ENERGIZING FINANCE
RESEARCH SERIES

SUSTAINABLE ENERGY FOR ALL

CLIMATE POLICY INITIATIVE

ENERGIZING FINANCE

Understanding the Landscape 2021

TABLE OF CONTENTS

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FOREWORD

This research is being released as the world gears up for one of the most critical convenings on climate change since the landmark Paris Agreement was reached in 2015. The expectation for this year's COP26 in Glasgow is that it becomes a watershed moment for the fight against climate change, one that will catalyse commitments to decarbonatization that will put countries on a net-zero pathway.

Meanwhile, 759 million people worldwide have no access to electricity, and roughly 3 times that number have no way of cooking cleanly. The consequences of these energy access gaps are grave: from undermining developing countries' economic growth to jeopardizing people's health and polluting our environment.

The global energy transition needs to be both clean and just, which means mitigating climate change and creating new opportunities for people to flourish through not just energy access but energy for development.

COP26 is an opportunity for countries to demonstrate real urgency and commitments to tackle the climate and energy access crises hand-in-hand. By working together, developed and developing countries can create clean energy offers to ensure access gaps are closed while addressing the climate crisis.

The value of *Energizing Finance: Understanding the Landscape 2021* is that it provides a detailed picture of current energy finance commitments to guide the decision-making of governments, development banks, the private sector and other leaders.

In its fifth year of publication, the report identifies public and private finance commitments for energy in 20 developing countries – known as the high-impact countries (HICs) – that together are home to nearly 80 percent of those living without access to energy. This analysis highlights where critical investments are needed to achieve Sustainable Development Goal 7 (SDG7) and provides recommendations to overcome current barriers hindering financial flows to clean energy access and, consequently, climate action.

Based on data from 2019, the report highlights significant shortfalls in investment for electricity and clean cooking in the HICs. For example, it finds that finance committed to residential electricity access was less than one-third of the USD 41 billion estimated annual investment needed to attain universal electricity access by 2030.

Finance commitments continue to fall dramatically short of the estimated USD 4.5 billion of annual investment required to achieve universal access to clean cooking. Continued reliance on polluting fuels for cooking is proven to cause premature death and is a major contributor to climate change. Clean cooking needs to be a part of countries' development and climate action plans, including Nationally Determined Contributions (NDCs), yet only 43 countries out of the 165 countries mention cooking and cookstoves in their NDCs submitted to UNFCCC.

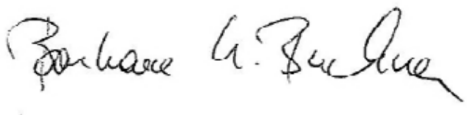
One of the positive trends from this year's research is that finance commitments for renewables in the HICs reached a new high in 2019. This progress needs to continue to meet SDG7 and the Paris Agreement targets, and there is positive momentum on this front.

Another important development is the move away from coal finance. During the UN General Assembly last month, China announced it would stop financing coal-fired power overseas and as part of the High-level Dialogue on Energy, seven other countries committed to stop their financing of coal in the No New Coal Energy Compact.

The hope is that these investments will be redirected to clean energy, with priority given to those countries whose energy systems are underdeveloped to date.

Only concerted, ambitious action can secure a low-carbon and equitable future for everyone. The insights found in *Energizing Finance: Understanding the Landscape 2021* provide direction for our collective efforts.

DAMILOLA OGUNBIYI
CEO and Special Representative of the UN Secretary-General for Sustainable Energy for All and Co-Chair of UN-Energy



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EXECUTIVE SUMMARY

INTRODUCTION

Sustainable Development Goal 7 (SDG7) sets out a global aim to ensure access to affordable, reliable, sustainable and modern energy for all. The Energizing Finance: Understanding the Landscape report, developed by Sustainable Energy for All in partnership with Climate Policy Initiative and produced annually since 2017, provides a comprehensive analysis of tracked finance commitments flowing to the two key areas of energy access: electrification and clean cooking. This fifth edition of the report tracks finance for electricity and clean cooking committed in 2019 to 20 Sub-Saharan African and Asian countries — known as the high-impact countries (HICs)[1] — which together are home to more than 80 percent of people globally without energy access.

For the seventh consecutive year, the world is falling far short of the level of investment required to achieve energy access for all. Finance for electricity in the HICs declined substantially in 2019 to USD 32 billion from USD 43.6 billion in 2018, and finance committed to residential electricity access fell to USD 12.9 billion, less than one-third of the USD 41 billion estimated annual investment needed to attain universal electricity access by 2030.[2] Clean cooking investment has also stagnated, falling critically short of the USD 4.5 billion in annual investment required for universal access. Annual tracked commitments to clean cooking in HICs have languished around USD 130 million between 2015 and 2019 (except in 2017 when commitments dropped precipitously to less than USD 50 million), and the overall clean cooking investment portfolio continues to be dominated by a few large projects in a small number of countries, funded by a handful of capital providers.

SDG7 is inextricably linked to the clean energy transition and must be achieved for a just transition and to deliver other SDG targets. No major country or region is decarbonizing its power sector at the pace required to meet the goals of the Paris Agreement, with continued financing of fossil fuel projects driving misalignment across a wide range of markets (CPI 2021). A failure to make substantial progress towards SDG7 and to transition to clean energy also affects attainment of other SDGs, including good health and well-being (SDG3), gender equality (SDG5), reduced inequalities (SDG10), and climate action (SDG13), as the social and economic impacts of poor energy access compromise progress on intersecting SDGs.

[1] Electricity HICs are Angola, Bangladesh, Burkina Faso, Chad, Congo (DR), Ethiopia, India, Kenya, Korea (DPR),Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, South Sudan, Sudan, Uganda and United Republic of Tanzania. Clean cooking HICs are Afghanistan, Bangladesh, China, Congo (DR), Ethiopia, Ghana, India, Indonesia, Kenya, Korea (DPR). Madagascar, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Philippines, Uganda, United Republic of Tanzania and Vietnam. More details on HICs available in Box 1.

[2] The HICs are home to 76 percent of the global population without access to electricity (580 million people), so USD 11.9 billion is substantially lower than their proportional need based on IEA's estimate that USD 41 billion in annual investment is needed globally to attain universal electricity access by 2030 (IEA et al. 2021).

The Covid-19 pandemic puts efforts to achieve SDG7 – already at risk – further behind. After six years of decline in the number of people without electricity access in Africa, that figure most likely increased in 2020 due to the Covid-19 health crisis and its associated economic downturn. Those impacts have shifted government priorities, caused supply chain disruptions, and limited activities associated with enhancing energy access to underserved populations (IEA et al. 2021).[3] The pandemic has also threatened progress in clean cooking access; under today's current and announced policies, 2020 and 2021 will see a reversal in hard-won, incremental progress, and by 2030, 2.4 billion people will remain without access to clean cooking.[4] Despite the ambition of domestic pandemic stimulus packages to date, only a fraction of pledges contain energy access components, risking further sidelining finance for sustainable energy access.

This report serves as a baseline for government leaders, public and private investors, and energy access enterprises that seek to drive the energy transition and meet the electricity and clean cooking access targets of SDG7. This Executive Summary follows the same structure as the report, highlighting 1) key findings on finance commitments to electricity across the HICs, 2) analysis from a case study on Mozambique regarding the need to invest in climate resilience in the electricity sector, 3) key findings on finance commitments to clean cooking across the HICs, and 4) analysis from a case study on Ghana and Vietnam exploring their divergent technological approaches to clean cooking access.

KEY FINDINGS ON FINANCE FOR ELECTRICITY

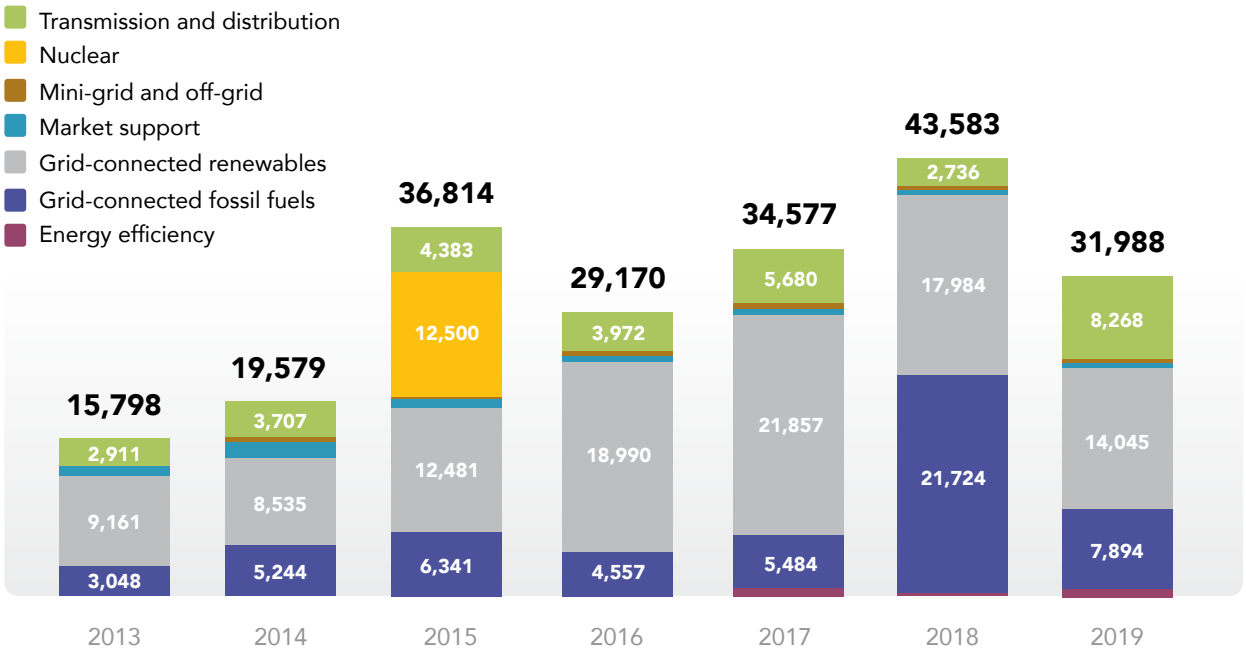
FINANCE CONTINUES TO FALL FAR SHORT OF NEEDS AND ACTUALLY DECLINED IN 2019

Tracked finance for electricity in the HICs declined in 2019 for the first time in three years. Total tracked finance commitments were USD 32 billion in 2019, a 27 percent decline from 2018 when USD 43.6 billion in finance was committed to electricity in HICs. This decline is attributable to a combination of factors including delays in financing projects, lower capital costs per megawatt of generation, and a decline in commitments from key financiers including institutions in China and India. Of the USD 32 billion, an estimated USD 12.9 billion, or approximately one-third of finance commitments, benefitted residential consumers. The HICs are home to 76 percent of the global population without access to electricity (580 million people), so USD 12.9 billion is substantially lower than their proportional need based on the IEA's estimate that USD 41 billion in annual investment is needed globally to attain universal electricity access by 2030 (IEA et al. 2021).

Investments shifted in 2019 in the direction of energy solutions aligned with the Paris Agreement, relative to 2018. Investment in fossil fuel generated electricity declined from 2018 to 2019; in 2018, 50 percent of total electricity finance was committed to grid-connected fossil fuels compared to 25 percent in 2019. This shift reverses a troubling trend where in 2018 fossil fuels accounted for the largest portion of new electricity finance commitments to HICs for the first time in at least six years. There was also an increase in finance tracked for transmission and distribution infrastructure in 2019, to its highest level since this report series began in 2013.

[3] Final data not yet available on 2020 access shifts but it is predicted that 2020 will have yielded growth in the number of people without electricity access.

FIGURE 1
Finance to Electricity by Sector, 2013-2019 (USD mn)



Country-level progress towards electricity access among HICs has been mixed. While the Indian government announced in 2019 that more than 99 percent of its population has access to electricity,[5] access rates remain low in other countries. In the seven[6] countries that *Tracking SDG7: The Energy Progress Report 2021* predicts will make up more than 50 percent of the global population without electricity access by 2030 under current and announced policies, only USD 5.8 billion in total was committed to electricity in 2019. In other words, less than 20 percent of all finance committed to the HICs.

Tracked commitments to off-grid and mini-grid solutions declined from an all-time high in 2018 and remain a very small proportion (0.9 percent) of finance tracked to electricity. Each year since tracking began in 2013 has seen finance remain well below the level of investment necessary for off-grid and mini-grid solutions. Decentralized electricity solutions are crucial to achieving universal access – the World Bank's *2020 Off-grid Solar Market Trends Report* notes that these need to reach more than 600 million people with Tier 1 products to support universal access, requiring USD 6.6 to 11 billion in additional finance between 2020 and 2030. Bilateral and multilateral development finance institution (DFI) finance fell sharply between 2018 and 2019; those entities accounted for USD 260 million of finance to the decentralized electricity sector in 2018, compared to USD 34 million in 2019. Finance commitments to off-grid and mini-grid solutions did however become more geographically distributed in 2019, with 19 HICs receiving some finance commitments to the sector,[7] up from 13 in 2018.

[5] Though India does indeed have access rates far beyond those of other HICs, the 99 percent formal access rate is potentially overstating true access in India as the government deems a village "electrified" if 10 percent of its households and public places are connected, thus likely overestimating total genuine electricity access of households. "India Nears Power Success, But Millions Still in the Dark" (T&D World. 2018.).
[6] Congo (DR), Niger, Nigeria, Uganda, Pakistan, Tanzania and Sudan.
[7] Only Korea (DPR) did not have any tracked finance to the sector in 2019.

A CASE STUDY IN MOZAMBIQUE DEMONSTRATES THE CRITICAL NEED TO INVEST IN CLIMATE RESILIENCE IN THE ELECTRICITY SECTOR

This case study assesses the existing and potential climate resilience of electricity finance in Mozambique. Electricity infrastructure assets across the globe are increasingly at risk from climate change impacts – with severe implications for sustainable energy access for all. Projected increases in the frequency and severity of floods, droughts and storms pose a grave risk to Mozambique's highly centralized electricity delivery system. A single hydropower plant — the Cahora Bassa dam — contributes more than 50 percent of the country's electricity supply via a single high-voltage power transmission line, making the electricity sector vulnerable, and hence, less secure.[8]

Recent finance committed to Mozambique's electricity sector has in large part targeted grid-connected fossil fuel projects (USD 1 billion in 2018 and USD 877 million in 2019). Expanding generation capacity by diversifying fuel sources with renewable energy technologies such as solar and wind is crucial to Mozambique's economic well-being, as is a move away from expansion of electricity supply through fossil fuel generation, which carries immense economic and climate risks. Moreover, Mozambique's low population density and affordability challenges mean that mini-grids and off-grid solutions should be considered permanent, cost-effective parts of Mozambique's energy mix to increase access and resilience to climate change.

There is substantial opportunity to invest in climate resilient energy infrastructure. The Global Commission on Adaptation finds that the benefits of climate-proofing existing infrastructure and building new infrastructure outweigh the costs by 4:1. In Mozambique, the creation of a sector regulator (ARENE) in 2018, the progressive phasing-out of tariff subsidies, relevant reforms within the national power utility (EDM) as well as significant financial support from donors in the off-grid electricity sector are all positive indicators for private investment, which could be increasingly directed towards resilient electricity infrastructure.

A TRANSFORMATION OF INVESTMENT IN THE ELECTRICITY SECTOR IS REQUIRED TO ACHIEVE UNIVERSAL ACCESS

Public financiers including national governments, bilateral donors, philanthropies and DFIs must collectively increase their own funding and accelerate efforts to mobilize commercial capital to Sub-Saharan African economies with persistent underinvestment in electricity access. These actors must support enabling conditions for private investment in Sub-Saharan Africa through actions including, but not limited to:

- Systematic country-level interventions built on data and evidence to identify investment bottlenecks and new ways to crowd in private-sector finance (for example through the World Bank's Maximizing Finance for Development) and to boost investor confidence.
- Increasing national governments' borrowing capacity, and by extension their access to international debt and commercial capital markets through, for example, making available currency-hedging instruments and guarantees, and through monetizing carbon offsets.
- Increasing the number of accredited entities to access climate finance funds.
- Increasing engagement and coordination between and among DFIs, national and regional development banks and institutions to better leverage finance, local experience and expertise.

[8] Many HICs in Sub-Saharan Africa are highly reliant on aging hydropower infrastructure.

The adoption of policy reforms, sustainable and innovative business models, and financial instruments is important to accelerate deployment of finance to the mini-grid and off-grid sector. Decentralized solutions represent an enormous opportunity to increase electricity access as they can be deployed quickly and in modular form and are often more affordable at the household level than the alternatives. The sector is failing to reach its potential with limited private investment and falling DFI finance commitments in 2019. Several actions should be taken concurrently to increase commitment volumes and efficacy to the sector. These actions are also discussed in detail in the forthcoming *Energizing Finance: Taking the Pulse 2021* report.

- Increase market support to assess customer demand and improve credit assessment and financing mechanisms, including through securitization, currency hedging, guarantees and risk pooling.
- Accelerate blended finance solutions to deploy grants and concessional finance alongside commercial investment more efficiently to de-risk electricity projects that commercial investors might find too risky.
- Formalize licenses for private-sector mini-grid developers and develop coherent national policy around subsidy planning to increase the viability of private-sector involvement.

Sustained effort is needed to increase the climate resilience of existing and future energy infrastructure. With ever-growing electricity demand across sectors and increasing shares of intermittent generating technologies like wind and solar, the resilience of the power sector to climate change-induced impacts is more crucial than ever. Building climate resilience requires the mainstreaming of climate-related risk into government policies and design planning. Systems thinking to address growing climate risk requires investment in energy storage technologies, energy efficiency mechanisms, information systems to capture granular climate data, and tools and frameworks to integrate climate risk into investment decisions, including pricing.

