy access using a two-step approach (summarized by Figure A1.1), followed by clarifications and caveats. The methodology is structured as follows:

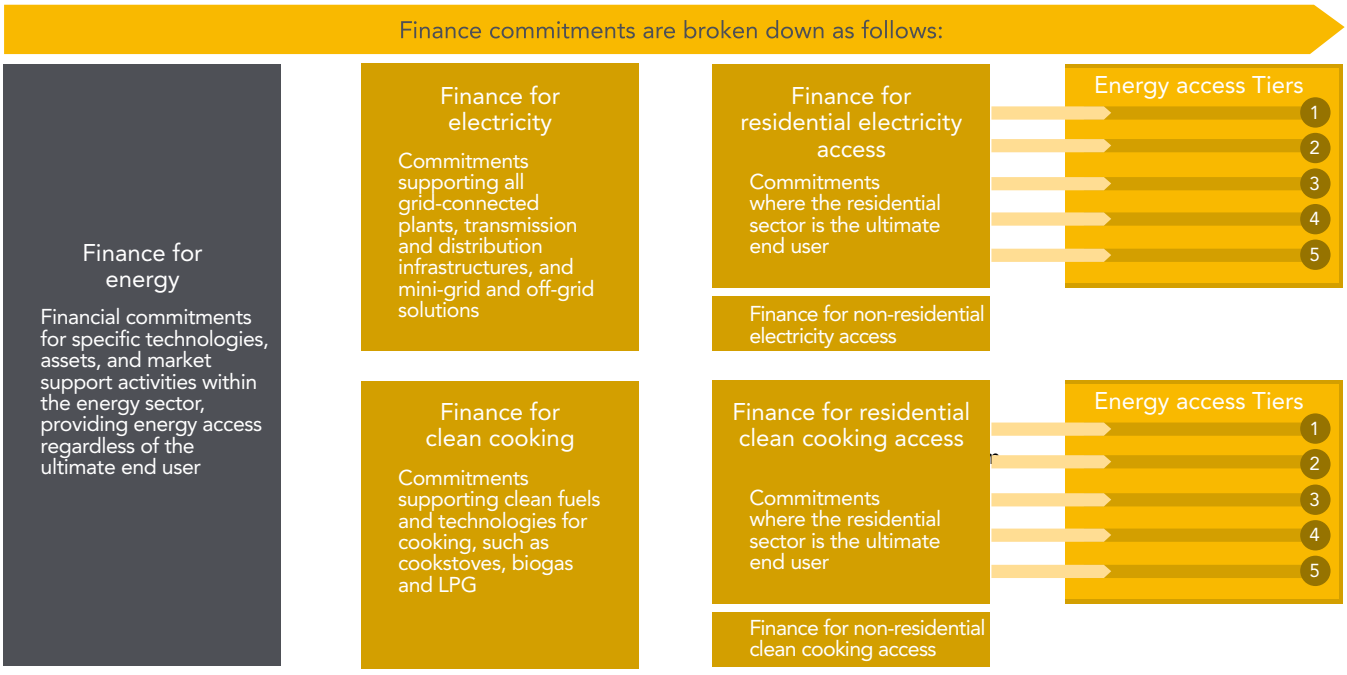
1) Tracking finance for energy access, with a focus on commitments.

2) Estimating the portion of finance for residential energy access and applying the Multi-Tier Framework (MTF) to identify the type of energy access provided.

3) Caveats and clarifications about the methodology.

4) List of the high-impact countries considered in the report, accompanied by relevant population figures and data.

Figure A1.1 - Methodology Summary



Note: Diagram is not to scale

TRACKING FINANCE FOR ENERGY

Building on the methodology developed by Climate Policy Initiative (CPI) for the Global Landscape of Climate Finance (Buchner et al., 2015), this mapping exercise tracks public and private finance commitments to any project that enhances energy access, including investments in electricity and clean fuels and technologies for cooking. These commitments include support for capacity-building measures as well as for the development and implementation of policies.

Chapter 2 of the report tracked more than 2,200 primary financial transactions plus public framework expenditures (e.g., development of national energy strategies or capacity-building) committed in the calendar years 2013 and 2014.[27] This means that the report only collected information that was available at the project level, disregarding aggregate (e.g., regional or global), unverifiable figures and top-down estimates.

The report does not track disbursements and policy-induced revenue support mechanisms such as feed-in tariffs, secondary market transactions, or other public subsidies. Feed-in tariffs, for example, pay back investment costs, so including them would constitute double counting. Secondary-market transactions (e.g., reselling of stakes) are only tracked if they do not constitute double counting with other areas of the data collection.

The report tracks commitments according to the following dimensions:

TECHNOLOGIES

Electricity technologies tracked in the report include electricity generation technologies and the transmission and distribution network.[28] Specifically, the following technologies are included, as either electricity generating or facilitating the ultimate consumption of electricity:

- Grid-connected electricity generating assets, including renewable energy (solar PV, wind, small and large hydro, biomass and waste, biofuels, geothermal), fossil fuels (coal, oil, gas) and nuclear technologies;
- Transmission and distribution (including grid extensions and connections) networks;
- Mini-grids including renewable energy assets, fossil fuel assets and hybrid solutions (i.e., a mix of renewable and fossil fuel energy); and
- Off-grid assets including solar (solar home systems, solar lanterns) and non-solar technologies.

Clean and Improved Cooking Solutions: As discussed in The State of the Global Clean and Improved Cooking Sector (World Bank, 2015), terminology in the clean and improved cooking sector is variable. This report applies the same definitions and used solution-specific definitions sourced from this report as well as the Global Alliance for Clean Cookstoves (2017):

- Stoves and fuels - advanced biomass, alcohol, biogas, improved biomass, electric, LPG, natural gas.
- Fuel infrastructure - investments in clean cooking fuel infrastructure (e.g., for LPG, natural gas, and alcohol cooking technologies) that targeted no more than two distribution levels away from final end-use.

[27] *Commitments represent a firm obligation by the means of Board decisions on investment, closure of a financing contract or similar actions, and backed by the necessary funds, to provide specified assistance/financing to a project, recipient country, or any other partner organization. Financial resources committed record the full amount of expected transfer, irrespective of the time required for the completion of disbursement. The focus on commitments rather than disbursements may affect the magnitude of flows, given that committed amounts are often disbursed over a number of years. Disbursement information would provide a more accurate picture of the actual volume of financial resources devoted to addressing climate change in a given year (which can include commitments from earlier years, as well as those due to commitments for the current year), but consistent data for disbursements are lacking.*

[28] *Infrastructure and pipelines for supplying LNG to power generation plants are excluded.*

PROVIDERS

Public sector institutions including:

- Multilateral development finance institutions (DFIs) - includes climate funds and EU institutions
- Bilateral DFIs - providers of bilateral climate-related development investors
- Export promotion agencies
- National DFIs - includes public banks and local public sector providers of debt instruments
- Government domestic - government entities or departments/ministries that do not directly sell energy
- Utilities and State-Owned Enterprises - ministries and state-owned institutions that produce and sell energy.