Efforts towards increasing electricity access and accelerating a low-carbon energy transition should be strategically paired with clean cooking investments to leverage finance and policies across the three sectors. Electric cooking is a technology solution that could combine progress made in electrification with new progress in clean cooking, especially over the longer term. Countries like India, Nepal and Nigeria have piloted projects and campaigns to tap the transformative potential of electric cookstoves. A strategic rethink of government policies and subsidies, such as adjusting electricity tariffs to favour electric cooking, rebalancing subsidies between gas and electricity, and strengthening countries' distribution networks, could place electric cooking front and centre.

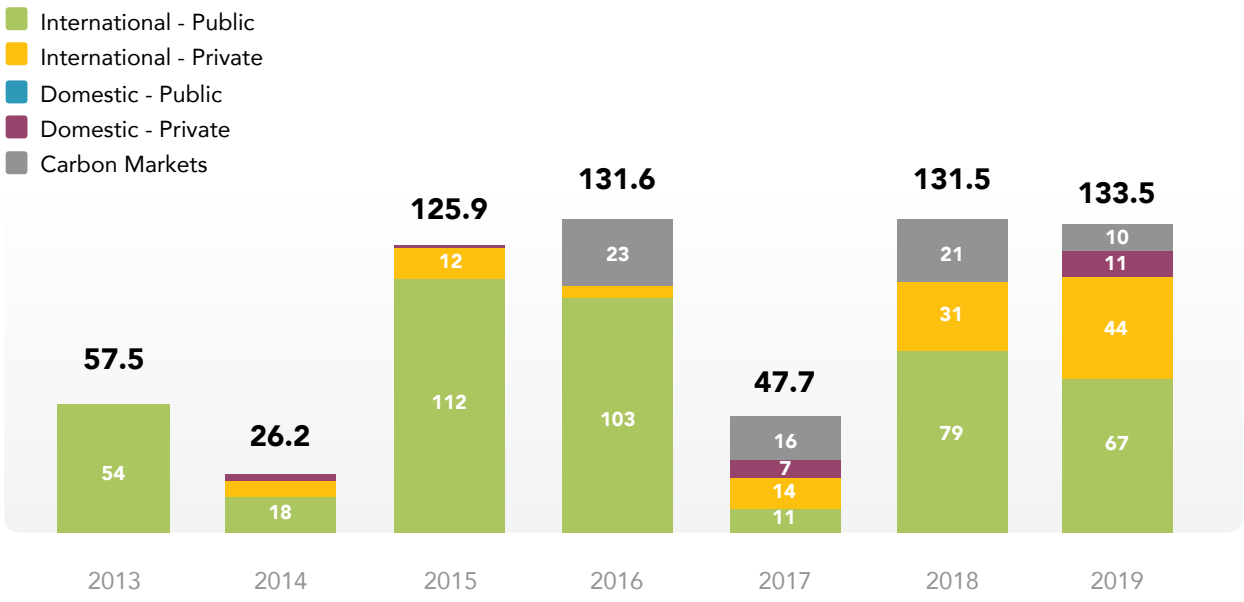
KEY FINDINGS ON FINANCE FOR CLEAN COOKING

CHRONIC UNDERINVESTMENT IN CLEAN COOKING CONTINUES

Despite incremental progress, clean cooking commitments chronically fall short of the USD 4.5 billion in annual investment required to achieve universal access. Annual tracked commitments languished at around USD 130 million between 2015 and 2019 (except in 2017, when there was a drop in commitments by multilateral DFIs, driven by just a handful of projects). The continued underinvestment in clean cooking solutions, year on year, compounds the negative health, climate and gender impacts associated with traditional cooking methods.

The overall clean cooking investment portfolio continues to be dominated by a few large projects in a small number of countries, funded by a handful of capital providers. While there were no large-scale multilateral DFI projects for clean cooking solutions in 2019, 70 percent of the finance committed to Bangladesh and Kenya came from just seven projects. Additionally, improved cookstoves (ICS), which attracted 58 percent of public finance, mobilized no private finance commitments in 2019 and only a small amount of committed finance in 2018. Carbon finance, a mechanism through which clean cooking project developers sell credits for verified emissions reductions (VERs) also received lower levels of finance commitments in 2019 than in 2018.

FIGURE 2
Clean Cooking Commitments in HICs by Source (2013–19, USD mn)



Country-level progress is highly heterogenous and Sub-Saharan Africa is being left behind. Countries in Sub-Saharan Africa including the Congo (DR), Madagascar and Mozambique, where an average of 96 percent of the population lack access to clean cooking solutions, each received less than USD 1 million in finance commitments in 2019 – less than 1 percent of the annual investment needed in each country. For the second year in a row, a significant portion of clean cooking finance commitments went to Kenya, which has increased access to clean cooking solutions by 14 percent in urban areas since 2018, and Bangladesh, where access has remained static since 2018. The remaining 18 HICs in this analysis, home to over 1.9 billion people without access to clean cooking solutions, received only 38 percent of all tracked finance commitments in aggregate in 2019.

No large-scale finance commitments from multilateral DFIs were found. Overall finance commitments from multilateral DFIs reached USD 4.5 million in 2019, down from USD 45 million in 2018, and comprised only 7 percent of total public finance. The largest multilateral DFI project tracked in 2019 was a USD 2 million World Bank commitment to ICS distribution in Bangladesh. The remaining multilateral DFI commitments were all well under USD 1 million per project and focused on a mix of ICS, liquefied petroleum gas (LPG) stoves and fuel, and advanced biomass stoves and fuel. The World Bank's Energy Sector Management Assistance (ESMAP) Clean Cooking Fund, announced in 2019 and operational in 2020, is expected to significantly increase multilateral DFI finance commitments for clean cooking in future years.

Private-sector investment in clean cooking increased. Tracked private finance commitments for clean cooking projects increased to their highest levels since tracking began in 2013, reaching USD 56 million in 2019, up from USD 32 million in 2018 and USD 21 million in 2017. Investment from the private sector also continued to flow to a range of clean cooking fuels and technology, such as LPG, ethanol and biogas projects. ICS, however, attracted no tracked private investment in 2019.

A CASE STUDY OF DIVERGENT TECHNOLOGICAL APPROACHES TO CLEAN COOKING ACCESS IN GHANA AND VIETNAM

In Ghana, LPG for cooking has gained traction in recent years under a government policy target aiming to reach 50 percent of households using LPG by 2030, but investment still falls well short of that required. The LPG value chain expansion required to meet the 2030 policy target requires approximately USD 400 million in total (including USD 279 million for cylinders) (GLPGP, KfW & EU 2018),[9] compared to USD 2 million in tracked finance commitments in 2019 for residential LPG cylinders.[10] A disciplined LPG market model (the so-called branded cylinder recirculation model (BCRM)) using branded, instead of consumer-owned, cylinders — in line with international best practice — will help make Ghana's LPG ecosystem less fragmented and more bankable, therefore attracting and catalysing investment while ensuring better safety for producers and consumers alike. Moreover, this market model can be paired with pay-as-you-cook financing solutions to close both affordability and accessibility gaps for clean cooking.[11]

In Vietnam, following strong LPG uptake, on-site residential biogas has become a commercially and technically viable clean cooking solution for rural and peri-urban farming households. A long-running public-private Biogas Programme has facilitated a commercially sustainable biogas market in Vietnam and demonstrated the potential to harness waste-to-energy clean cooking solutions to enable decarbonization and achieve the country's Nationally Determined Contribution (NDC) target.[12] Moving forward, Vietnam should seek to improve its regulatory framework regarding carbon finance — a key pool of capital — and look towards larger-scale urban applications (for example, in restaurants) alongside on-site, household biogas. With 80 percent of 8.5 million farming households yet to install biodigesters, targeted financial support can also help biogas, and therefore clean cooking, become a reality for these households.

[9] In the period 2019–2030; investments are primarily dedicated to cylinders and other infrastructure including bottling plants, pallets and cages.
[10] See Box 7 and Appendix IV for more details on LPG value chain methodology.
[11] Acknowledging LPG is a fossil fuel, it is clean relative to baseline "cooking-as-usual."
[12] Vietnam's NDC includes a target of constructing 500,000 biodigesters by 2030.
[13] Providing Tier 1/2 access under the Multi-Tier Framework (MTF).

In both Ghana and Vietnam, the viability of (renewable) bio-LPG is yet to be explored but could, in time, provide for a new addition to the clean cooking mix; a drop-in solution that leverages existing LPG infrastructure. With nine years remaining, meeting SDG7 will demand a whole suite of clean cooking solutions — from ICS[13] to electric stoves — to move households up the energy ladder and towards universal clean cooking. Closing the clean cooking access gap requires a comprehensive approach that considers three key policy pillars: availability, affordability and accessibility.

CLEAN COOKING INVESTMENT MUST MOVE FROM THE BACK BURNER TO THE FOREFRONT

Governments must make clean cooking a national priority. Countries like India and Indonesia have shown that ambitious and targeted domestic programmes are instrumental in rapidly increasing clean cooking access, especially for urban populations. Depending on individual country contexts and available resources, there must be movement on all fronts including, but not limited to, consumer awareness and behavioural change programmes, and capacity building for policy and financial institutions. There is also a pressing need for governments to focus on programmes designed to effectively target vulnerable populations, and to coordinate with international donors to create a sustainable, well-funded market for clean cooking solutions. While this report is unable to capture direct domestic public finance for clean cooking solutions, more innovation is needed to direct large-scale funding to smaller companies and facilitate the scale-up of manufacturing, supply chains and distribution to transform markets.

Clean cooking should be integrated across cross-sectoral planning and awareness campaigns to leverage electrification and climate initiatives. It is critical that clean cooking is integrated into climate policies, electrification plans and relevant sectoral policies given the sector's cross-cutting nature. This includes NDCs, net-zero roadmaps, integrated energy plans, and Covid-19 recovery plans – to bring the clean cooking agenda, and associated investment need, into the spotlight. For instance, only 43 of the 165 countries that have submitted NDCs to the UNFCCC mention cooking and cookstoves in their NDC, including just 12 HICs. Efforts must be directed to sensitize and instill awareness in government agencies and the general population of the positive health impacts and co-benefits of using cleaner fuels and technology for cooking.

The current piecemeal, project-by-project approach to clean cooking investment by international public financiers requires a strategic rethink across the value chain. Finance commitments from DFIs have long focused on a limited number of countries and technologies, largely directed towards ICS and transition solutions rather than a suite of clean cooking fuels and technologies. DFI investments must be pushed across the ecosystem – supporting innovation and business models through research funding, pilot demonstration activity, and large-scale programmes in the field, partnering with national DFIs, coordinating with local stakeholders, and leveraging their mandates to bring the clean cooking agenda to global prominence as well as incentivizing private-sector financiers through the clean-cooking value chain. The World Bank's ESMAP has taken a substantial step in the right direction by establishing the USD 500 million Clean Cooking Fund, with contributions to date from the Netherlands, Norway and the United Kingdom to capitalize it.

[14] Domestic governments' expenditure on clean cooking has increasingly been expressed as policy tools, which are not included in the tracking methodology. Additional information is available in Appendix 1.
[15] Afghanistan, Bangladesh, Ethiopia, Ghana, India, Korea (DPR), Madagascar, Myanmar, Niger, Nigeria, Pakistan and Uganda. Data from Solar Cookers International.
[16] This investment is not tracked in the current report that captures finance in 2019.

Increased innovation in financial instruments as well as a drastic increase in local currency finance and blended finance are needed to deploy the scale of capital necessary to reach universal clean cooking access. A number of business models and finance mechanisms have benefitted the clean cooking sector in several countries, including results-based financing (RBF), 'pay-as-you-cook' services, and carbon finance. Efficiently designed voluntary carbon markets provide opportunities by raising investment in exchange for emissions reductions from efficient stoves and cleaner fuels. While tracked carbon finance commitments were lower in 2019 than in 2018, supporting negotiations on Article 6 of the Paris Agreement and facilitating access to the voluntary carbon markets could provide a critical source of investment for clean cooking solutions by monetizing high-quality carbon offsets generated by these projects. Crowdfunding, driven by environmental and social impact concerns, is also a promising instrument but must be adapted to individual country contexts, accounting for differences and stages of market development.

Increased targeting of public finance is necessary to leverage and de-risk private capital to mobilize more finance. Private finance has shown an openness to a variety of clean cooking solutions, particularly LPG and ethanol stoves. This is despite a lack of policy support for developing sustainable markets for clean cooking solutions in many HICs. RBF has the potential to play a pivotal role, particularly as the clean cooking sector can expand metrics for success to include outcomes such as positive health and gender equity impacts. Blended finance can prioritize co-benefits with other SDGs; for example, Bangladesh's blended finance clean cooking programme created more than 3,000 direct and indirect jobs for women in 2019. In Indonesia, an RBF pilot provided incentives to ten private-sector suppliers, five of which were women-led businesses.

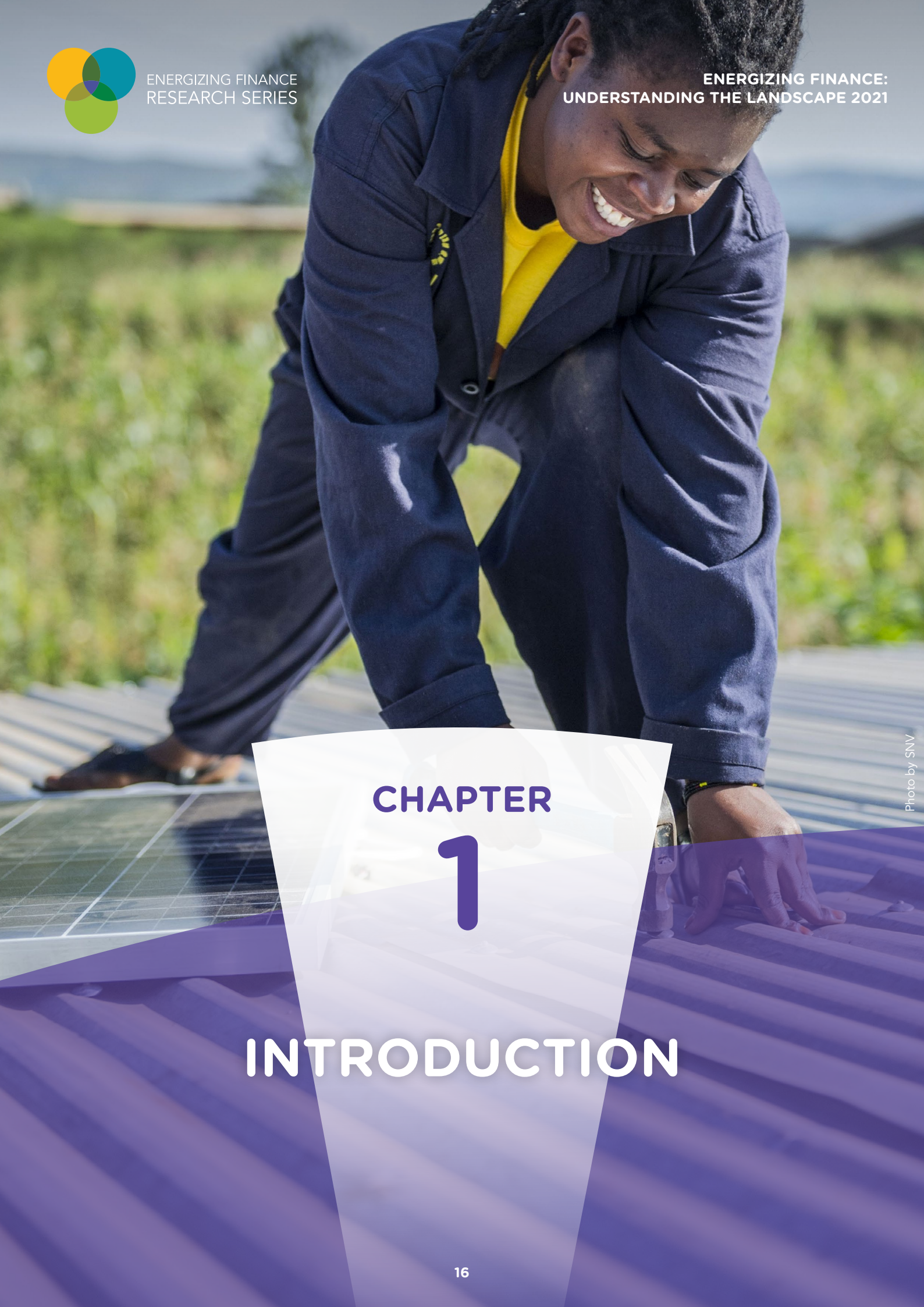


Photo by SNV

CHAPTER 1

INTRODUCTION

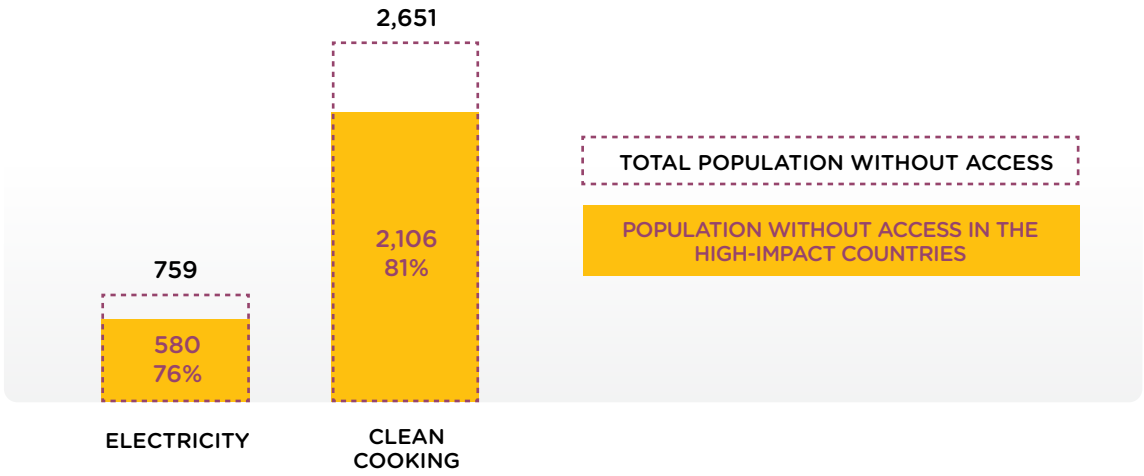
CURRENT ENERGY ACCESS SITUATION

The Covid-19 pandemic puts efforts to achieve SDG7 — already at risk — in further doubt. *Tracking SDG7: The Energy Progress Report 2021* predicts that the population without electricity access in Africa is likely to have risen in 2020 after six years of decline due to the Covid-19 health crisis and associated economic downturn (IEA et al. 2020). The share of the global population with access to electricity grew to 90 percent in 2019, but 759 million people still lack access. The report projects that under today's current and announced policies, by 2030, 660 million people will continue to lack electricity access – and that given population growth, approximately 940 million people would have to gain access to electricity by 2030 to achieve universal coverage. Circumstances are even more challenging for reaching universal access to clean fuels and technology for cooking, where under current policy settings, the report projects that 2.4 billion people will remain without access by 2030.[17]

Approximately 1.1 billion people gained electricity access between 2010 and 2019, though given population growth, the number of people without access only declined from 1.2 billion to 759 million in that same period. In the 20 high-impact countries (HICs) (see Box 1 for further information on the HICs), 580 million people, 76 percent of the global total, do not have access to electricity. Approximately one third of the global population, or 2.6 billion people, do not have access to clean cooking, and 2.1 billion of these live in the 20 clean cooking HICs – 81 percent of the global total.

To achieve universal electricity[18] access by 2030, Sub-Saharan Africa needs an estimated USD 19.3 billion per year in investment, while South Asia needs USD 10.2 billion (IEA et al. 2020).[19] For clean cooking access, the annual investment required in Sub-Saharan Africa is USD 2.4 billion and in South Asia, 2.1 billion. Most HICs continue to see severe underinvestment in both electricity and clean cooking (Figures 4 and 5), with the situation most acute in the clean cooking sector. Countries such as the Congo (DR) and Niger, with nearly 95 percent of their populations without access to clean cooking fuels and technology, saw only negligible levels of committed finance in 2019 (Figure 5).

FIGURE 3
Total Population in the HICs without Energy Access (millions)

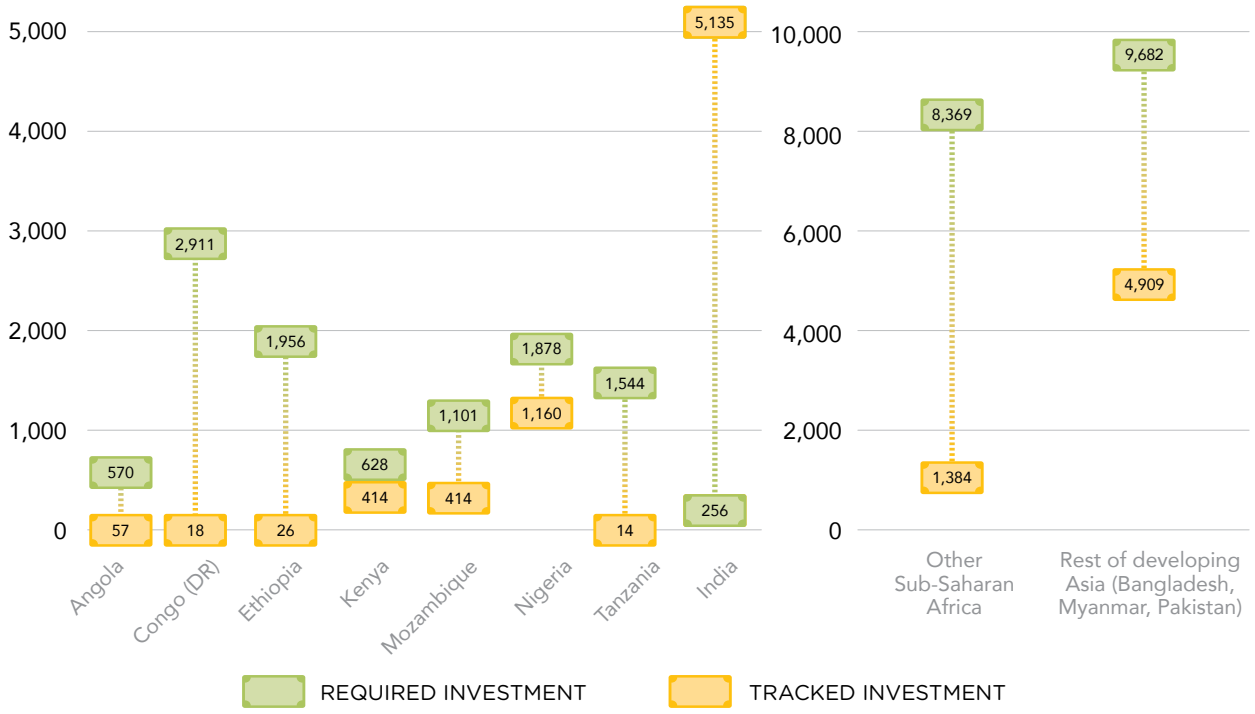


Source: IEA, IRENA, UNSD, World Bank, WHO 2021. Tracking SDG 7: The Energy Progress Report. World Bank and CPI's own estimates using the World Bank's indicators on population and access levels in 2019.

[17] Ibid
[18] IEA et al. estimates of required investments refer to generating assets and new transmission and distribution networks with a focus on household access. These include centralized power plants (e.g., coal, natural gas, hydro, solar photovoltaic, biogas, wind), mini-grid, and standalone systems and exclude pico solar products.
[19] The country-level annual investments needed for African countries are based on the IEA's African Outlook from 2019 to 2030 to reach full access by 2030. The India and other estimates are based on annual investments needed to reach full access in the Sustainable Development Scenario. The required investment estimates are available for only a few countries and not all the HICs.

FIGURE 4

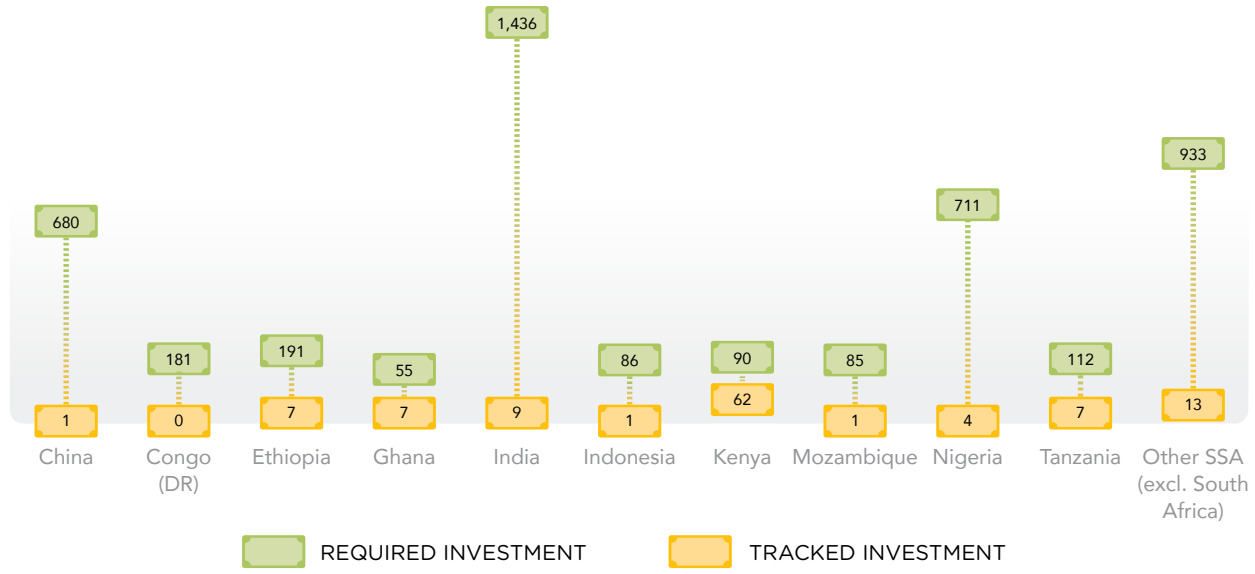
Electricity – Required investment (USD mn, per annum) and tracked electricity access investment in 2019



Note: The tracked investment numbers for "Other Sub-Saharan Africa (excl. South Africa)" include estimates for Burkina Faso, Madagascar, Malawi, Mali, Niger, South Sudan, Sudan and Uganda. The required investments numbers for "Other Sub-Saharan Africa (excl. South Africa)" include all SSA economies except South Africa. The "Rest of developing Asia" includes Bangladesh, Myanmar and Pakistan.[20]

FIGURE 5

Clean Cooking – Required investment (USD mn, per annum) and tracked clean cooking access investment in 2019



Note: Other SSA countries capture estimates for Madagascar, Niger, Uganda, and Tanzania.[21]

[20] IEA's African Outlook and Sustainable Development Scenario inform the required investment figures tracked here. IEA estimates of required investments refer to generating assets and new transmission and distribution networks with a focus on household access. These include centralized power plants (e.g., coal, natural gas, hydro, solar photovoltaic, biogas, wind), mini-grid, and standalone systems and exclude pico solar products, mainly solar lanterns, as they are considered to be below the minimum threshold to count as access by a household.

[21] IEA's African Outlook and Sustainable Development Scenario inform the required investment figures tracked here.

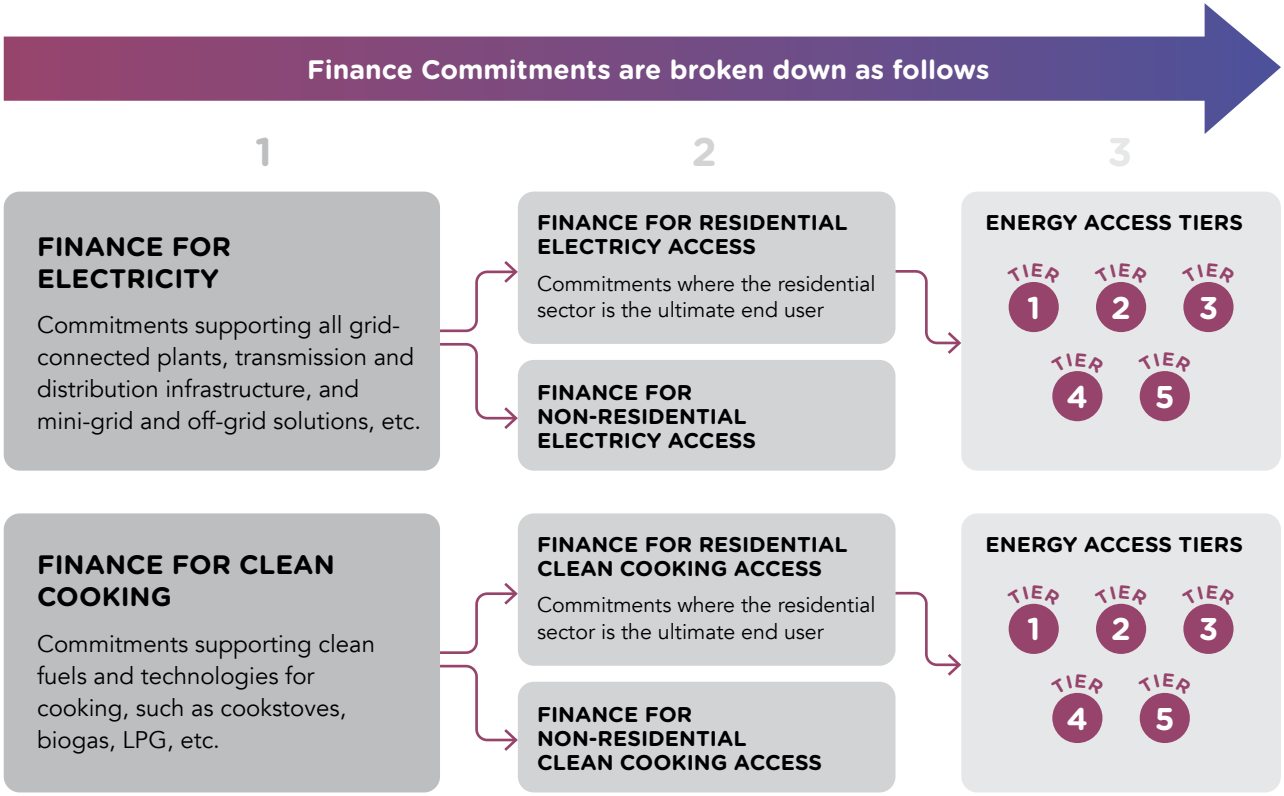
SUMMARY OF METHODOLOGY

This report follows a three-step approach to provide a comprehensive overview of finance for energy access:

1. **Identifying finance commitments to the energy sector:** The report tracks finance commitments, i.e., transactions that reached financial close or were backed by the necessary funds flowing to the electricity and clean cooking sectors in 2019.[22]
2. **Allocate tracked commitments to the residential and non-residential sectors:** After identifying the total finance commitments relevant to electricity and clean cooking access in the HICs, they are allocated to residential and non-residential consumption, using assumptions about the relative shares of power consumption in each country by sector, available in the IEA's World Energy Balances 2021. Following the IEA's definition, this report considers energy access as 'household access,' which excludes businesses, public buildings, etc.
3. **Attribute residential access commitments to energy access tiers:** As the final step, this analysis allocates the residential element of the finance commitment to the appropriate energy access tier using the World Bank's Multi-Tier Framework (MTF). This allows it to consider energy access as a continuum, accounting for availability, reliability, quality, and affordability of service, rather than as a binary measure (i.e., a household with or without access). Under the MTF, tier 1 represents access at a level of a minimum of four hours of electricity during the day and one hour during the evening with a power capacity of minimum 12 daily Wh, while tier 5 represents minimum access of 23 hours per day and four hours during the evening, with a minimum power capacity of 8.2 kWh daily (World Bank 2015).

The detailed methodology is available in the Annexes.

FIGURE 6
Tracking methodology



[22] Given delays in reporting of finance, the Understanding the Landscape report series focuses analysis on the year two years prior to report publication.

STRUCTURE OF THE REPORT

Chapters 2 and 4 analyse international and domestic finance commitments in 2019 for electricity and clean cooking, respectively, in the HICs. **Chapter 3** assesses climate risks affecting the electricity sector in Mozambique and climate resilience strategies to increase adaptive capacity to those risks. **Chapter 5** provides a comparative analysis of liquefied petroleum gas (LPG) in Ghana and biogas in Vietnam as pathways to improved clean cooking access to understand financing strategies that have been employed in each country.

CHANGES TO THE HIGH-IMPACT COUNTRIES (HICS)

Much has changed since the first edition of the *Understanding the Landscape* report. To better reflect the evolving realities of the energy access landscape, this year's report has expanded its coverage of the HICs it tracks, adding and substituting the countries noted below as reported in *Tracking SDG7: The Energy Progress Report 2021* (IEA et al. 2021).