Private sector institutions, including:

- Corporate actors and project developers designing, commissioning, operating and maintaining energy projects (e.g., private sector utilities and energy companies, independent power producers)
- Commercial financial institutions providing private debt capital, like commercial and investment banks and micro-financial institutions
- Commercial finance, including asset managers and early-stage investors (private equity, venture capital and infrastructure funds)
- Philanthropic foundations
- Households, such as family-level economic entities, high-net-worth individuals and their intermediaries (e.g., family offices investing on their behalf)
- Entrepreneurs (own capital)

FINANCIAL INSTRUMENTS

The report tracks all investment-like commitments—including debt, equity and grants—whether with concessional or non-concessional terms. The report tracks guarantees and other risk mitigation instruments but does not include them in total commitments to avoid double counting between, for example, the face value of full loan guarantees and loans.

DOUBLE COUNTING

Aggregating data from different sources presents some challenges. To avoid double counting, some financial data from select sources and secondary market transactions were excluded. Specifically, the report excluded external resources that DFIs manage on behalf of third parties, governments' contributions to DFIs or climate funds, bilateral climate funds' commitments, and DFIs' contributions to projects reported by BNEF (2015). Nonetheless, challenges remain, including the issue that multilateral DFIs and development agencies are often reported through different channels.

The tracking exercise is focused on international finance commitments. However, several data sources provided information on domestic commitments.

Figure A1.2 - List of data sources used to track financial commitments

Source name	Description	Sector relevance	Manipulations
Organization for Economic Co-Operation and Development (OECD, 2017)	Data on international aid for project and market support from bilateral and multilateral donors, publicly available from the OECD DAC Creditor Reporting System (CRS).	Electricity – all. Cooking – all. International only.	As information was not directly available, "key words" search was performed to identify and separate off-grid, smart-grid and clean-cooking activities.
Bloomberg New Energy Finance (BNEF, 2017a)	Asset finance database for grid connected renewable energy. Contains data on finance raised by solar companies.	Electricity – grid-connected renewable generation (excluding large hydro) and off-grid solar. International and domestic.	Main reference for finance for grid-connected renewable energy. Data on Indian renewable energy projects was complemented with information from the Solar Energy Corporation of India (SECI). VC/PE financing deals for solar companies located in the 20 high-impact countries.
Climate Policy Initiative (CPI, 2015)	Project-level data from DFIs retrieved from the Global Landscape of Climate Finance.	Electricity – all. Cooking – all. International only.	Additional data for bilateral and multilateral DFIs that includes guarantees, risk mitigation instruments and non-concessional finance not reported in OECD DAC CRS.
Climate Funds Update (2017)	Additional data on national and multilateral Climate Funds' commitments.	Electricity – grid-connected and decentralized renewable generation. International only.	Complements data on international and domestic public finance for electricity projects.
World Bank (2017c)	Private Participation in Infrastructure Database, contains data on investment commitments in infrastructure with private participation in Emerging Markets and Developing Economies.	Electricity – grid connected renewable and fossil fuel generation. International and domestic.	Complements data for electricity projects.
Global Alliance for Clean Cook stoves (GACC, 2017c)	Venture investment database.	Cooking – all. International and domestic.	Used to track commitments in clean cooking companies.

Figure A1.2 - List of data sources used to track financial commitments

Source name	Description	Sector relevance	Manipulations
Global Off-Grid Lighting Association (GOGLA, 2016)	The Global Off-Grid Solar Market Report, produced by GOGLA and Lighting Global, provides information on sales of solar lanterns and solar home systems reported by GOGLA members and Lighting Global associates on a half-yearly basis.	Electricity – off-grid. International only.	Used to collect data on values associated with off-grid lighting systems.
AidData (2017)	Data on international Chinese financing, publicly available from AidData.	Electricity – all. International only.	Only "Official Finance" was considered. A number of commitments (in particular on off-grid) were not included as ambiguous or lacking sufficient details for verification
IJGlobal (2017)	Energy and infrastructure finance database.	Electricity – grid-connected generation (fossil fuel, nuclear and large hydro) and transmission and distribution. Cooking – LNG distribution International and domestic.	Main reference for grid-connected fossil fuel and LNG distribution projects.
Natural Resources Defense Council (NRDC, 2017)	Additional data on international coal financing from bilateral and multilateral institutions.	Electricity – grid-connected coal generation. International only.	Complements coal finance data. Includes guarantees.
Boston University GEGI (2016)	The Boston University's China Global Energy Finance database tracks overseas development finance in the energy sector provided by China's two global policy banks.	Electricity – grid-connected renewable and fossil fuel generation. International only.	Complements coal finance data.
Rockefeller Foundation (2017)	Personal communication and review of activities on website.	Electricity – decentralized generation. International only.	Additional data on mini-grids.
Partnerships for SDGs (2017)	Partnership Data for SDGs.	Electricity – decentralized generation. International only.	Website reviewed to identify commitments in the high-impact countries.

IDENTIFYING FINANCE COMMITMENTS FOR RESIDENTIAL ENERGY ACCESS AND ALLOCATING TIERS

Once finance commitments for energy access are identified, the portion specifically referring to residential energy access is determined and then allocated to the relevant Tier. Unless project-specific information is available, assumptions are made at country/technology level, following two steps:

Firstly, adjustments to estimates and commitment values are made so that only the proportion of value relating to residential energy access is recognized. More specifically:

- If part of the capacity of a specific technology in a country is used for energy exports, the investment value is discounted by the share of exports.

- The remaining value is then discounted by the existing share of consumption going to non-residential sectors (e.g., commercial, industrial, public sector). From a methodological standpoint, it would be preferable to use the marginal consumption—i.e., how one extra unit of electricity in a country is consumed across the various sectors. Given that these data are largely absent, existing consumption shares have been used as a proxy.

For example, a grid-connected wind farm is likely to supply electricity to residential, commercial and industrial consumers, and therefore only a proportion of the value of the wind farm should be recognized as granting residential electricity access.

Secondly, for a given residential asset or flow attribute, the report then identifies which Tiers of energy access the associated technology will provide, proposing an initial, simplified categorization of commitments by applying the Multi-Tier Framework approach (IEA and the World Bank, 2015; Bhatia and Angelou, 2015) to available information at country/technology level on selected attributes within the framework.[29]

The report first uses technology-specific ranges of attribution as an initial starting point for allocating technologies to energy access Tiers. Figure A1.3 illustrates those used for electricity (Bhatia and Angelou, 2015) and Figure A1.4 illustrates those used for cooking.

Where a technology covers more than one Tier, specific attributes based on the Multi-Tier Framework are used to determine specific allocation. For example, in the case of central-grid connected plants— ranging between Tiers 3 and 5, based on the Figure A1.3—country-specific data was applied on the reliability of the grid in that country to determine the final Tier of allocation.