Access Type	Countries	New Additions	Exclusions
Electricity	Angola, Bangladesh, Burkina Faso, Chad, Congo (DR), Ethiopia, India, Kenya, Korea (DPR), Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, South Sudan, Sudan, Uganda, United Republic of Tanzania	South Sudan	Yemen
Clean Cooking	Afghanistan, Bangladesh, China, Congo (DR), Ethiopia, Ghana, India, Indonesia, Kenya, Korea (DPR), Madagascar, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Philippines, Uganda, United Republic of Tanzania, Vietnam	Niger	Sudan

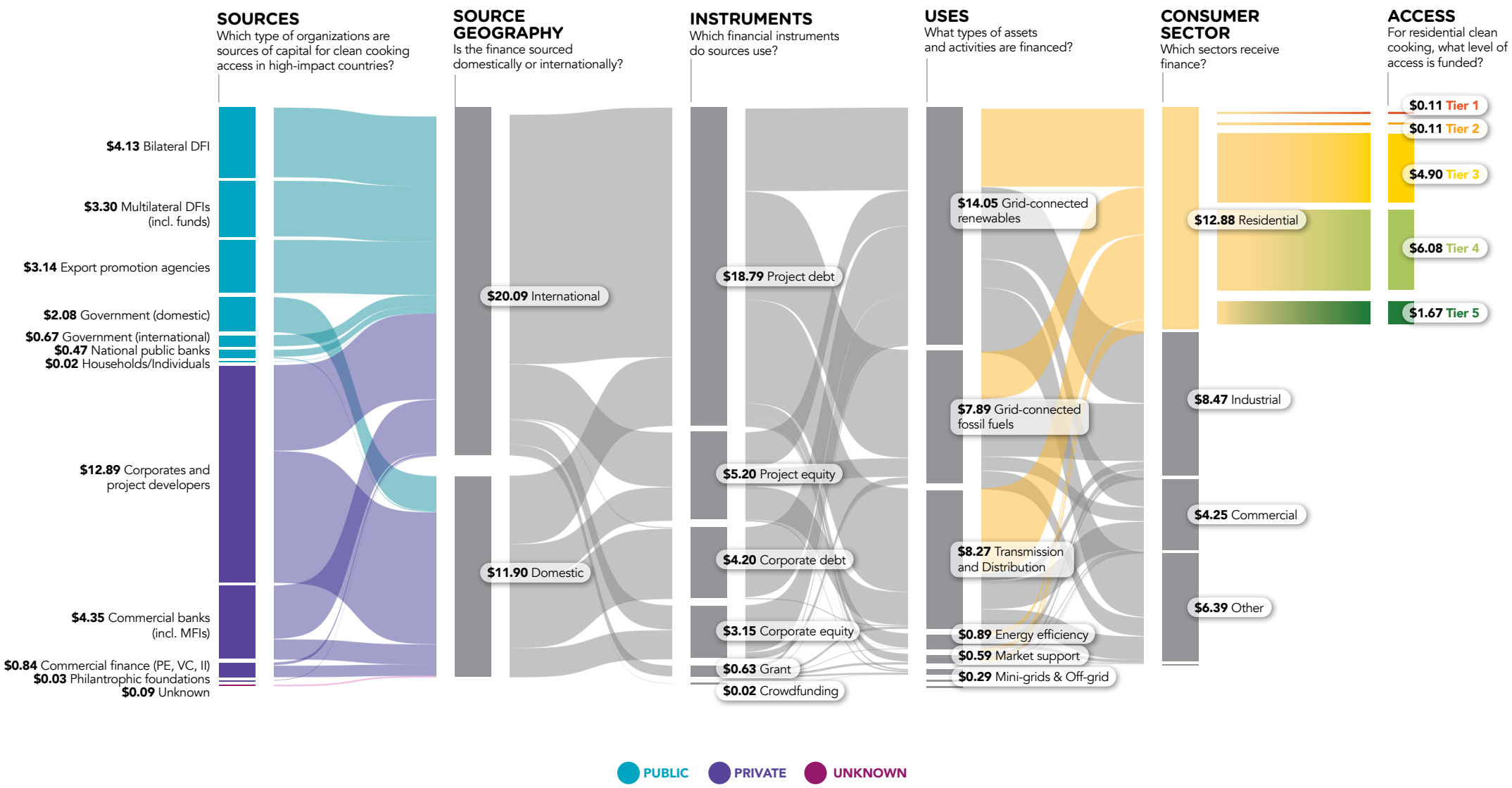
The changes in the HICs tracked in this year's report do not lead to significant comparability issues with prior editions of Understanding the Landscape because the volume of finance to the excluded countries was so insignificant. For example, total annual electricity finance commitments to Yemen across 2013–2018 averaged USD 140 million (0.5 percent of total finance to HICs), while clean cooking finance to Sudan averaged USD 355,000 per annum during the same period (0.3 percent of total finance to HICs). The updates to the HICs for 2019 are additional to changes made in assessing 2018 data where Chad and Pakistan were added to the list of HICs for electricity while Afghanistan and the Philippines were removed, and Ghana was added for clean cooking and Nepal removed.

CHAPTER

2

FINANCE FOR ELECTRICITY

TRACKED FINANCE FOR ELECTRICITY IN HICs (USD, BN)



INTRODUCTION

The USD 32 billion in finance committed for electricity in the high-impact countries (HICs) in 2019 marked a decline of more than 25 percent from USD 43.6 billion in 2018. Of the USD 32 billion, an estimated USD 12.9 billion, or approximately one-third of finance commitments, benefitted residential customers. This is less than one-third of the USD 41 billion estimated annual investment needed to attain universal electricity access by 2030 (IEA et al. 2021). The decline in 2019 aligns with global trends in renewable energy investment in 2019, attributable to a combination of factors including delays in financing projects, lower capital costs per megawatt generated, and reduced volumes of finance from key sources including institutions in China and India (Frankfurt School et al. 2020).

Finance continues to be committed unevenly geographically in relation to the populations of the countries without electricity access. Finance committed for residential electricity access in Bangladesh and India amounted to USD 170 and USD 169 per person without electricity, respectively. This is in sharp contrast to many Sub-Saharan African countries (and Myanmar) where finance committed was less than USD 10 per person without electricity access in 2019. The concentration of finance commitments among a few countries has remained relatively consistent from 2013 to 2019. In each of those years, the three countries receiving the most finance commitments in any given year received no less than 66 percent of total finance committed to all the HICs. Table 1 reflects the concentration of finance among a handful of HICs, year on year.

FIGURE 7
Electricity Finance in HICs, 2013–2019 (USD mn)

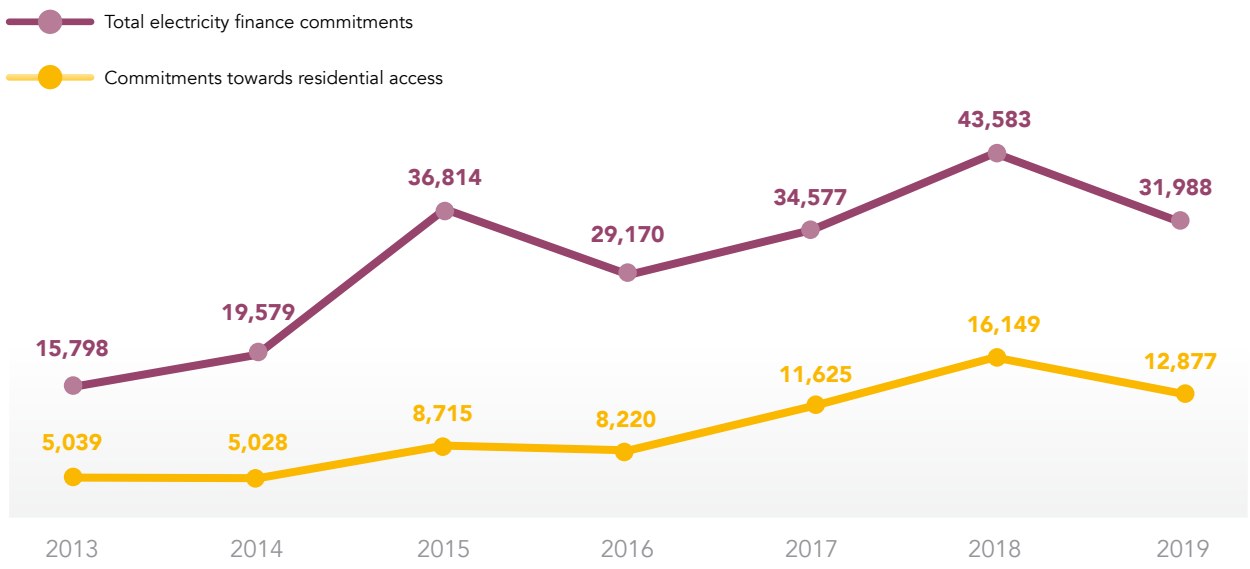


FIGURE 8
Finance Committed (USD) per Person without Electricity Access

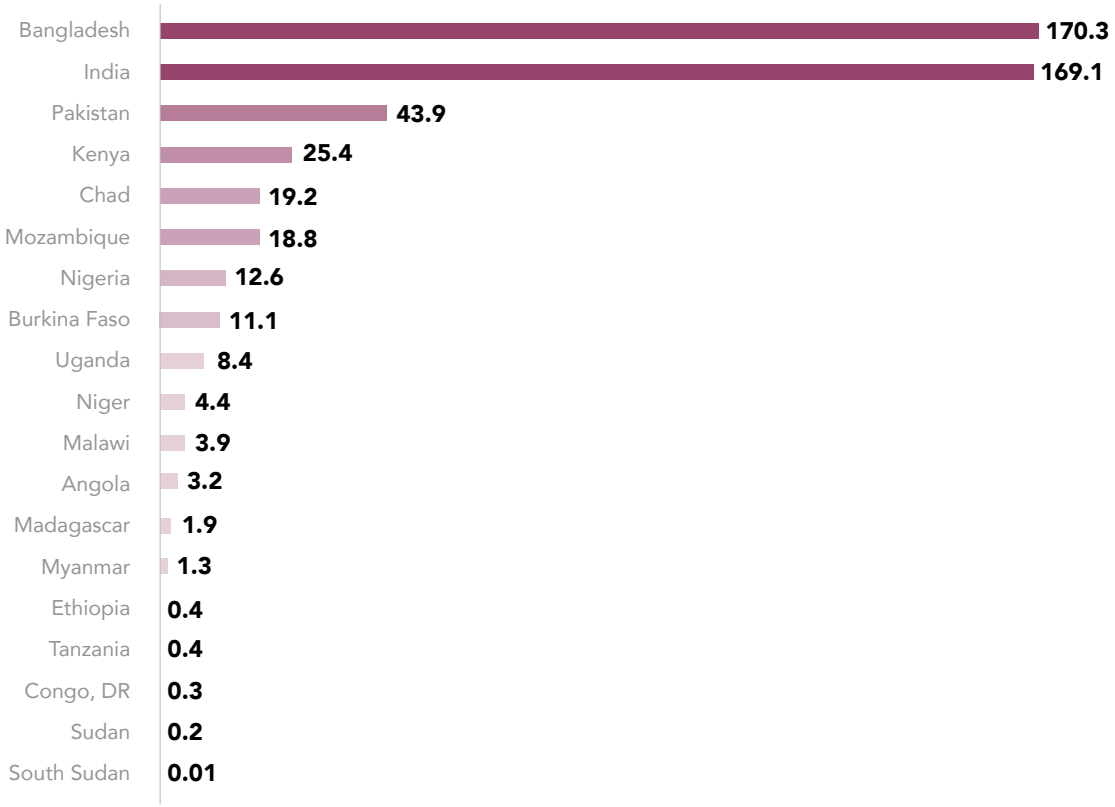


TABLE 1
Percentage of Finance Commitments to Top 3 Countries, 2013–2019

Year	2013	2014	2015	2016	2017	2018	2019
% of Total to Top 3 Countries	71%	66%	86%	92%	89%	79%	82%
Top 3 Countries	India, Ethiopia, Nigeria	India, Bangladesh, Pakistan	India, Bangladesh, Uganda	India, Bangladesh, Kenya	India, Bangladesh, Nigeria	Bangladesh, India, Pakistan	India, Pakistan, Bangladesh
% of Total to SSA	46%	31%	15%	19%	28%	20%	18%

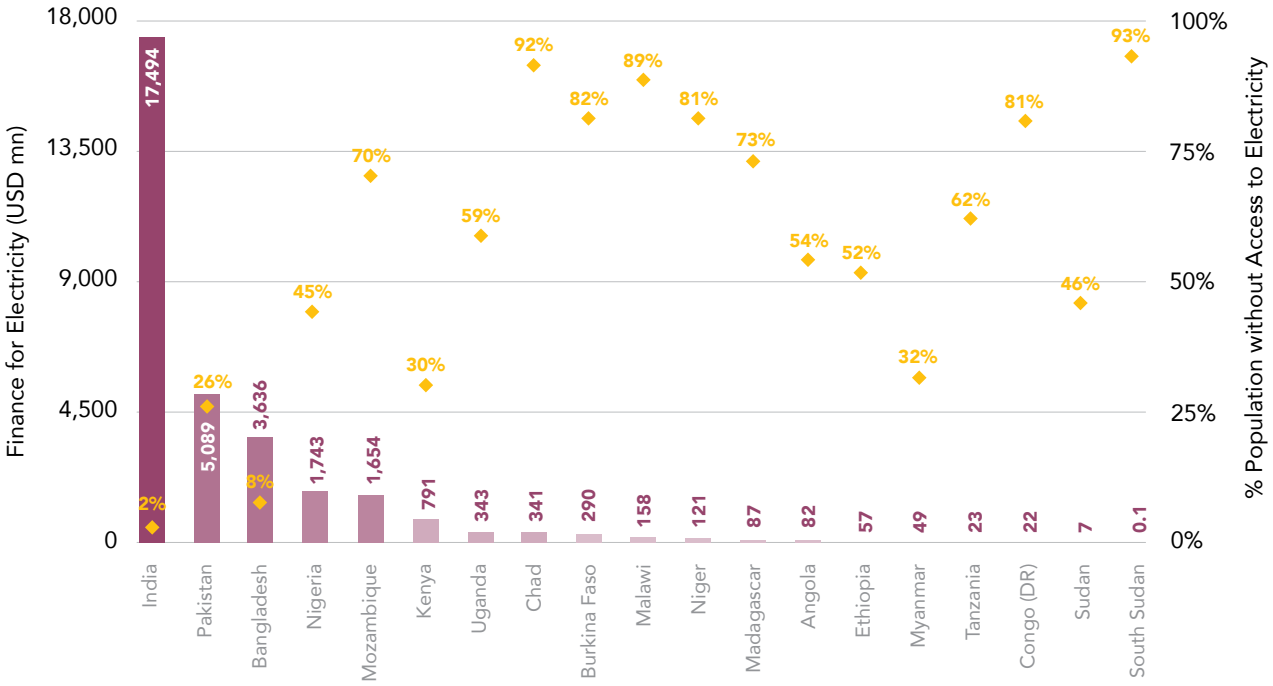
The concentration of finance commitments in a small number of HICs is likely due to a confluence of factors including diversity in the quality of investment environments across HICs, the scale of their economies, and government policy prioritization of energy access. India and Bangladesh, which have both been among the top two recipients of finance commitments every year except 2013, have the two highest sovereign credit ratings of the 20 HICs, suggesting a relatively more conducive investment environment than that of other HICs. Except for Uganda in 2015 and Kenya in 2016, the top three recipient countries have also been from among the five HICs with populations above 100 million (India, Pakistan, Nigeria, Bangladesh and Ethiopia), suggesting that market size is also a significant factor informing volumes of finance commitment to the energy sector.

Several countries that consistently received little or no finance commitments prior to 2019 did see substantial increases in 2019 compared to previous years. Most notably, Chad (where more than 90 percent of the population lives without electricity access) received USD 341 million in finance commitments in 2019 towards transmission and distribution infrastructure and off-grid solar home systems, the first finance commitments observed in Chad since this tracking exercise began.[23] Niger and Madagascar also saw significant increases relative to 2018, from USD 29 million to USD 121 million and from USD 10 million to USD 87 million, respectively.

Despite these gains, overall volumes of finance to the electricity sectors of HICs continue to fall short of that required to meet SDG7's universal access targets. In the HICs receiving less than USD 100 million in finance commitments towards their electricity sectors in 2019, the average proportion of the population without electricity access was 62 percent. The six HICs with the lowest electricity access rates, where more than 80 percent of the population does not have access — Burkina Faso, Chad, Congo (DR), Malawi, Niger and South Sudan — received in aggregate USD 933 million in finance commitments across a combined population of approximately 181 million people without access.

FIGURE 9

Distribution of Finance Commitments for Electricity Across the HICs, 2019 (USD mn)

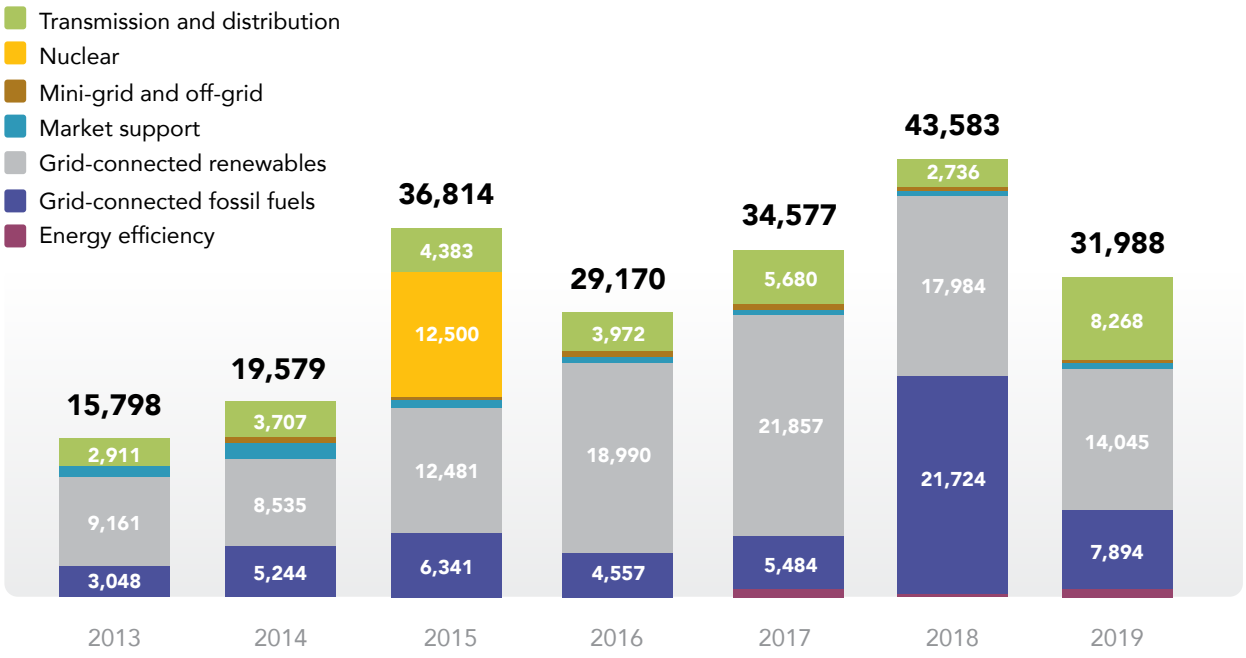


[23] Chad has approximately 314 MW of installed generation capacity to serve a population of 15 million people. The capacity comes primarily from diesel, natural gas and heavy fuel oil generation and was largely financed prior to 2013, when Understanding the Landscape's tracking began. Chad's electricity generation capacity per capita is .02 KW/person compared to 3.4KW/person in the US - or 170x the per capita generation capacity. "Chad: Power Africa Fact Sheet" (World Bank 2021).

SECTORS

Fossil fuels accounted for the largest portion of electricity finance commitments in 2018, but grid-connected renewables took the top spot in 2019. The decline in finance committed to fossil fuel-generated electricity is partially attributable to policy shifts away from coal projects in key HICs including Bangladesh and Pakistan. Both countries made explicit policy statements in 2020 to end approvals for new coal projects.[24] This policy shift may be responsible for some of the decline in fossil fuel finance from 2018 to 2019, as Bangladesh and Pakistan saw USD 14.5 billion in finance for coal-fired power in 2018 compared to USD 4 billion in 2019.

FIGURE 10
Finance Committed to Electricity by Sector, 2013-2019 (USD mn)



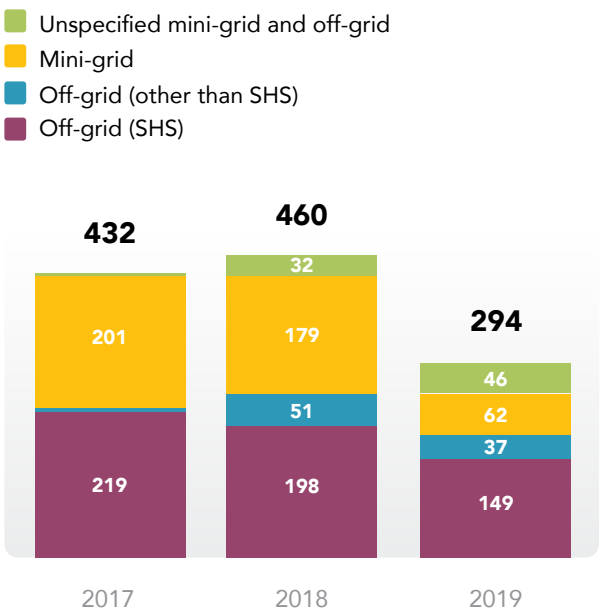
Finance committed to transmission and distribution infrastructure increased to USD 8.3 billion in 2019 compared to USD 2.7 billion in 2018. The USD 8.3 billion identified in 2019 is the most of any year since tracking began in 2013. The increase in finance for transmission and distribution infrastructure was relatively evenly distributed across HICs – with four HICs receiving more than USD 1 billion each in finance commitments and 10 HICs receiving at least USD 50 million. Improving transmission and distribution infrastructure, especially to manage increased penetrations of renewable energy, is critical to ensuring quality electricity access (though it does not impact those beyond the grid), and investment to date has lagged, so the increase is particularly promising (World Bank 2016).

Finance commitments for energy efficiency increased in 2019 to USD 900 million, the highest level tracked since 2013 and a significant increase compared to USD 260 million in 2018. Energy efficiency is key to reducing high transmission and distribution losses, managing the total investment cost of new electricity generation by controlling excessive demand and meeting national climate goals. As such, the increase in finance committed for energy efficiency paired with the increase in finance for grid infrastructure is a promising sign if growth continues year on year. The increase in energy efficiency finance was attributable to an increase in finance from bilateral development finance institutions (DFIs) to the sector and was concentrated in Bangladesh and India, which received all but USD 3 million of tracked energy efficiency finance commitments in 2019.

[24] See Power Technology 2021 and Climate Home News 2020.

Tracked investment in the off-grid and mini-grid sector declined substantially in 2019. Mini-grid and off-grid electricity solutions remain crucial to achieving universal access – the World Bank's 2020 Off-Grid Solar Market Trends report notes that these solutions need to reach more than 600 million people with tier 1 products to support universal access, requiring USD 6.6 to 11 billion in additional finance between 2020 and 2030. As illustrated in Figure 11, USD 294 million was committed to off-grid and mini-grid solutions across all 20 in HICs in 2019. As HICs represent 76 percent of the world's total population without electricity access, a significant portion of the estimated investment need exists in HICs. As such, the USD 294 million tracked in 2019 is orders of magnitude below the volume of finance required to deliver universal access.

FIGURE 11
Finance Committed to Off-grid and Mini-grid Sectors (USD mn)

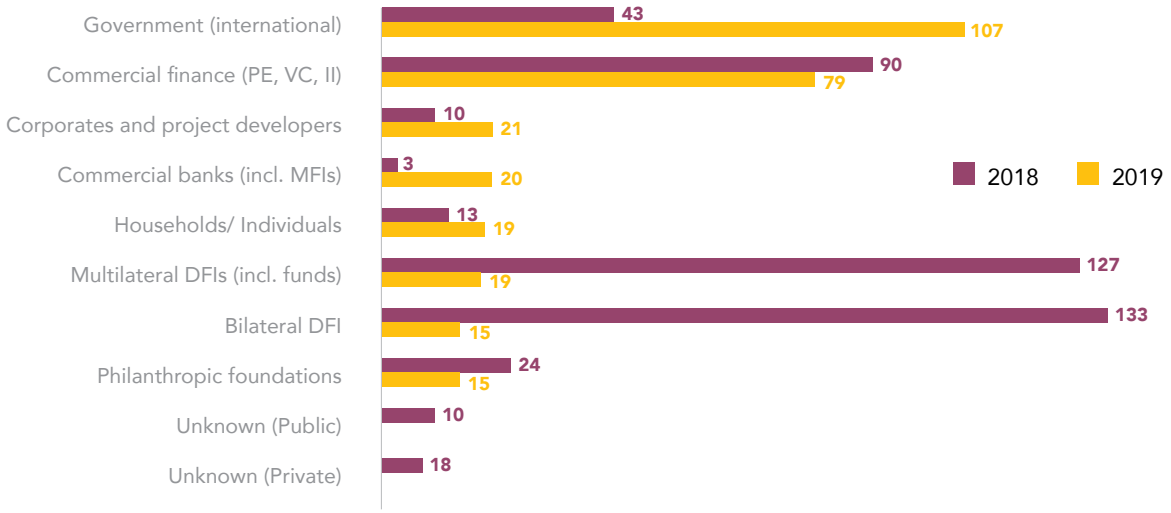


Bilateral donor governments accounted for the majority of total tracked finance commitments in 2019 (USD 107 million), followed by commercial finance at USD 79 million, and bilateral and multilateral DFIs (USD 34 million combined). The increase in finance from bilateral European donor governments is promising, as is the continued engagement of commercial financiers, which indicates the commercial viability of at least portions of the mini-grid and off-grid electricity sector. The decline in bilateral and multilateral DFI finance is striking: those entities accounted for USD 260 million of finance to the decentralized electricity sector in 2018, compared to just USD 34 million in 2019. The decline in DFI finance to the sector may represent a single year aberration as DFI finance tracked in previous years was primarily sourced from only a handful of institutions and climate funds and is therefore highly sensitive to shifts in even a single organization's priorities for any given funding year. Several mini-grid and off-grid projects intended to be funded by multilateral and bilateral DFIs are in the design phase. In the interim, the sector faces a significant timing issue as investment is urgently needed and projects often take time to be designed and subsequently implemented.

A bright spot in finance to decentralized electricity solutions was a significant improvement in distribution across HICs, with 19 HICs receiving some finance commitments in 2019,[25] up from 13 in 2018. Angola, Chad, Myanmar, Nigeria and Pakistan all saw increases of at least USD 10 million towards mini-grids and off-grid electricity solutions in 2019 compared to 2018. This continued increase in the distribution of finance across HICs suggests that enabling conditions and policy may be becoming more widespread to support the deployment of off-grid and mini-grid solutions in HICs (GOGLA 2020).[26]

[25] Only Korea (DPR) did not have any tracked finance to the sector in 2019.
[26] The future of the off-grid sector also looks fairly promising; according to GOGLA total investment to the off-grid solar sector in 2020 increased by USD 4 million from 2019 – suggesting that investment may not have been detrimentally affected by Covid-19.

FIGURE 12
Sources for finance for off-grid and mini-grid electricity, 2018 (USD mn)



RECIPIENT COUNTRIES

South Asian countries continue to receive the majority of total electricity finance commitments, as Sub-Saharan Africa continues to lag behind. Bangladesh, India and Pakistan alone accounted for 82 percent of total tracked electricity finance commitments in 2019.[27] Of these countries, finance commitments in India increased from USD 13.8 billion to USD 17.5 billion. Committed finance to Bangladesh declined, from a high of USD 16.4 billion in 2018 to USD 3.6 billion in 2019 – though this is attributable to a decrease in finance to grid-connected fossil fuel projects (USD 14.8 billion in 2018 to USD 1.3 billion in 2019).[28] At the same time, Bangladesh saw a record high volume of finance committed for grid-connected renewables (USD 324 million) and a near record for transmission and distribution infrastructure (USD 1.8 billion). Finance commitments to Pakistan — first tracked as an HIC in 2018 — increased by 16 percent to USD 5.1 billion in 2019, compared to USD 4.4 billion in 2018.

The concentration of committed finance in Bangladesh, India and Pakistan is attributable to a range of factors. In India, the relatively high volume of investment in electricity compared to other HICs is likely attributable to population size and investment environment (as discussed above) as well as to a strong domestic finance market – which accounts for by far the highest proportion of local finance tracked of any HIC. In 2019, a full 59 percent of total committed finance in India came from domestic sources. Both Bangladesh and Pakistan have weaker domestic finance markets for electricity– just 2 percent and 16 percent of electricity sector finance tracked in 2019 came from domestic sources, respectively, but those two countries have seen substantial investment from Chinese financial institutions and enterprises, beyond the volumes of any other HIC.

TABLE 2
Change in Finance Commitments in South Asian Countries, 2017–2019 (USD mn and %)

Countries	2017	Change 2017 to 2018	2018	Change 2018 to 2019	2019
India	16,756	-18%	13,815	27%	17,494
Bangladesh	7,137	129%	16,367	-78%	3,636
Pakistan	0	N/A	4,385	16%	5,089

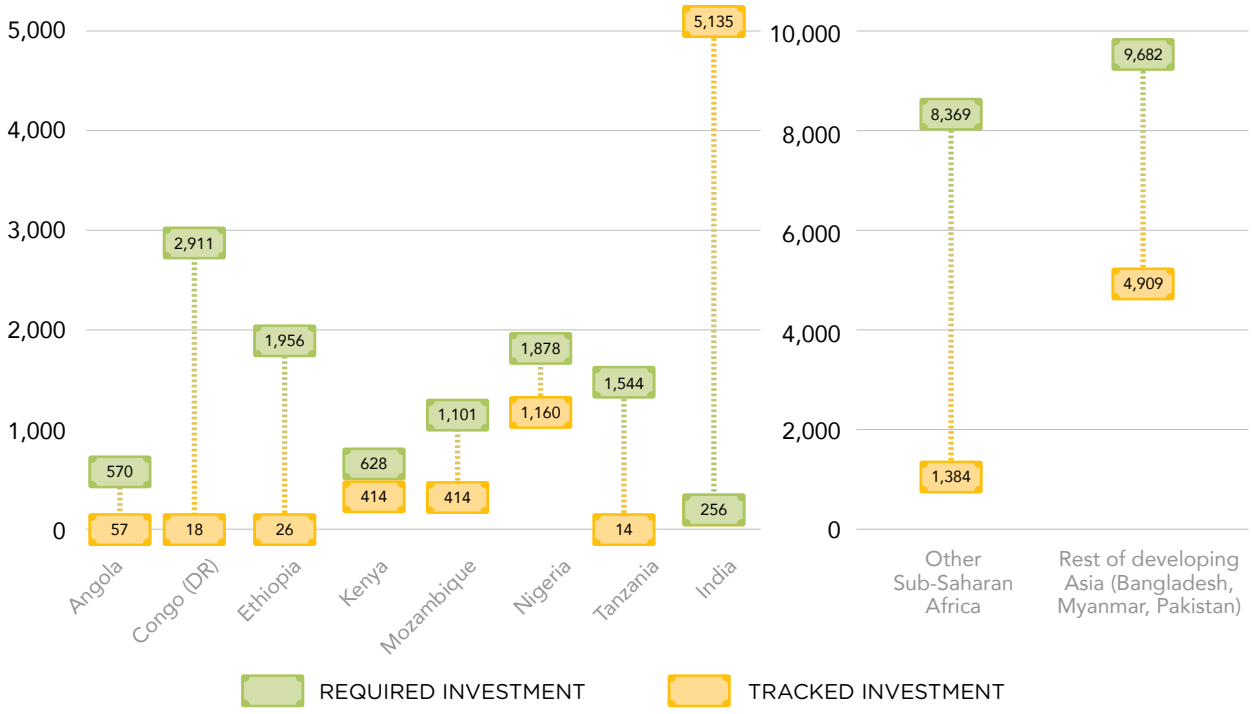
[27] The methodology for tracking electricity finance commitments to the HICs has held relatively steady with modest improvements in data sources over time, so these numbers reflect the intense concentration of finance in a handful of countries.
[28] In 2020, the Energy Ministry of the Government of Bangladesh announced that no new coal would be approved. Even before 2020, in the financial years 2018–2019 and 2019–2020, Bangladesh saw coal capacity utilization of under 30 percent, indicating that Bangladesh already has more coal capacity than it can use. Though the announcements of coal approval cessation occurred in 2020, the decline in finance even in 2019 may be a harbinger of further declines in finance to the sector in Bangladesh given the shifting policy environment and over capacity issues.

Sub-Saharan African countries recorded the lowest overall volume of committed finance since 2016, at USD 5.7 billion across 15 of them compared to USD 8.5 billion in 2018 and USD 9.6 billion in 2017. A handful of very large projects can influence changes in year-on-year finance commitments, so it will be valuable to assess future years of data to better understand trends. The reduction in finance was attributable largely to the top-end size of the largest projects (over USD 500 million) rather than a decline in medium-to-large-scale projects overall.

Of the countries where the IEA[29] has estimated the required annual investment to reach universal electricity access by 2030, only India is above the assessed annual average required between 2019 and 2030. Though finance tracked to India in 2019 far exceeds the estimated annual investment required to achieve full access by 2030 (USD 256 million annually), this finance can still be crucial if deployed towards targeted technologies to successfully transition electricity supply away from fossil fuels and to improve reliability and affordability, even for those who already have at least baseline access. The remaining countries assessed — all in Sub-Saharan Africa — are below the IEA's estimated required investment (ranging from Kenya, at USD 215 million below the estimated annual average investment needed for universal access, to Congo (DR) at USD 2.9 billion below the estimated need).

FIGURE 13

Electricity – Required investment (USD mn, per annum) and tracked electricity access investment in 2019



Note: The tracked investment numbers for "other Sub-Saharan Africa" (SSA) include estimates for Burkina Faso, Madagascar, Malawi, Mali, Niger, Sudan, Uganda and Zambia. The required investments numbers for "other Sub-Saharan Africa" include all SSA economies except South Africa. The "Rest of developing Asia" includes Bangladesh, Myanmar and Pakistan.

[29] For Figure 13, the country-level annual investments needed for African countries are based on the IEA's African Outlook from 2019 to 2030 to reach full access by 2030. The India and other estimates are based on annual investments needed to reach full access in IEA's Sustainable Development Scenario. The required investment estimates are only available for a few countries and not all the HICs.

2 PARIS ALIGNMENT OF ENERGY SECTOR INVESTMENT IN INDIA

In its 2020 analysis on misalignment with the Paris Agreement, Climate Policy Initiative (CPI) found that no major country or region is decarbonizing its power sector at the pace required to meet the Paris Agreement goals, with fossil fuel finance driving misalignment across a wide range of markets (CPI 2020). Among the HICs, this finding is represented most strongly in India where even as it forecasts a falling proportion of coal-fired generation, India's 2018 National Electricity Plan targets an increase in total coal-fired generation of 60 percent by 2030 (Montrone et. al 2020), in an attempt to increase the quality and reliability of electricity for its population.

CPI analysis indicates that of the power sector investment made by Indian state-owned enterprises in 2018, USD 0.9 billion was "extremely misaligned" with the Paris Agreement. Across SOE investments to India (USD 0.9 billion) and Southeast Asia (0.6 billion) that was assessed as "extremely misaligned", 77 percent went to high-carbon intensive coal projects. India has signaled its intention to further utilize its coal resources by auctioning off 67 coal mine blocks to the private sector as part of an effort to liberalize the coal mining industry.

Although India's 450GW renewable energy target paired with falling prices of renewable energy have resulted in a pivot away from coal overall, the sheer scale of India's coal industry has led it to remain home to the largest coal pipeline among HICs, with over 66GW under active development as of 2020. The state-owned enterprise Power Finance Corporation (PFC), India's largest lender to the power sector, grew its loan book for thermal assets by nearly USD 2 billion during the first three quarters of 2020 (IEEFA 2021).

Of finance tracked to India in 2019, USD 11.9 billion was committed to grid-connected renewables, while USD 2.9 billion was committed to grid-connected fossil fuels. Of the USD 2.9 billion, just under USD 2.4 billion went to coal-fired power, while approximately USD 500 million went to oil. Table 3 summarizes finance by sector in India across 2018 and 2019.

TABLE 3
Electricity Finance in India by Sector (USD mn)

Sector	2018	2019
Grid-connected renewables	10,136	11,870
Grid-connected fossil fuels	2,799	2,874
Transmission and distribution	440	2,009
Energy efficiency	228	705
Market support	128	23
Mini-grid and off-grid	85	13
Grand Total	**13,815**	**17,494**

A key contributor to the continued financing of coal in India is regional dependence on the coal industry for jobs and public revenues. This has in turn resulted in political pressure for public institutions to continue developing new coal infrastructure. For example, India's state-owned coal mining monopoly, Coal India, is the world's largest coal producer. Coal India employs over 272,000 people and provided USD 6 billion in revenue to the Indian Government in the 2018–2019 financial year. Further, coal transportation accounts for approximately half the total profits realized by Indian Railways, India's largest single employer (Brookings 2018).