Figure A1.5 summarizes technology-specific assumptions used for the estimates of consumption shares across sectors and allocation to Tiers.

[29] As the Multi-Tier Framework relies on extensive use of surveys to determine allocation, unavailable at the global level, the framework itself suggests the use of simpler versions to facilitate its implementation on a global scale, capturing varying amounts of information. Three different levels of the framework are envisaged: (i) comprehensive framework, (ii) simplified framework, and (iii) minimalistic framework (Bhatia and Angelou, 2015).

Figure A1.3 The Multi-Tier Framework (MTF) for electricity Multi-tier Matrix for Measuring Access to Household Electricity Supply

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
1. Peak capacity	Power capacity ratings (in W or daily Wh)		Min 3 W	Min 50 W	Min 200 W	Min 800 W	Min 2 kW
			Min 12 Wh	Min 200 Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kWh
	OR Services		Lighting of 1,000 lmhr/ day	Electrical lighting, air circulation, television, and phone charging are possible			
2. Availability (duration)	Hours per day		Min 4 hrs	Min 4 hrs	Min 8 hrs	Min 16 hrs	Min 23 hrs
	Hours per evening		Min 1 hr	Min 2 hrs	Min 3 hrs	Min 4 hrs	Min 4 hrs
3. Reliability						Max 14 disruptions per week	Max 3 disruptions per week of total duration <2 hrs
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability					Cost of a standard consumption package of 365 kWh/year < 5% of household income		
6. Legality						Bill is paid to the utility, pre-paid card seller, or authorized representative	
7. Health & safety						Absence of past accidents and perception of high risk in the future	

Source: Bhatia and Angelou, 2015

Figure A1.4 The Multi-Tier Framework (MTF) for cooking Multi-tier Matrix for Measuring Access to Cooking Solutions

		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
1. Indoor air quality	PM2.5 ($\mu g/m^3$)		[To be specified by a competent agency, such as WHO, based on health risks]	[To be specified by a competent agency, such as WHO, based on health risks]	[To be specified by a competent agency, such as WHO, based on health risks]	< 35 (WHO IT-1)	< 10 (WHO guideline)
	CO (mg/m^3)					< 7 (WHO guideline)	
2. Cookstove efficiency (not to be applied if cooking solution is also used for space heating)			Primary solution meets Tier 1 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 2 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 3 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	Primary solution meets Tier 4 efficiency requirements [to be specified by a competent agency consistent with local cooking conditions]	
3. Convenience	Fuel acquisition and preparation time (hrs/ week)			< 7	< 3	< 1.5	< 0.5
	Stove preparation time (min/ meal)			< 15	< 10	< 5	< 2
4. Safety of primary cookstove	IWA safety tiers		Primary solution meets (provisional) IWA Tier 1 for Safety	Primary solution meets (provisional) IWA Tier 2	Primary solution meets (provisional) IWA Tier 3	Primary solution meets (provisional) IWA Tier 4	
	OR past accidents (burns and unintended fires)					No accidents over the past year that required professional medical attention	
5. Affordability						Levelized cost of cooking solution (inc. cookstove and fuel) < 5% of household income	
6. Quality of primary fuel: variations in heat rate due to fuel quality that affects ease of cooking						No major effect	
7. Availability of primary fuel						Primary fuel is readily available for at least 80% of the year	Primary fuel is readily available throughout the year

Source: Bhatia and Angelou, 2015

Figure A1.5 - Approaches used to estimate consumption shares and Tier allocation

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
Electricity		
Grid-connected fossil fuels and renewables. Transmission & Distribution	**Export and sector-specific breakdown** To allocate investment to the different sectors, the report looks at the composition of both electricity supply and demand as per country-specific electricity balances for the years 2013-14 using IEA (2017) for the majority of high-impact countries, looking at export data, as well as consumption data from the residential, commercial and industrial sectors. For countries not covered by IEA, other sources were used. More specifically, Aminjonov et al. (2016) for Afghanistan, Moner-Girona et al. (2016) for Burkina Faso, World Bank (2016b) and Khennas et al. (2013) for Madagascar, Banda Saidi Jabu (2015) and Gamula et al. (2013) for Malawi, and Mawejje (2016) and UERA (2011) for Uganda. Sector-specific figures and export figures are then presented as a percent of domestic generation. **Exception: Export and sector-specific breakdown for the distribution network** As investments in the distribution network do not benefit exports or large industry (taking place at higher voltages), distribution values are presented net of the share going to the commercial sector to identify residential investments.	**Tier allocation** Grid-connected capacity ranges between Tiers 4 and 5 according to IEA and WB (2015, Figure A2.3). However emerging data from country-level studies from the World Bank (World Bank, 2017) suggest concentrations around Tier 3 as well. The starting point for grid-connected capacity, is then a range between Tier 3 and 5. To reflect country specific circumstances, the report allocates investment to Tiers within this range, based on available aggregate country-level data matching Tier attributes identified as per MTF methodology (Bhatia and Angelou, 2015). In the absence of reliable sources at country level on power capacity available for individual residences via grid-connected plants (and associated transmission investment), the report looked at country-specific "reliability" of grid electricity supply, measured with frequency of disruptions occurring in a country, using World Bank (2017) national data on "Power outages in firms in a typical month (number)" as a conservative proxy for disruptions for the residential sector. More specifically, the report applied: -Tier 5, if disruptions per week ≤ 3 -Tier 4, if disruptions per week > 3 and ≤ 14 -Tier 3, if disruptions per week > 14

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
	Electricity	
Mini-grids, fossil fuels and renewable/ hybrid	**Export and sector-specific breakdown** Although there are no specific geographic limits on the boundaries of a mini-grid, the report assumed that mini-grid generation would serve only a concentrated local area (e.g. village, group of villages, small island) with zero exports. While mini-grids would not support the same level of energy-intensive heavy industry as a national or regional grid, evidence from the literature suggests that, on top of residential and commercial use, a significant share of mini-grid generation is for industrial applications, and indeed that industrial "anchors" on mini-grids such as factories or telecom towers may, in many cases, be necessary to sustain the network and subsidize residential mini-grid connections (USAID/ARE, 2014). Project-specific data also confirm that.[10] The residential share for investments in mini-grid installation reflects electricity consumption patterns for residential, commercial and industrial use observed in the grid excluding exports from the equation on the assumption that region-specific usage is similar to usage observed at a national level.	**Tier allocation** Mini-grid capacity ranges between Tiers 3 and 4, according to IEA and World Bank (2015, Figure A2.3). In the absence of reliable sources at country level on power capacity made available to individual residences via mini-grid plants, the report looked at country-specific availability (duration) of resources for each technology type. Due to a lack of data on storage capacity, the report looked at availability during the 24 hours only as defined in the MTF methodology (Bhatia and Angelou, 2015). The report then applied: -Tier 4, if hours of availability per day ≥ 16 -Tier 3, if hours of availability per day <16 Hours of availability were estimated applying capacity factor figures to the hours of maximum continuous operation of a plant. Figures with capacity factors for renewable energy technologies in specific countries were obtained primarily from BNEF (2015). For high-impact countries not covered by BNEF, the report referred to EIA (2015) technology-specific capacity factors in different global regions.[31] For fossil fueled mini-grid capacity, due to flexibility it allows in meeting demand, a factor of 80 percent was used as per the World Bank (2006), accounting principally of downtime/maintenance.
Other off-grid	**Export and sector-specific breakdown** The report assumes the larger off-grid generators (1kW – 15 MW) are used for industrial and commercial use. Smaller off-grid generators (<1kW) are instead used both for residential and commercial uses in developing countries, as the latter are usually run at family level. The residential share for investments in off-grid installation (<1kW) reflects electricity consumption patterns for residential and commercial use observed in the grid, on the assumption in the absence of more specific data that usage of off-grid electricity is similar to usage observed at national level.	**Tier allocation** Off-grid capacity ranges between Tiers 1 and 4 according to IEA and WB (2015, Figure A2.1 and A2.3). Tier allocation is defined by technology types, following the approach suggested for mini-grid. The report applies: - Tier 4, if hours of availability per day ≥ 16 - Tier 3, if hours of availability per day ≥ 8 and <16 - Tier 2, if hours of availability per day < 8.