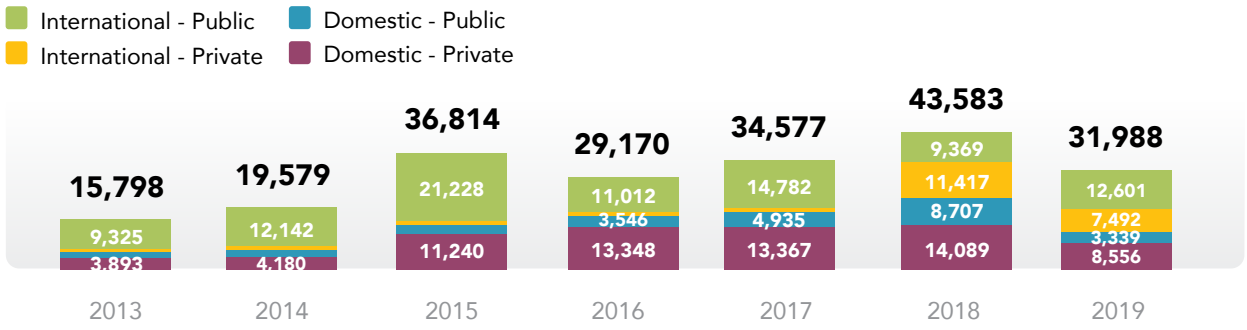
Until policy and economic conditions in India shift dramatically, a significant volume of finance to India's electricity sector will remain deeply misaligned with Paris Agreement ambitions. There is potentional that conditions will shift given the dramatic increase in finance for grid-connected renewables over the last five years. Pursuing a "Just Transition" or "People-centred Clean Energy Transition" is therefore crucial to create both short-term and long-term strategies to reduce the impacts of job losses in the fossil fuel sector and fortify cross-sector support for clean energy.

SOURCES

Domestic finance from both public and private sources represented 37 percent of all finance tracked in 2019, a total of USD 11.9 billion (Figure 14). International finance represented the remaining 63 percent at USD 20.1 billion. Domestic finance declined approximately 50 percent from USD 22.8 billion in 2018.[30] This decline is largely attributable to a handful of large projects financed in 2018 — including two commitments of over USD 1 billion — suggesting that the trend may be temporary.[31] More details on changes in sources of finance from 2013 to 2019 are illustrated in Figure 15.

Corporates, including project developers, remained the most significant source of finance for the electricity sector in HICs in 2019, while committed finance from multilateral and bilateral DFIs combined increased by 7 percent from 2018 levels to USD 7.4 billion in 2019. The distribution of finance from multilateral and bilateral DFIs shifted moderately between the two years, with an increase in finance for energy efficiency, market support and grid-connected fossil fuels in 2019, while that for grid-connected renewables declined from USD 2.3 billion in 2018 to USD 1.7 billion in 2019. Only four DFIs committed finance to grid-connected coal power projects in 2019: Japan International Cooperation Agency, China Development Bank, Islamic Development Bank, and OPEC Fund for International Development.

FIGURE 14
International vs. Domestic Sources of Finance for Electricity Across HICs, 2013–2019 (USD mn)



Note: The figure excludes a few categories like households, national DFIs and unspecified reporting of small investments.

[30] Domestic public finance captures export promotion agencies, national government budgets, national banks and national DFIs.
[31] Data tracking for domestic public finance, such as spending through national public budgets, transfers from national government to local government, and infrastructure investment in state-owned enterprises, remains largely limited. Collecting such information is challenging due to a lack of consistent methodologies and guidelines across countries, difficulty in distinguishing between different budget items (operational and investment), and in many cases insufficient institutional capacity within national governments and their agencies.

INSTRUMENTS

Proportions of committed finance by financial instrument remained relatively stable in 2019 compared to 2018, with project debt moderately increasing while corporate finance and project equity declined. Grants, which have stagnated below USD 1 billion over the last three years , remained stable at USD 635 million in 2019; these were provided mainly by bilateral donor governments (66 percent), DFIs (28 percent), and philanthropic foundations (5 percent). Grants are valuable to fund risky early-stage project development activities and to bridge affordability and project viability gaps.

Every sector other than that for mini-grid and off-grid solutions saw finance committed primarily in the form of project and corporate debt (Figure 17). The proportion of debt by sector ranged from energy efficiency (94 percent of total finance) to grid-connected renewables (64 percent of total finance). The mini-grid and off-grid sector saw the highest proportion of grant commitments, at 37 percent of total finance committed to the sector. Grid-connected renewables were financed 34 percent through equity contributions (combined corporate and project equity) compared to grid-connected fossil fuels at 19 percent.

FIGURE 15
Detailed Sources of Finance for Electricity Across HICs, 2013–2019 (USD mn)

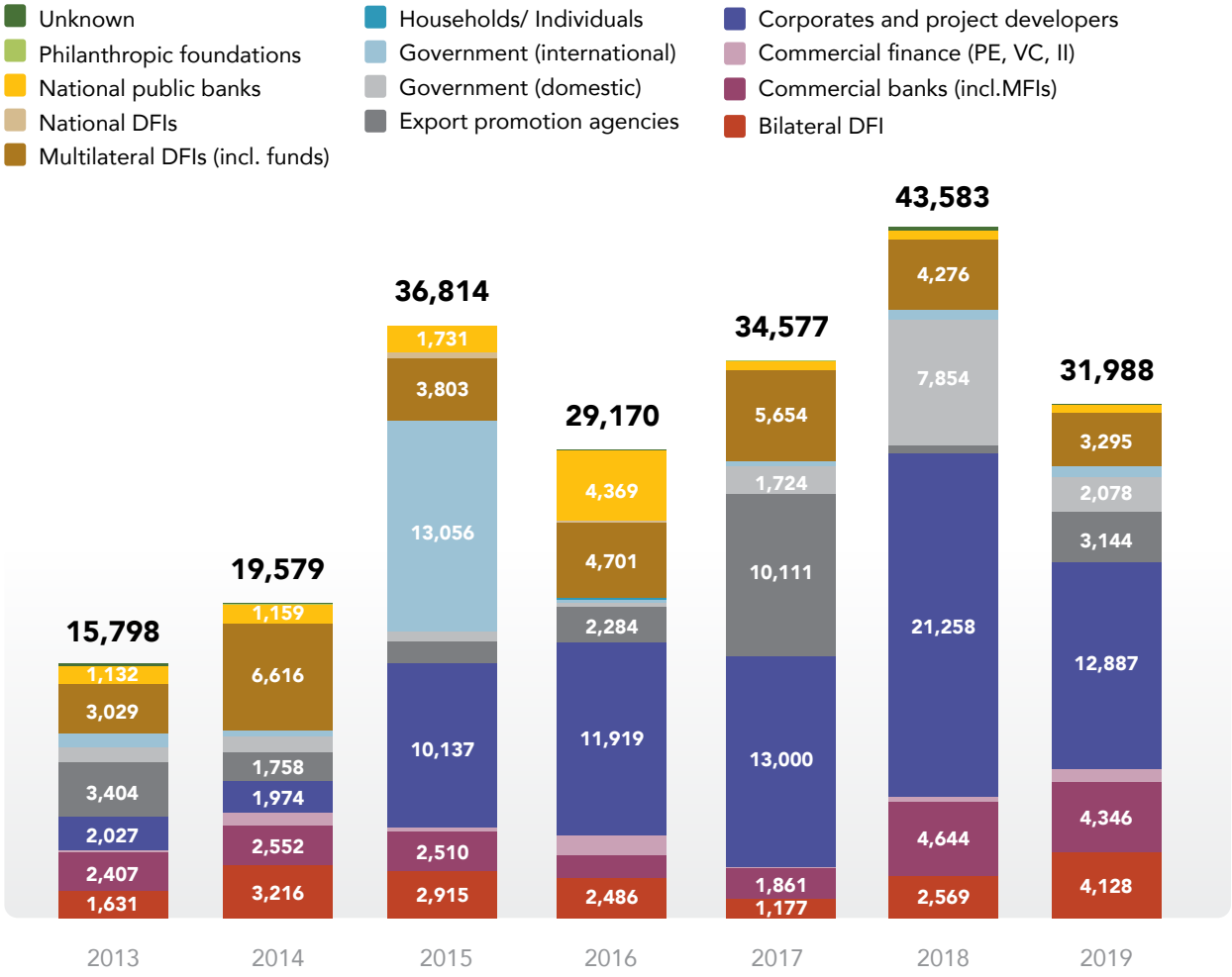
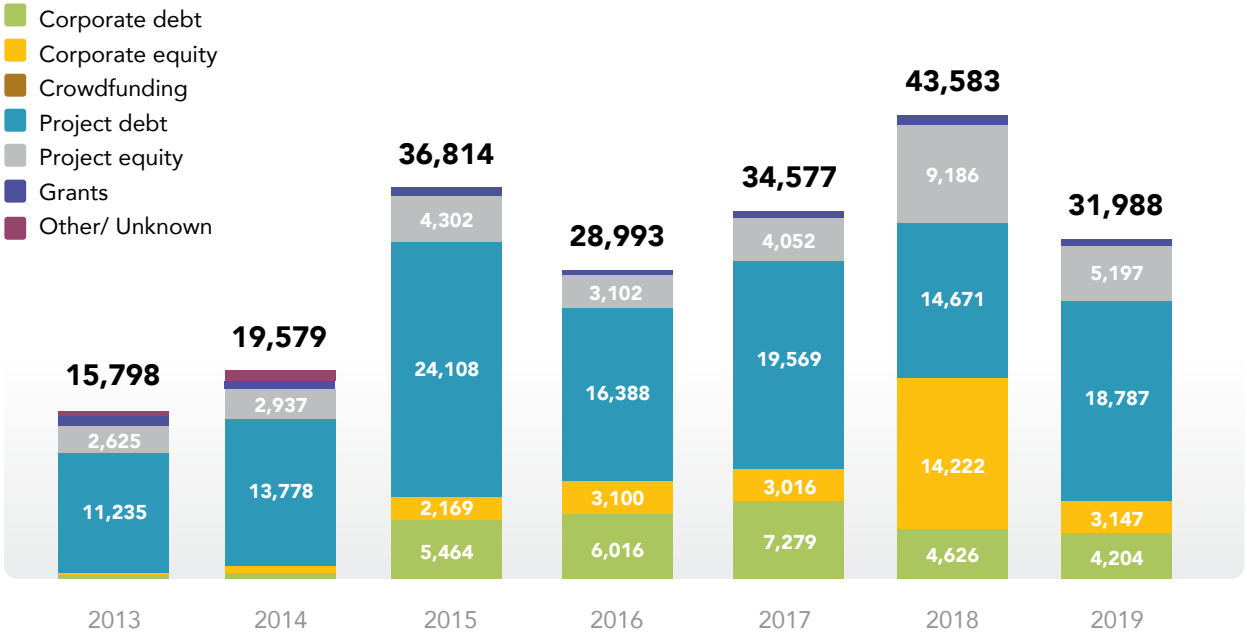


FIGURE 16
Finance to Electricity by Instrument Type, 2013–2019 (USD mn)



USES

As in the analysis for previous years, to assess the share of finance committed to residential users, this report applies relative shares of power consumption in the HICs to the total finance tracked for electricity in those countries.[32] In 2019, USD 12.9 billion was allocated to residential electricity access across the HICs for grid-connected and decentralized solutions. Commercial and industrial entities are estimated to have received USD 12.7 billion of electricity finance commitments in the HICs, while an additional USD 6.45 billion financed other largely public economic activities, for example schools and public hospitals.

Finance commitments to increase access to residential electricity consumers were also allocated to tiers per the World Bank's Multi-Tier Framework (MTF), which assesses levels of household electricity access based on the technology and, for tiers 3–5, reliability of each HIC's grid. As was the case in 2018, most finance for residential electricity in 2019 was for tier 4 access (USD 6.1 billion), while USD 4.9 billion was committed to tier 3. Tier 5, which requires electricity access for at least 23 hours a day with three or fewer disruptions per week, received the third most finance, USD 1.7 billion in 2019, a decline from USD 2.8 billion in 2018. Tiers 3, 4 and 5 are most frequently associated with a connection to a central grid or mini-grid, but grid connections often do not reach remote, rural populations.

The very low proportion of finance committed to energy access tiers 1 and 2 reflects the relatively limited pool of finance committed towards the off-grid sector, which predominantly delivers access at those tiers. These early access tiers are critical to targeting low-income and rural populations and launching a process towards higher tiers of energy access, so the low volumes of investment targeting tiers 1 and 2 is troubling. As indicated by the sectoral analysis above, a step-change in finance to low-income and rural populations, including through decentralized electricity solutions, is critical to achieve SDG7.

[32] See Methodology section for details.

FIGURE 17
Finance to Electricity by Sector and Instrument Type, 2019 (%)

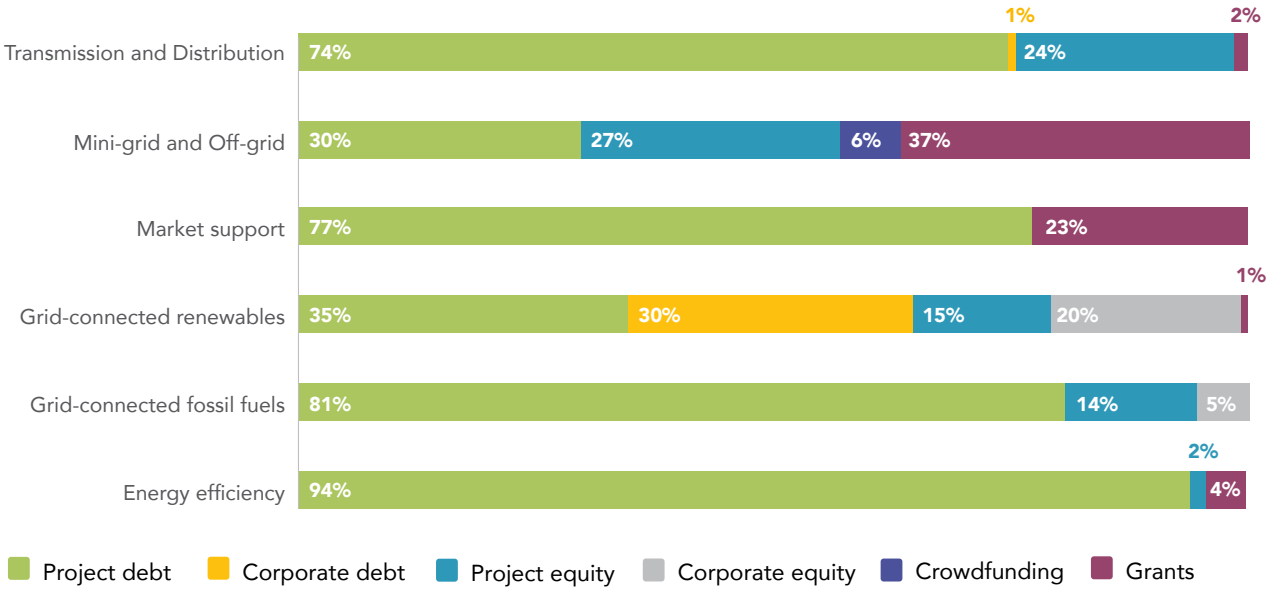
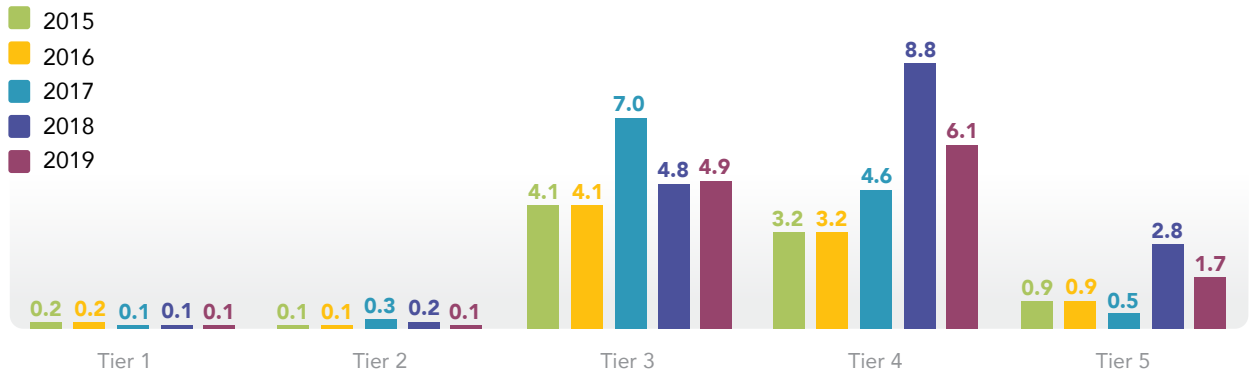


FIGURE 18
Finance Commitments by Energy Access Tier, 2015-2019 (USD bn)



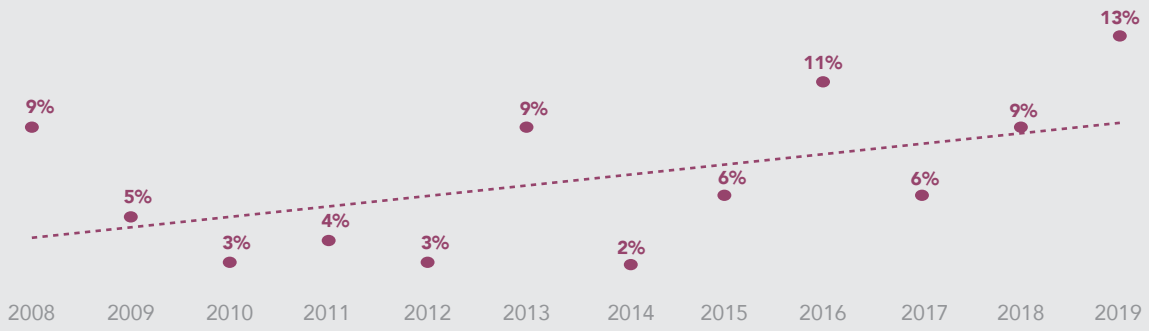
3 FINANCE FOR ENERGY PROJECTS WITH A GENDER EQUALITY OBJECTIVE

The *Energizing Finance: Understanding the Landscape 2019* report assessed public sector finance for energy projects targeting women and girls and discussed strategies to reduce gender inequality in and through the energy sector. In follow-up, the *Energizing Finance: Understanding the Landscape 2020* report updated figures and proposed a framework for donor countries to improve the accuracy and consistency of reporting finance for energy projects with a gender equality objective. Since the release of the 2020 report, there have not been significant methodological advancements in tracking finance with a gender equality objective in the energy sector, hence new analysis of such finance in this year's report is necessarily limited. The recommendations outlined in the 2020 report hold true – that to enhance tracking of finance to energy access projects with a gender equality objective, projects, through their design and documentation, should meet the following criteria:

1. Set out the context of gender inequality in the sub-sector and region where the project will be implemented, referencing the types of inequalities listed.
2. Establish and state the project's intent to address the identified gender inequality in each element of the project cycle – from planning to implementation to monitoring/reporting.
3. Demonstrate a direct link or outcome between the identified gender inequality context and the financed activities.