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
	Electricity	
Off-grid solar home systems and solar lanterns	**Export and residential shares** The source used for tracking deployment and cost of technology (GOGLA, 2016a and 2016b), mainly refers to sales to residences in specific geographies. GOGLA impact metrics uses a conservative estimate of 10 percent as the default coefficient indicating the proportion of customers using solar for business purposes – based on research within GOGLA members and externally. (GOGLA, 2017) i.e. the balance of 90 percent of output is used for residential purposes.	**Tier allocation** The report allocates investments to Tiers based on GOGLA (2016c), which is estimating how sales volumes can be attributed to the different Tiers per the MTF as part of his assessment of the social, environmental impact of off grid lanterns. The suggested approach is focusing on technologies types: - Solar lanterns increase access to Tier 1, - SHSs increase access to Tier 1 for systems with PV panel capacity between 11 and 20 Wp, and Tier 2 for systems with PV panel capacity above 20Wp.
Market support (including technical assistance)	Not applicable. Assumed beneficial to all sectors.	Not applicable

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
	Cooking	
Advanced biomass (stoves and fuel)	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to advanced biomass stoves were approximated at 100 percent to the residential sector based on market knowledge and in consideration of the data source.	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. This same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 2 Efficiency (per GACC): 2 Convenience (Internal Analysis): 5 Safety (Internal Analysis): 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): < 4 Availability of Primary Fuel (Internal Analysis): < 4 Overall Tier used in databases: 2
Advanced biomass (infrastructure)	N/A – no transactions found.	N/A – no transactions found.

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
	Cooking	
Alcohol (stoves and fuel)	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to alcohol stoves were approximated at 100 percent to the residential sector based on market knowledge and in consideration of the data source.	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. These were then mapped to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. The same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 4 or 5 Efficiency (per GACC): 1 Convenience (Internal Analysis): 5 Safety (Internal Analysis): 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): 4 Availability of Primary Fuel (Internal Analysis): 4 Overall Tier used in databases: 1
Alcohol (infrastructure)	N/A – no transactions found.	N/A – no transactions found.
Biogas digesters	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to biogas digesters were approximated at 100 percent to the residential sector based on a review of the specific transactions included.	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. The same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 4 or 5 Efficiency (per GACC): 3 Convenience (Internal Analysis): 3 Safety (Internal Analysis): 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): < 4 Availability of Primary Fuel (Internal Analysis): 4 Overall Tier used in databases: 3

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
	Cooking	
Electric stoves	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to electric stoves were approximated at 100 percent to the residential sector based on market knowledge and in consideration of the data source.	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enables Level 1 services, and so forth. The same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 4 or 5 Efficiency (per GACC): 4 or 5 Convenience (Internal Analysis): 5 Safety (Internal Analysis): 5 Affordability (World Bank, 2015a): <4 Quality of Primary Fuel (Internal Analysis): <4 Availability of Primary Fuel (Internal Analysis): <4 Overall Tier used in databases: 3
Improved biomass (stoves)	**Determination of percent of units (number of individual assets) applied to residential vs. non-residential sector:** Financial commitments to improved biomass stoves were allocated at either 100 percent or 70 percent to the residential sector. Allocations of 100 percent were based on a review of specific transactions. Allocations of 70 percent residential/30 percent non-residential were applied to vendors that commercialize both residential and institutional size stoves, based on a benchmark provided by the Paradigm Project Kenya (ERMC, 2016).	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. The same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 1 Efficiency (per GACC): 1 Convenience (Internal Analysis): 2 Safety (Internal Analysis): < 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): < 4 Availability of Primary Fuel (Internal Analysis): 4 Overall Tier used in databases: 1

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
Cooking		
Kerosene (stoves)	N/A – no transactions found.	N/A – no transactions found.
LPG (stoves and fuel)	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to LPG were allocated at both 41 percent and 100 percent to the residential sector, for the two observed transactions. For the former, the approximate split of final LPG consumption for Kenya was applied (IEA, 2017). The transaction was in Uganda, however no IEA indicators are available for LPG in Uganda. For the latter, the 100 percent allocation was determined following a review of the project details provided through the OECD CRS database. Estimates of asset values in LPG stoves similarly used national mix figures of residential vs. non-residential LPG final consumption. IEA indicators were used for Bangladesh (Indian figures used, as no IEA indicators available for Bangladesh), India, Indonesia, Nigeria, Sudan, and Uganda.	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. The same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 4 or 5 Efficiency (per GACC): 3 Convenience (Internal Analysis): 5 Safety (Internal Analysis): < 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): 4 Availability of Primary Fuel (Internal Analysis): <4 Overall Tier used in databases: 3
LPG (infrastructure)	N/A – no transactions found.	N/A – no transactions found.

Technology type	Approach used to estimate technology/country specific breakdown by target sector (export, residential, commercial, industrial, other)	Estimate for Tiers linkage
	Cooking	
Natural gas (infrastructure)	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** For the one identified transaction, sector allocation was made based on IEA (2017) indicators for natural gas in India	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. The same logic was applied for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 4 or 5 Efficiency (per GACC): 3 Convenience (Internal Analysis): 5 Safety (Internal Analysis): 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): 4 Availability of Primary Fuel (Internal Analysis): 4 Overall Tier used in databases: 3
Solar cooking (stoves)	**Determination of percent of units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to solar cookers were approximated at 100 percent to the residential sector based on market knowledge and in consideration of the data source.	The report used aggregate indoor emissions and efficiency data Tiers provided by GACC per technology type. It then mapped these to MTF attributes, whereby Tier 1 efficiency requirements enable Level 1 services, and so forth. The report applied this same logic for aggregate indoor air quality metrics received. The report then used a combination of secondary data and internal analysis over the remaining five MTF attributes to arrive at the maximum potential level of service that may be delivered by a particular solution. As per the MTF, the lowest level applied for any individual attribute comprises the highest potential Tier of access that may be delivered through a given solution. Indoor Emissions (per GACC): 4 or 5 Efficiency (per GACC): 4 or 5 Convenience (Internal Analysis): 3 Safety (Internal Analysis): 4 Affordability (World Bank, 2015a): < 4 Quality of Primary Fuel (Internal Analysis): < 4 Availability of Primary Fuel (Internal Analysis): < 4 Overall Tier used in databases: 3
Market support	Not applicable.	Not applicable.

CAVEATS AND CLARIFICATIONS

The Multi-Tier Framework relies on extensive use of surveys—which are typically unavailable at a global level—to determine Tier allocation. The framework itself therefore suggests the use of simpler versions to facilitate its implementation on a global scale. This yields the following limitations:

- Limited availability of data at the global level requires a pragmatic approach of using accessible indicators (Groh et al., 2015). Thus, the analysis focuses on fewer attributes within the MTF and adopts a more "simplified" approach. This results in Tier allocations being necessarily more "optimistic."

- Sectoral, sub-regional/provincial, or technology-specific data are usually missing and global data are usually aggregated at country level. This constrains the ability to define allocations at more granular levels, even when sub-regional differences exist. While this could be inadequate in the context of a country-specific analysis—where discussions on regional differences may be relevant—this is compatible with the objectives of an analysis targeting a larger geographical scope, such as the high-impact countries covered in this study.

- The portion of finance going to the residential sector is expressed gross of transmission losses, technology-specific capacity factors and replacement rates of technologies based on their longevity. While these factors do impact the amount of electricity delivered to end consumers, they are technology-related variables, independent from the actual dynamics informing the prioritization of the distribution across the energy supply chain (e.g., choice of exporting energy or choice of targeting a specific sector). Discounting figures to account for all these structural elements would produce estimates that are barely comparable with actual investment needs, usually expressed in gross values.

- In the absence of a baseline for electricity access Tiers for each country, only retrievable through survey-level data, available data does not allow financing to be distinguished between that which goes to new connections and to improved connections. For example, in a Tier 5 investment, it was not possible to determine whether the investment improves connections from Tier 4 to Tier 5 or whether they are used for new connections (e.g., from no access to Tier 5). Ideally, commitments should be categorizable in three buckets: improved connections (moving already existing grid users to higher Tiers), inferred connections (assuming new connections based on upstream investments) and direct connection (investments in the distribution network that feed the new connections (World Bank, 2017c). For the country case studies—in the absence of data—half of investment in connections has been assumed to provide new connections and half assumed to upgrade existing ones. The World Bank, in partnership with the Scaling up Renewable Energy Program (SREP), is currently carrying out a global baseline survey to collect MTF data in 15 high-impact countries, which will provide more accurate information on a country-by-country basis. The survey will be extended to cover another 10-15 countries in 2018-19.

DATA ON HIGH-IMPACT COUNTRIES

This section describes the high-impact countries that were considered for the report. The list of high-impact countries, both for access to electricity and access to clean cooking, is taken from the 2015 Global Tracking Framework (IEA and the World Bank, 2015) that was the most up to date list at the time this work was commissioned (Figure A1.6). The recently published Global Tracking Framework (IEA and the World Bank, 2017) has a slightly updated list reflecting countries' progress in energy access. The list includes Chad, Mali and Zambia, and removed Afghanistan, the Philippines, and Yemen for electricity access. For clean cooking, Ghana was added and Nepal removed.

Figure A1.6 - High-impact countries analyzed in the report

Country	Electricity	Cooking	Region	Income level	Population (in millions)	Percent of population without access to electricity	Percent of population without access to clean cooking
Afghanistan	X	X	South Asia	Low	31.2	18	82
Angola	X		Sub-Saharan Africa	Upper-middle	23.8	67	53
Bangladesh	X	X	South Asia	Lower-middle	158.1	38	90
Burkina Faso	X		Sub-Saharan Africa	Low	17.3	82	93
China		X	East Asia and Pacific	Upper-middle	1360.8	0	43
Congo, DR	X	X	Sub-Saharan Africa	Low	73.7	86	94
Ethiopia	X	X	Sub-Saharan Africa	Low	95.8	74	98
India	X	X	South Asia	Lower-middle	1287.4	22	66
Indonesia		X	East Asia and Pacific	Lower-middle	252.9	3	45
Kenya	X	X	Sub-Saharan Africa	Lower-middle	44.3	68	94
Korea, DPR	X	X	East Asia and Pacific	Low	25.0	68	93
Madagascar	X	X	Sub-Saharan Africa	Low	23.2	85	98
Malawi	X		Sub-Saharan Africa	Low	16.4	90	97
Mozambique	X	X	Sub-Saharan Africa	Low	26.8	79	96
Myanmar	X	X	East Asia and Pacific	Lower-middle	53.2	48	91
Nepal		X	South Asia	Low	28.0	18	75
Niger	X		Sub-Saharan Africa	Low	18.7	86	97
Nigeria	X	X	Sub-Saharan Africa	Lower-middle	175.1	43	97
Pakistan		X	South Asia	Lower-middle	183.1	4	56
Philippines	X	X	East Asia and Pacific	Lower-middle	98.4	12	55
Sudan	X	X	Sub-Saharan Africa	Lower-middle	38.9	58	78
Tanzania	X	X	Sub-Saharan Africa	Low	51.0	84	98
Uganda	X	X	Sub-Saharan Africa	Low	37.2	83	98
Vietnam		X	East Asia and Pacific	Lower-middle	90.2	0	50
Yemen	X		Middle East and North Africa	Lower-middle	25.9	26	38

Note: Region and income level are based on World Bank's country and lending groups. Population and access levels are an average for 2013-14, based on World Bank Indicators.

BIBLIOGRAPHY

AidData. (2017). Tracking Chinese Development Finance. Available at: http://china.aiddata.org/

Aminjonov, F. (2016). *Afghanistan's energy security: Tracing Central Asian countries' contribution*. Bonn, Germany: Friedrich Ebert Stiftung. Available at: http://library.fes.de/pdf-files/bueros/kabul/12790.pdf

Banda, S. (2015). "Malawi - Country Report for Energy Policy Training." Tokyo: Institute for Energy Economics, Japan (IEEJ). Available at: https://eneken.ieej.or.jp/data/6207.pdf

Bazilian, M., Nussbaumer, P., Haites, E., Levi, M., Howells, M. and Yumkella, K. (2010). "Understanding the Scale of Investment for Universal Energy Access." *Geopolitics of Energy 32* (10-11): 19-40.