The most comprehensive data on development finance targeting projects with a gender equality objective remain the Organisation for Economic Co-operation and Development (OECD) data on development finance. The OECD's Development Assistance Committee (DAC) gender marker follows a three-point scoring system to mark project flows as "Principal",[33] "Significant"[34] and "Not Targeted"[35] to gender equality aims. Development finance in the energy sector with a Principal or Significant gender equality marker reached an all-time high in 2019 at 13 percent of total development finance for energy projects. However, this remains well below the average proportion across all development finance (25 percent in 2019) and represents slow progress towards increased integration of gender equality elements into energy sector projects.

FIGURE 19
Energy Sector Development Finance with Gender Equality Objective (% of Total)



[33] Projects that are marked "Principal" are scored 2, where gender equality is the main objective of the project and is fundamental in its design.
[34] Projects that are marked "Significant" are scored 1, where gender equality is an important and deliberate objective but not the principal reason for undertaking the project.
[35] Projects that are marked as "Not Targeted" are scored 0, where the project has been screened and has been found not to target gender equality.

Photo by SNV

CHAPTER

3

CLIMATE-RESILIENT INVESTMENT IN ELECTRICITY IN MOZAMBIQUE

CASE STUDY CONTEXT

This case study assesses existing and potential climate resilience of finance commitments to the electricity sector in Mozambique and offers recommendations to increase resilience. Electricity infrastructure assets across the globe are increasingly at risk from climate change impacts – with severe implications for sustainable energy access for all. Electricity sector infrastructure, generation and supply are highly vulnerable to projected changes in the climate including increased frequency and severity of floods, droughts and storms. Alongside the negative impacts on economic development, a lack of electricity access has a significant effect on vulnerability to climate risks. For example, lack of access is a significant bottleneck for rural agriculture production because farmers must travel long distances to processing facilities in extreme temperatures, which may have a negative impact on health and incomes (Energypedia 2021). Moreover, a lack of energy security may lead to food insecurity if industrial energy needs, such as for food processing plants, are not met.

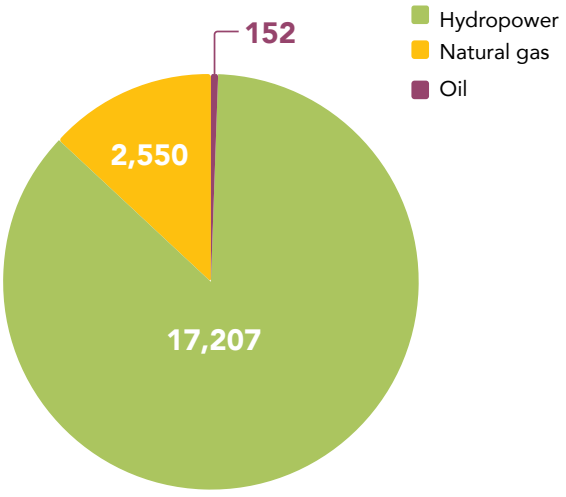
To address Mozambique's energy sector risks, there is a substantial opportunity to invest in resilient energy infrastructure; according to the Global Commission on Adaptation the benefits of climate proofing existing infrastructure and building new infrastructure outweigh the costs by 4:1. The World Bank estimates that if actions needed for resilience are delayed by 10 years, the cost will double (IEA). Numerous activities in the energy sector can contribute to climate resilience and the International Energy Agency (IEA) categorizes these activities across three "R's": robustness, resourcefulness and recovery:

- *Robustness* activities increase the capacity of an energy system to withstand chronic changes to the climate and could include building to increased cooling requirements.
- *Resourcefulness* captures the ability of a system to continue operating during immediate climate shocks and could include construction of drainage systems to handle higher frequency and severity of floods.
- *Recovery* describes the capacity to restore system functionality following an event and could capture activities like development of back-up generation and storage.

COUNTRY CONTEXT: CLIMATE-RELATED RISKS FACING MOZAMBIQUE'S ELECTRICITY SECTOR

Mozambique is among the 30 most climate-vulnerable countries per ND-GAIN[36] given its relatively high climate exposure and sensitivity[37] and low capacity to adapt to the negative effects of climate change. Hydropower, which accounts for 86 percent of total electricity generated in Mozambique (IEA 2018), is expected to be severely affected by the likelihood of longer droughts. The increased frequency and severity of climate-related disasters such as floods and cyclones also put the transmission and distribution (T&D) system in Mozambique at significant risk (World Bank 2021).

FIGURE 20
Mozambique Energy Generation Mix in GWh (2018)



Source: IEA

[36] The ND-GAIN Country Index assesses a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience.
[37] ND-GAIN defines exposure as the degree to which a country is exposed to biophysical climate risks and defines sensitivity as the extent to which a country is dependent upon a sector in the economy that is susceptible to climate risks or where a high proportion of the population is susceptible to a biophysical climate risk.

Electricity generation in Mozambique faces two major climate risks: a volatile precipitation regime and evapotranspiration.[38] Given these risks, the country's hydropower generation capacity is expected to decline, with regional studies estimating an output decline of 10 to 20 percent between 2011 and 2070 from major Zambezi hydropower plants (Uamusse et al 2020). Changing precipitation regimes may also lead to flooding, damaging hydropower infrastructure built without climate resilient features such as the capacity to manage and discharge excess water flows (Uamusse et al 2020). Across Africa, between 2015 - 2050, climate-related declines in water flows could cause a 60 percent drop in hydropower generation revenues and yield a three-fold increase in energy prices (GCA 2019).[39]

Extreme weather events also pose a significant risk to T&D in Mozambique where a single hydropower plant — the Cahora Bassa dam — contributes more than 50 percent of the country's power supply via a single high voltage power transmission line. In 2015, floods swept away the T&D lines from Cahora Bassa, and Mozambique's national energy utility could not access affected areas for extended periods – causing communities to lose access to electricity for a month (PPCR).

STATUS OF ELECTRICITY ACCESS AND ELECTRICITY SECTOR FINANCE IN MOZAMBIQUE

ELECTRICITY ACCESS

Mozambique's climate-related risks are compounded by existing electricity access challenges. Access to electricity has been gradually improving: in 2019, 35 percent of the population had access to electricity compared to 17 percent in 2010 (IEA 2019). However, there are still approximately 20 million people living without electricity, 85 percent of whom live in rural areas (Uamusse et al. 2020). The existing grid covers all of the country's 154 administrative districts, but most households are still not connected to it (SEforALL 2019). Grid expansion alone is not expected to achieve Mozambique's target of universal electrification by 2030, set in 2018 (Taking the Pulse Report 2021). Under this target, electricity supplied through the national grid is expected to reach 70 percent of the population whereas off-grid solutions are expected to reach the remaining 30 percent (Ibid). Mini-grids currently account for about 1 percent of household electricity access while off-grid solar access accounts for 2 percent; this figure is expected to increase with more international actors entering the market (Ibid).

ELECTRICITY FINANCE

Sectors: An overwhelming majority of finance committed to Mozambique's electricity sector between 2013 and 2019 was to grid-connected fossil fuel power plants – around USD 1 billion each in 2018 and 2019. This compares to an annual average of USD 110 million in 2018 and 2019 for grid-connected renewable projects. Finance commitments to mini-grid and off-grid solutions averaged USD 41 million in 2018 and 2019. 2019 also saw record investment in T&D projects at USD 416 million, almost half of the total amount committed to grid-connected fossil fuel plants.

Sources: Corporates, project developers and multilateral and bilateral development finance institutions (DFIs) were by far the most significant sources of committed finance to the Mozambican electricity sector between 2013 and 2019. 2019 saw record finance commitments from bilateral and multilateral DFIs, and from international governments, at USD 547 million. While large projects dominated the electricity landscape in 2018 and 2019, there has been increased diversity in sources of finance for these projects.

Instruments: 2019 saw the greatest diversity in financial instruments employed in finance commitments to Mozambique since tracking began in 2013. While project debt dominated from 2013 to 2017 and corporate finance from a single mega project dominated 2018,[40] 2019 saw a more diverse array of debt, equity and grants. Because finance commitments tracked to Mozambique's electricity sector represent finance for a relatively small number of projects, the breakdown of instruments employed is best assessed over time to capture multi-year trends.

[38] **Precipitation regime:** Defined as the characteristics of seasonal distribution in rainfall in a particular geography. **Evapotranspiration:** Defined as the process by which moisture is transferred from the earth to the atmosphere by evaporation of water and transpiration from plants.
[39] The capacity to produce hydropower is dependent on both the available flow of water and the height from which it falls. A reduction in precipitation may lead to a lower flow of water in dams which translates to lower energy output. Revenues are used as a proxy for reduced energy output as they are closely correlated.
[40] The spike in balance sheet funding in 2018 is a result of a single mega project: the Tete Coal-Fired Power Plant (300MW) and Coal Mine. The financing will be used for the development of the 300MW Ncondezi coal-fired power plant and coal mine project in Tete, Mozambique (see Box 4).

FIGURE 21

Electricity Finance to Mozambique by Technology Type, 2013-2019 (USD mn)

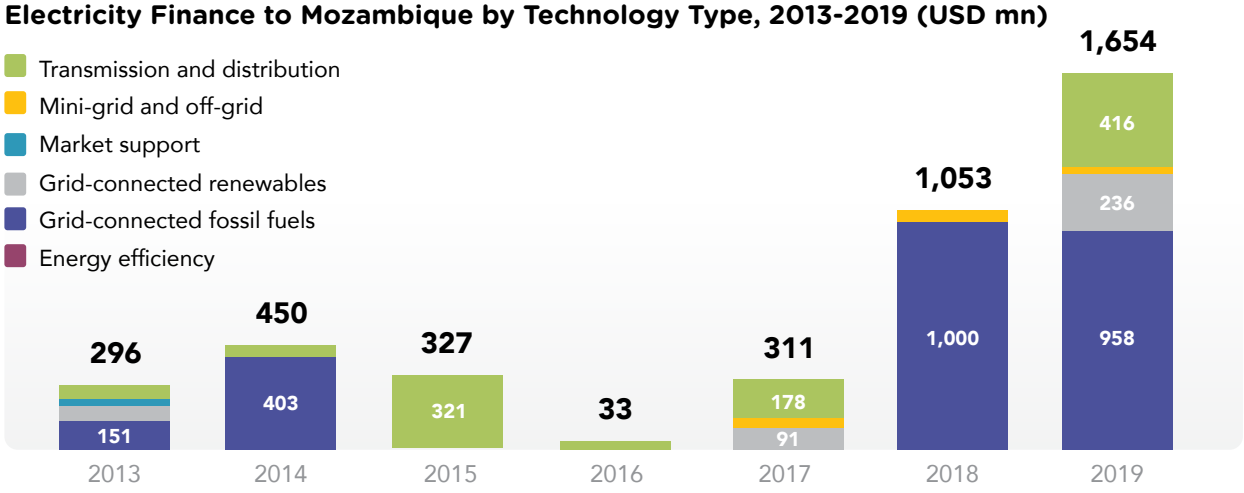


FIGURE 22

Electricity Finance to Mozambique by Finance Provider Type, 2013-2019 (USD mn)

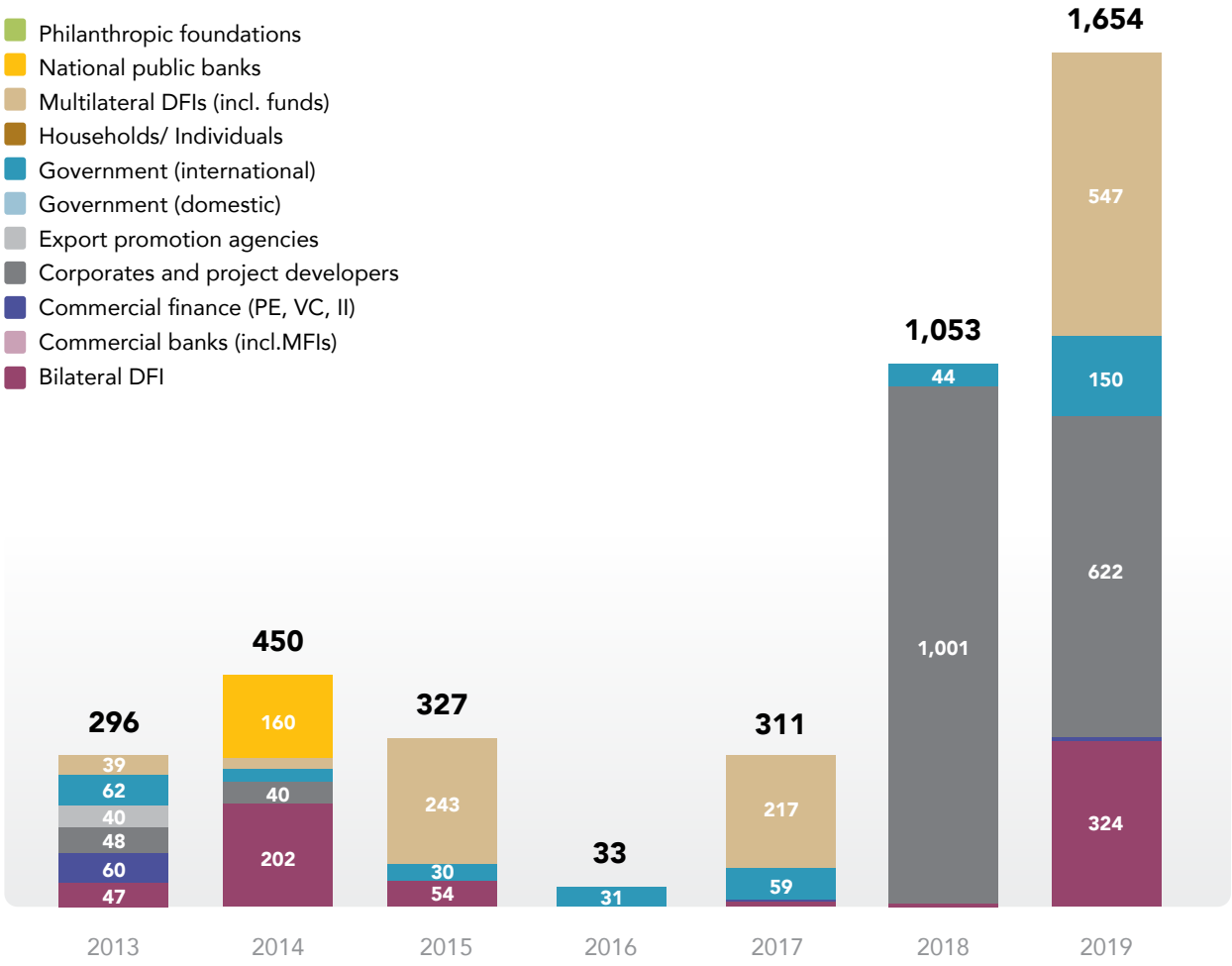
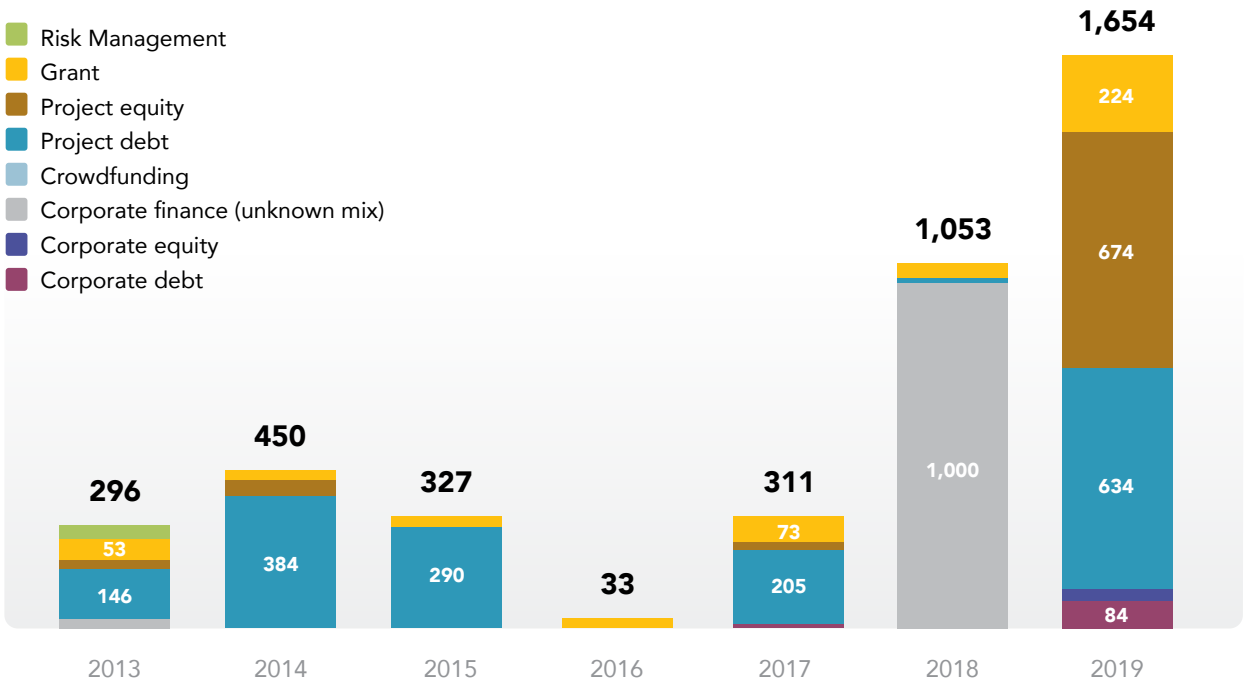