Bhatia, M. and Angelou, N. (2015). *Beyond Connections: Energy Access Redefined*. ESMAP Technical Report. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/24368

Blechinger, P. (2013). *Hybrid Mini-Grids: A Huge Market for Rural Electrification and Island Energy Supply*. Reiner Lemoine Institute. GIZ Mini-Grid workshop Berlin, 26/02/2013. Available at: https://www.giz.de/fachexpertise/downloads/2013-en-blechinger-pep-informationsworkshop-minigrids.pdf

Bloomberg New Energy Finance (BNEF). (2015). *Levelized cost of electricity: DFID priority countries*. Available at: https://assets.publishing.service.gov.uk/media/57a0897b40f0b652dd00023e/61646_Levelised-Cost-of-Electricity.pdf

Bloomberg New Energy Finance (BNEF). (2017a). *Internal Database on Renewable Energy Companies*.

Bloomberg New Energy Finance (BNEF). (2017b). Q1 2017 *Off-Grid and Mini-Grid Market Outlook*. Available at: https://about.bnef.com/blog/off-grid-mini-grid-q1-2017-market-outlook/

Bloomberg New Energy Finance (BNEF), Lighting Global, and Global Off-Grid Lighting Association (GOGLA). (2016). *Off-grid solar market trends report 2016*. Utrecht, the Netherlands. Available at: https://data.bloomberglp.com/bnef/sites/4/2016/03/20160303_BNEF_WorldBankIFC_Off-GridSolarReport_.pdf

Bhattacharyya, S.C. (2013). "Financing Energy Access and Off-Grid Electrification: A Review of Status, Options and Challenges." *Renewable and Sustainable Energy Reviews* 20: 462-472.

Boston University, Frederick S. Parade School of Global Studies. (2016). China's Global Energy Finance Database. Available at: https://www.bu.edu/pardeeschool/chinas-global-energy-finance-database/

Buchner, B., Trabacchi, C., Mazza, F., Abramskiehn, D. and Wang, D. (2015). *Global Landscape of Climate Finance 2015*. Venice: Climate Policy Initiative (CPI). Available at: https://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf

Buckley, T. (2015). India's Electricity Sector Transformation. Cleveland, USA: Institute for Energy Economics and Financial Analysis (IEEFA). Available at: http://ieefa.org/wp-content/uploads/2015/08/IEEFA-Indian-Electricity-Sector-Transformation-August-2015.pdf

AidData. (2017). Tracking Chinese Development Finance. Available at: http://china.aiddata.org/

Aminjonov, F. (2016). *Afghanistan's energy security: Tracing Central Asian countries' contribution*. Bonn, Germany: Friedrich Ebert Stiftung. Available at: http://library.fes.de/pdf-files/bueros/kabul/12790.pdf

Banda, S. (2015). "Malawi - Country Report for Energy Policy Training." Tokyo: Institute for Energy Economics, Japan (IEEJ). Available at: https://eneken.ieej.or.jp/data/6207.pdf

Bazilian, M., Nussbaumer, P., Haites, E., Levi, M., Howells, M. and Yumkella, K. (2010). "Understanding the Scale of Investment for Universal Energy Access." *Geopolitics of Energy 32* (10-11): 19-40.

Bhatia, M. and Angelou, N. (2015). *Beyond Connections: Energy Access Redefined*. ESMAP Technical Report. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/24368

Blechinger, P. (2013). *Hybrid Mini-Grids: A Huge Market for Rural Electrification and Island Energy Supply*. Reiner Lemoine Institute. GIZ Mini-Grid workshop Berlin, 26/02/2013. Available at: https://www.giz.de/fachexpertise/downloads/2013-en-blechinger-pep-informationsworkshop-minigrids.pdf

Bloomberg New Energy Finance (BNEF). (2015). *Levelized cost of electricity: DFID priority countries*. Available at: https://assets.publishing.service.gov.uk/media/57a0897b40f0b652dd00023e/61646_Levelised-Cost-of-Electricity.pdf

Bloomberg New Energy Finance (BNEF). (2017a). *Internal Database on Renewable Energy Companies*.

Bloomberg New Energy Finance (BNEF). (2017b). Q1 2017 *Off-Grid and Mini-Grid Market Outlook*. Available at: https://about.bnef.com/blog/off-grid-mini-grid-q1-2017-market-outlook/

Bloomberg New Energy Finance (BNEF), Lighting Global, and Global Off-Grid Lighting Association (GOGLA). (2016). *Off-grid solar market trends report 2016*. Utrecht, the Netherlands. Available at: https://data.bloomberglp.com/bnef/sites/4/2016/03/20160303_BNEF_WorldBankIFC_Off-GridSolarReport_.pdf

Bhattacharyya, S.C. (2013). "Financing Energy Access and Off-Grid Electrification: A Review of Status, Options and Challenges." *Renewable and Sustainable Energy Reviews* 20: 462-472.

Boston University, Frederick S. Parade School of Global Studies. (2016). China's Global Energy Finance Database. Available at: https://www.bu.edu/pardeeschool/chinas-global-energy-finance-database/

Buchner, B., Trabacchi, C., Mazza, F., Abramskiehn, D. and Wang, D. (2015). *Global Landscape of Climate Finance 2015*. Venice: Climate Policy Initiative (CPI). Available at: https://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf

Buckley, T. (2015). India's Electricity Sector Transformation. Cleveland, USA: Institute for Energy Economics and Financial Analysis (IEEFA). Available at: http://ieefa.org/wp-content/uploads/2015/08/IEEFA-Indian-Electricity-Sector-Transformation-August-2015.pdf

Carbon Africa Limited (CAL), Trama TecnoAmbiental S.L. (TTASL), Research Solutions Africa Limited (RSAL), Energy Research Centre of the Netherlands (ERCN). (2015). *Kenya Market Assessment for Off-Grid Electrification. Climate Technology Centre and Network*. Available at: http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf

Climate Funds Update (2017). Data dashboard. Available at: http://www.climatefundsupdate.org/data

Gallagher, K. (2017), "China's Global Energy Finance," Global Economic Governance Initiative, Boston University. Available at: http://www.bu.edu/cgef/#/intro

Gamula, G., Hui, L. and Peng, W. (2013). "An Overview of the Energy Sector in Malawi." *Energy and Power En-*

gineering 5: 8-17. Available at: http://file.scirp.org/pdf/EPE_2013010415455754.pdf

Global Alliance for Clean Cookstoves (GACC). (2014). *2013 Results Report: Sharing Partner Progress on Path to Adoption of Clean Cooking Solutions*. Washington, DC. Available at: http://cleancookstoves.org/resources/285.html

Global Alliance for Clean Cookstoves, (GACC). (2017a). Available at: https://www.cleancookstoves.org

Global Alliance for Clean Cookstoves, (GACC). (2017b). "The Clean Cooking Catalog." Available at: http://catalog.cleancookstoves.org/

Global Alliance for Clean Cookstoves, (GACC). (2017c). Internal Database on Clean Cooking Investments.

Global Alliance for Clean Cookstoves, (GACC). (2017d). Internal and Anonymized Database on Clean Cooking Sector.

Global Off-Grid Lighting Association (GOGLA). (2016a). *Global Solar Off-Grid Semi-Annual Market Report - July-December 2015*. Utrecht, The Netherlands. Available at: https://www.gogla.org/sites/www.gogla.org/files/recource_docs/glb_solar_og_market_report_h22015_public_web.pdf

Global Off-Grid Lighting Association (GOGLA). (2016b). *Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data - January - June 2016*. Utrecht, The Netherlands. Available at: https://www.gogla.org/sites/www.gogla.org/files/recource_docs/global_off-grid_solar_market_report_jan-june_2016_public.pdf

Global Off-Grid Lighting Association (GOGLA). (2016c). *Standardized Impact Metrics for the Off-grid Energy Sector*. Utrecht, The Netherlands. Available at: https://www.gogla.org/sites/default/files/afbeeldingen/gogla-standardised-impact-metrics-for-the-off-grid-energy-sector1.pdf

Global Off-Grid Lighting Association (GOGLA). (2017). Personal communication with Laura Sundblad.

Government of Bangladesh, General Economics Division Planning Commission. (2012). *Making Vision 2021 a Reality: Perspective Plan of Bangladesh 2010-2021*. Available at: http://bangladesh.gov.bd/sites/default/files/files/bangladesh.gov.bd/page/6dca6a2a_9857_4656_bce6_139584b7f160/Perspective-Plan-of-Bangladesh.pdf

Groh, S., Pachauri, S. and Narasimha, R. (2015). *What are we measuring? An empirical analysis of household electricity access metrics in Bangladesh*. Energy for Sustainable Development 30: 21-31.

Hervé-Mignucci, M. and Wang, X. (2015). *Slowing the Growth of Coal Power Outside China: The Role of Chinese Finance*. Venice: Climate Policy Initiative (CPI). Available at: https://climatepolicyinitiative.org/wp-content/uploads/2015/11/Slowing-the-Growth-of-Coal-Power-Outside-China.pdf

International Energy Agency (IEA). (2003). *World Energy Investment Outlook 2003*. Paris: IEA Publishing. Available at: http://www.worldenergyoutlook.org/media/weowebsite/2008-1994/weo2003.pdf

International Energy Agency (IEA). (2011). *Energy for All: Financing Access for the Poor*. Paris: IEA Publishing. Available at: http://www.worldenergyoutlook.org/media/weowebsite/2011/weo2011_energy_for_all.pdf

International Energy Agency (IEA). (2012). *World Energy Outlook 2012*. Paris: IEA Publishing. Available at: https://www.iea.org/publications/freepublications/publication/WEO2012_free.pdf

International Energy Agency (IEA). (2014). *Africa Energy Outlook*. Paris: IEA Publishing. Available at: https://www.iea.org/publications/freepublications/publication/WEO2014_AfricaEnergyOutlook.pdf

International Energy Agency (IEA). (2015). *World Energy Outlook 2015*. Paris: IEA Publishing. Available at: https://www.iea.org/publications/freepublications/publication/WEO2015.pdf

International Energy Agency (IEA). (2016). *World Energy Outlook 2016*. Paris: IEA Publishing. Available at: http://www.worldenergyoutlook.org/publications/weo-2016/

International Energy Agency (IEA). (2017). Statistics. Available at: https://www.iea.org/statistics/statisticssearch/

International Energy Agency (IEA), United Nations Development Programme (UNDP), and United Nations Industrial Development Organization (UNIDO). (2010). *Energy Poverty: How to Make Modern Energy Access Universal?* Paris: IEA Publishing. Available at: http://www.undp.org/content/undp/en/home/librarypage/environment-energy/sustainable_energy/energy_poverty_howtomakemodernenergyaccessuniversal.html

International Energy Agency (IEA) and the World Bank. (2013). *Global Tracking Framework 2013*. Washington, DC: World Bank. Available at: https://www.iea.org/publications/freepublications/publication/Global_Tracking_Framework.pdf

International Energy Agency (IEA) and the World Bank. (2015). *Global Tracking Framework—Progress Toward Sustainable Energy*. Washington, DC: World Bank. Available at: http://seforall.org/sites/default/files/GTF-2105-Full-Report.pdf

International Energy Agency (IEA) and the World Bank. (2017). Global Tracking Framework—Progress Toward Sustainable Energy. Washington, DC: World Bank. Available at: http://gtf.esmap.org/data/files/download-documents/eegp17-01_gtf_full_report_for_web_0516.pdf

International Institute for Applied Systems Analysis (IIASA). (2012). *Global Energy Assessment - Toward a Sustainable Future*. Cambridge, UK, and Laxenberg, Austria: Cambridge University Press and IIASA. Available at: http://www.iiasa.ac.at/web/home/about/news/Global-Energy-Assessment-now-available.en.html

International Renewable Energy Agency (IRENA). (2015). *Off-Grid Renewable Energy Systems: Status and Methodological Issues*. Available at: https://www.irena.org/DocumentDownloads/Publications/IRENA_Off-grid_Renewable_Systems_WP_2015.pdf

IJ Global. (2017). Energy and infrastructure finance database. Available at: https://ijglobal.com/data

KENGEN site, Investor Relations page, Shareholders' Information: "Shareholders' Circular On The Allotment Of Offer Shares To The Public Investment Corporation SOC Limited," 22 March 2017 http://www.kengen.co.ke/sites/default/files/financial-reports/press/Shareholders%20Circular%20on%20Shares%20Allotment%20to%20PIC.PDF

KPLC 2016 Annual Report, p. 70: "Katibu, Hazina Kuu: Asilimia = 50.086" http://www.kplc.co.ke/AR2016/KPLC%202016%20Annual%20Report%20Upload.pdf

Khennas, S., Coupe, S. and Denruyter, J.P. (2013). Boa Nguvu: *An African Sustainable Energy Country – Special Summary*. World Wildlife Fund (WWF). Available at: http://awsassets.panda.org/downloads/wwf_boa_nguva_summary_low_res.pdf

Krishnaswamy, V. and Stuggins, G. (2007). *Closing the Electricity Supply-Demand Gap*. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/186531468156581388/pdf/397410Electricity0gap01PUBLIC1.pdf

Lazard. (2015). *Levelised Costs of Electricity Analysis*. Available from: https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf

Martinot, E. (2001). *Renewable Energy Investment by The World Bank*. Energy Policy 29 (9): 689-699.

Mawejje, J. (2016). "*Electricity consumption and sectoral output in Uganda: an empirical investigation.*" *Journal of Economic Structures - The Official Journal of the Pan-Pacific Association of Input-Output Studies* 5:21.

Meller, H., Marquardt, J. (2013). *Renewable Energy in the Philippines: Costly or competitive?* Makati, The Philippines: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Available from: https://www.giz.de/en/down-

loads/giz2013-en-desk-study-costs-renewable-energy-philippines.pdf

Mentis, D., Howells, M., Rogner, H., Korkovelos, A., Arderne, C., Zapeda, E., Siyal, S., Taliotis, C., Bazilian, M., de Roo, A. (2017). *Lighting the World: the first application of an open source, spatial electrification tool (OnSSET) on Sub-Saharan Africa*. Environmental Research Letters 12: 085003. Available at: http://iopscience.iop.org/article/10.1088/1748-9326/aa7b29/meta

Ministry of Energy and Petroleum, Government of Kenya. (2017). *5000MW Power Generation Program*. Available at: http://www.energy.go.ke/index.php/projects/243-5000mw-power-generation-program.html

Moner-Girona, M., Bódis, K., Huld, T., Kougias, I. and Szabó S. (2016). *Universal access to electricity in Burkina Faso: scaling-up renewable energy technologies*. Environmental Research Letters 11: 084010. Available at: http://iopscience.iop.org/article/10.1088/1748-9326/11/8/084010

MNRE (2014). *Physical Progress (Achievements)*. Ministry of New and Renewable Energy, Government of India. Ministry of New and Renewable Energy, Government of India. Available at: http://mnre.gov.in/ mission-and-vision-2/achievements

Natural Resources Defense Council (NRDC). (2017). Database on public and international energy finance. Available at: https://www.nrdc.org/experts/han-chen/why-are-g20-governments-financing-coal-over-renewables

Organisation for Economic Co-Operation and Development (OECD). (2017). Creditor Reporting System (CRS). Available at: https://stats.oecd.org/Index.aspx?DataSetCode=CRS1

Pachauri, S., Ruijven, B., Nagai, Y., Riahi, K., Vuuren, D., Brew-Hammond, A. and Nakicenovic, N. (2013). *Pathways to achieve universal household access to modern energy by 2030*. Environmental Research Letters 8: 024015. Available at: http://iopscience.iop.org/article/10.1088/1748-9326/8/2/024015/meta

Putti, V.R., Tsan, M. and Sumi, K.S. (2015). *The State of the Global Clean and Improved Cooking Sector*. ESMAP Technical Paper. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/21878/96499.pdf

Partnership for SDGs. (2017). *Partnership Data for SDGs (PD4SDGs)*. Available at: https://sustainabledevelopment.un.org/sdinaction/pd4sdgs

REN21. (2015). *Renewables 2015 Global Status Report*. Paris: REN21 Secretariat. Available at: http://www.ren21.net/wp-content/uploads/2015/07/REN12-GSR2015_Onlinebook_low1.pdf

Rockefeller Foundation. *Smart Power for Rural Development: Electrifying rural (2017) villages in India to spur economic growth*. Available at: https://www.rockefellerfoundation.org/our-work/initiatives/smart-power-for-rural-development/

SEforALL. (2015). *Scaling up Finance for Sustainable Energy Investments: Report of the SE4All Advisory Board's Finance Committee*. Available at: http://www.se4all.org/sites/default/files/SE4All-Advisory-Board-Finance-Committee-Report.pdf

Sustainable Energy for All (SEforALL) and the African Development Bank. 2017. *Missing the Mark - Gaps and lags in disbursement of development finance for energy access*. SEforALL, Washington, DC. License: NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0).

Sustainable Energy for All (SEforALL), Practical Action Consulting and E3 Analytics. 2017. *Taking the Pulse - Understanding energy access market needs in five high-impact countries*. SEforALL, Washington, DC. License: NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0).

S&P Global PLATTS. (2017). PLATTS World Electric Power Plants Database, December 2016. Available at: http://www.platts.com/products/world-electric-power-plants-database

Trimble, C., Masami, K., Arroyo, I. And Mohammadzadeh M. (2016). *Financial Viability of Electricity Sectors in Sub-Saharan Africa*. Washington, DC: World Bank. Available from: http://documents.worldbank.org/curated/en/182071470748085038/Financial-viability-of-electricity-sectors-in-Sub-Saharan-Africa-quasi-fiscal-deficits-and-hidden-costs

U.S. Energy Information Administration (EIA). (2015). *Electric generator capacity factors vary widely across the world*. Washington, DC. Available at: https://www.eia.gov/todayinenergy/detail.php?id=22832

Uganda Electricity Regulatory Authority (UERA). (2011). *Electricity Sector Performance Report*. Available at: http://www.era.or.ug/index.php/component/mijosearch/search?query=performance%20report

United Nations (UN). (2017). *Affordable and Clean Energy: Why it Matters. New York*. Available at: http://www.un.org/sustainabledevelopment/wp-content/uploads/2016/08/7_Why-it-Matters_Goal-7_CleanEnergy_2p.pdf

United Nations Industrial Development Organization (UNIDO) and International Center on Small Hydro Power (ICSHP). (2016). *World Small Hydropower Development Report 2016*. Available at: http://www.smallhydroworld.org/fileadmin/user_upload/pdf/2016/Africa_Western/WSHPDR_2016_Burkina_Faso.pdf

Von Hippel. (2015). "North Korean drought is hobbling the power supply and the economy with it." In Fifield, A. Washington Post, 21.06.2015. Available from: https://www.washingtonpost.com/world/asia_pacific/north-korean-drought-is-hobbling-the-power-supply-and-the-economy-with-it/2015/06/21/65e51c02-14ff-11e5-8457-4b431bf7ed4c_story.html?utm_term=.dd1eb239c1bc

World Bank. (2006). *Technical and Economic Assessment of Grid, Mini-Grid and Off-Grid Electrification Technologies – ANNEX. Washington, DC*. Available at: http://siteresources.worldbank.org/EXTENERGY/Resources/336805-1157034157861/ElectrificationAssessmentRptAnnexesFINAL17May07.pdf

World Bank. (2014). *Clean and Improved Cooking in Sub-Saharan Africa*. Available at: https://openknowledge.worldbank.org/handle/10986/22521

World Bank. 2015. *The State of the Global Clean and Improved Cooking Sector*. Available at: https://www.esmap.org/globalstatusofcooking

World Bank. (2016b). *International Development Association Project Appraisal Document on a proposed credit in the amount of SDR 47.1 million ($65 million equivalent) to the Republic of Madagascar for an electricity sector operations and governance improvement project.* Available at: http://documents.worldbank.org/curated/en/107891468184443896/pdf/PAD1147-P151785-IDA-R2016-0023-1-OUO-9.pdf

World Bank. (2017a). *World Bank DataBank*. Available at: http://databank.worldbank.org/data

World Bank. (2017b). *World Bank Country and Lending Groups*. Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

World Bank. (2017c). *Private Participation in Infrastructure Database*. Available at: https://ppi.worldbank.org/

World Bank. (2017d). *Indicators*. Available at: http://data.worldbank.org/indicator

World Nuclear Association. (2017). *Nuclear Power in India*. Available at: http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/india.aspx

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