FIGURE 23
Electricity Finance to Mozambique by Instrument Type, 2013-2019 (USD mn)



Barriers to tracking the adaptation component of electricity finance: *Finance committed to projects with expected climate-adaptation outcomes is difficult to track given a variety of challenges. These include a lack of universally accepted impact metrics, data limitations, and definitional issues associated with boundaries between development finance and adaptation finance (CPI 2020). From the finance that was tracked and presented in this chapter, very little can be said about what constitutes adaptation finance versus development finance, as almost none of the finance tracked to electricity in Mozambique is reported as adaptation finance by financiers or project implementers.*[41]

4 KEY ACTORS IN MOZAMBIQUE'S ELECTRICITY SECTOR

Ncondezi Energy is one of Mozambique's largest domestic power companies and is currently developing a USD 1 billion project – the Tete Coal-Fired Power Plant (300MW) and Coal Mine. In its audited results for the 2019 fiscal year, Ncondezi listed climate as a potential investment risk. The company justified its project investment by framing the goal as improving Mozambique's energy security given the hydropower sector's vulnerability to climate-related risks (Ncondezi Energy Ltd 2020).

[41] Though climate finance in the power sector largely targets mitigation outcomes, projects can have adaptation outcomes that meet climate adaptation tracking criteria when an energy project has set out the context of climate-related risks the project seeks to address, states the project's intent to address those risks, and can sufficiently demonstrate a link between the identified risks and financed activities.

While coal-fired power plants may improve Mozambique's energy security,[42] there are economic and reputational risks involved with the underlying investments and a risk of both investors and project sponsors pulling out due to pressure by their respective shareholders (Coaltrans 2019). Integrating new coal generation to the existing grid infrastructure also presents significant technical challenges such as fragmentation, deterioration and lack of reliability (SEforALL 2021).[43]

Globeleq, a power utility company, under the ownership of shareholders CDC[44] (70 percent) and Norfund (30 percent), is committed to reducing climate risk in Mozambique and applies the IFC Performance Standards as the benchmark for environmental integration in all its projects (Globeleq 2021). In 2021, the company announced a 19MWp solar PV and 7MWh storage power project at Cuamba in northern Mozambique, bringing clean power and jobs to the region (CDC 2021).

Neoen, a French independent power producer, is developing the largest Solar PV project in Mozambique with a generation capacity of 41MW (PV 2020). The project is being developed under the PROLER initiative funded by the French Development Agency (AFD). PROLER aims to create a regulatory framework and auction mechanism for the development of large-scale renewable energy projects in Mozambique (PV 2020).

SCALE OF FINANCE NECESSARY TO EXPAND ELECTRICITY GENERATION CAPACITY AND ACCESS

Electricity demand is rising in Mozambique as a result of both industrial and residential demand, while affordability gaps persist. Electricity demand in Mozambique is expected to increase by 5 to 7 percent per year until 2070, a consequence of a rapidly growing population and greater wealth generated from the mining and manufacturing industries (Uamusse et al. 2020). Access to electricity for households and industry will be an important enabler for economic growth, to reduce poverty and build climate resilience. However, in the near-term electricity demand is expected to be driven mainly by industry as the residential affordability gap (USD 500 million) persists despite subsidized tariffs (Taking the Pulse 2021 and International Trade Administration 2021).

The Government of Mozambique has developed an ambitious electricity infrastructure master plan but mobilization of investment across capital providers has been slow. In October 2018, the Mozambican government approved the Integrated Master Plan for electricity infrastructure for the period 2018–2043. The Master Plan, costing USD 34 billion, will seek to diversify the national grid to accommodate a range of renewable and traditional sources of energy (USD 16 billion), and T&D (USD 18 billion). A rise in installed generation capacity from the current 2.7 GW to 17.7 GW is expected as Mozambique's electricity demand reaches approximately 8 GW, ten times more than current levels, by 2042. Moreover, the plan envisages electricity exports to other Sub-Saharan Africa countries, which may lead to more public resources to invest in and de-risk climate-resilient energy infrastructure, such as off-grid solutions (JICA 2018).

[42] Mozambique has significant coal reserves, ranking nine out of the 49 active coal-producing countries globally (Coaltrans 2019).
[43] **Fragmentation:** Grid networks with limited interconnection between regions. **Deterioration:** Grid networks that have not been sufficiently maintained, and therefore cannot operate at full capacity. **Lack of reliability:** frequent outages due to several issues that may or may not be systemic, such as system operator shortfalls and slow repair times.
[44] CDC is a public limited company owned by the UK's Department for Industrial Development.

RECOMMENDATIONS

As climate-related shocks and stressors increase in frequency and severity in Mozambique, investment is needed both to ensure the electricity sector itself is resilient to climate impacts and to scale up electricity access to build climate resilience, so that Mozambique's population can more effectively cope with climate-related risks. To achieve both aims simultaneously, action can be taken on several fronts:

Diversifying power generation sources and strengthening infrastructure is critical to ensure the electricity sector's climate resilience. The following actions are recommended:

- **Diversify power generation sources and transition from fossil fuels:** Hydropower generation capacity is expected to diminish in Mozambique due to issues of evapotranspiration and variability in precipitation. The reduction in generation capacity represents lost revenue to Mozambique as much of the electricity produced is exported to neighbouring countries through regional interconnectors. Expanding generation capacity by diversifying sources of electricity with more climate-resilient technologies such as solar is crucial to the country's economic well-being.[45] It will also be crucial to simultaneously invest in energy storage capacity to address the intermittency of renewable energy generation, as Mozambique transitions its electricity sector. Investing in energy efficiency and storage is also important as hydropower is geographically fixed due to specific conditions of water flow and terrain and the electricity produced must travel long distances.

- **Increase investment in climate-resilient T&D infrastructure to secure operations during climate shocks:** Because approximately 50 percent of the electricity in Mozambique is carried through one transmission cable, a single climate-related shock can have devastating operational effects. In some cases, underground distribution cables may significantly increase the central grid's resilience to the impacts of climate change, such as cyclones or floods.[46] For pre-existing T&D infrastructure, climate-proofing strategies such as higher design standards for distribution poles, effective cooling systems for substations and transformers, and robust operational and maintenance procedures would also help (ADB 2013).

- **Ensure that electricity infrastructure planning includes analysis of climate-related risks over appropriate timeframes:** Hydropower plants are usually planned on 100-year time horizons, which means that hydrologic regimes should be evaluated for at least this period as power generation depends on predictable rainfall. Currently, climate effects are rarely included in hydropower feasibility studies, which may result in policy decisions misaligned with future climate conditions.

Increased investment in electricity access is critical to build societal resilience to climate-related risks To that end, Mozambique should:

- **Increase investment in off-grid and mini-grid solutions to create a more robust electricity system, address the affordability gap, and build resilience:** The mini-grid and off-grid electricity sector can build climate resilience through both the sector's resilience to climate-related risks and through increased electricity access made possible by the sector. Decentralized electricity solutions are often more resilient to climate-related shocks than centralized generation because they can separate from the larger network and self-start to maintain power supply without waiting for

[45] Solar power is less sensitive to changes in the climate in Mozambique as the country's access to solar radiation is not projected to be negatively affected by climate change.

the grid to be restored. Decentralized solutions are also critical to expanding electricity access in Mozambique, where it is not cost-effective to provide electricity to most rural villages through the national grid and where access to electricity is critical to building climate resilience, for example through access to cooling and climate hazard information.

- **Develop a clear regulatory framework for greater private sector investment:** Mozambique's current legal framework is negatively impacting the uptake of mini-grids. Since 2018, USAID has been assisting the government to revise the national electricity law to be more conducive to private sector participation. The revision focuses on providing adequate legal guarantees for private investors as well as simplified authorization procedures for mini-grid projects (UNDP 2020). A recent positive development to this end is that the government in early September 2021 approved a new regulatory framework for the off-grid energy sector which will seek to ensure conditions are met for the private sector in Mozambique to invest in off-grid solar home systems and mini-grids (SNV 2021). Aside from the quality of the regulatory framework, bankable and innovative business models are needed to mobilize private sector investment in various climate resilient electricity solutions.

- **Leverage its maturing energy institutional framework to crowd in private investment:** The recent creation of a sector regulator (ARENE) in 2018, the progressive phasing-out of tariff subsidies, relevant reforms within the national power utility (EDM), including the separation between distribution and generation activities, as well as significant financial support from donors in the off-grid sector are all positive indicators (AFDB 2020). Moreover, Mozambique's National Climate Change Adaptation and Mitigation Strategy (NCCAMS) for 2013–2025, a landmark document adopted in 2012, defines adaptation to climate change as a national priority. It emphasizes the promotion of access to, and the efficient use, of energy and the use of more renewable energy sources.

- **Prioritize catalytic grants, technical assistance, and implementation support by DFIs:** Due to a lack of domestic capacity to finance climate-resilient electricity solutions, catalytic grants, technical assistance, and project preparation support from DFIs is crucial to improve electricity-sector resilience in Mozambique. The involvement of DFIs should be based on alignment with national priorities and stakeholder engagement that emphasizes local participation, capacity building and technology transfer. Catalytic grants and technical assistance can be particularly critical in supporting climate data collection and analysis and in building technical capacity for climate risk assessment to support further climate adaptation funding.

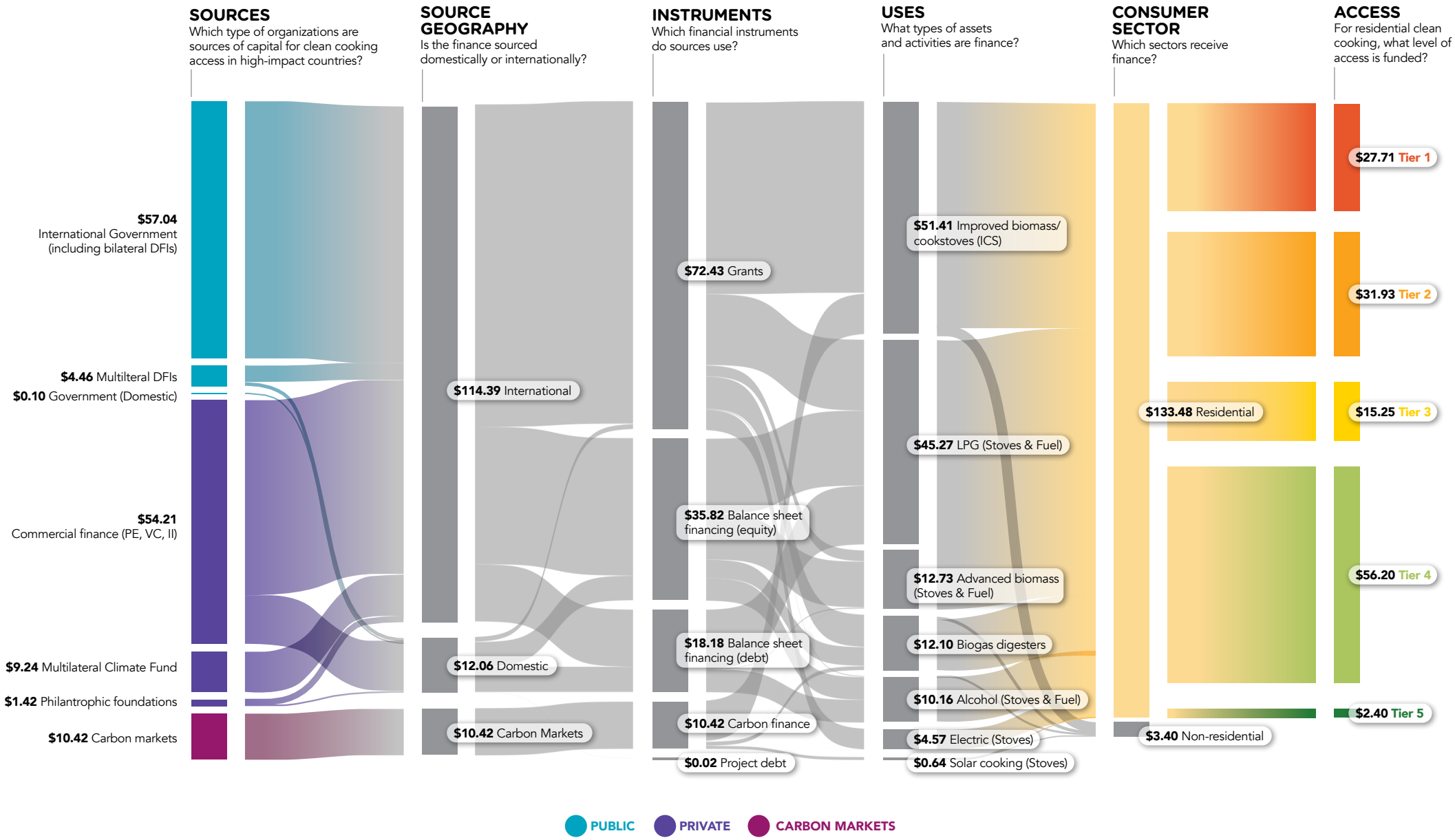
Photo by Clean Cooking

CHAPTER

4

FINANCE FOR CLEAN COOKING

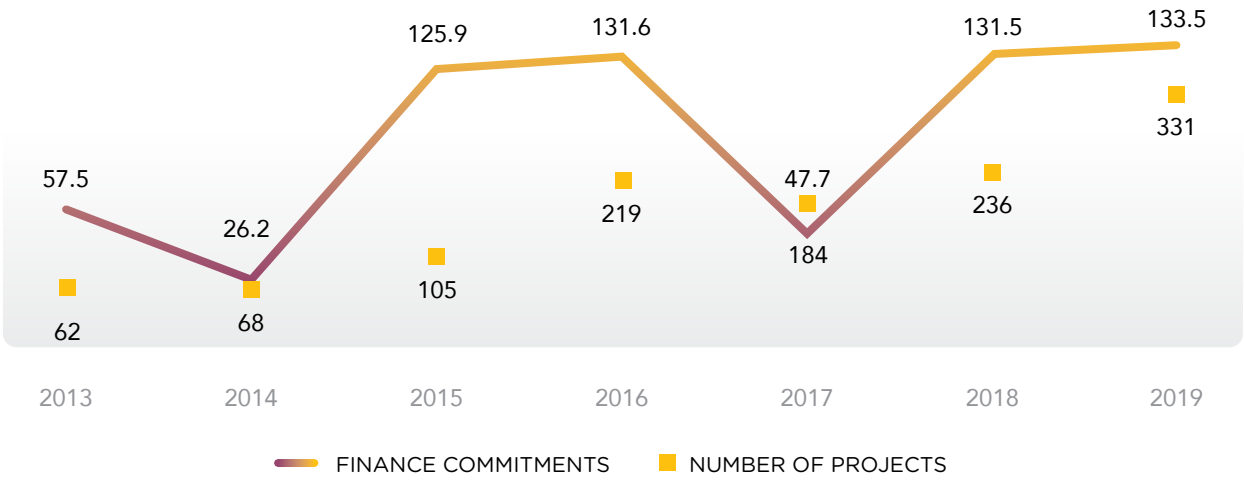
TRACKED FINANCE FOR CLEAN COOKING IN HICs (USD, MN)



INTRODUCTION

Clean cooking finance commitments have stagnated over the last five years, falling critically short of the investment required to achieve universal clean cooking access by 2030. Commitments are still orders of magnitude below the estimated USD 4.5 billion,[48,49] (IEA et al. 2021) needed annually worldwide to achieve SDG 7.1.2, which calls for universal access to clean fuels and technology for cooking by 2030. Except in 2017, annual commitments stagnated at around USD 130 million between 2015 and 2019, driven by just a handful of large projects (Figure 24). However, unlike previous years, finance commitments in 2019 predominantly came from commercial financiers and bilateral donors rather than multilateral development finance institutions (DFIs). The total USD 133.5 million in committed finance reported in 2019 corresponds to residential clean cooking access, representing 97 percent of the total USD 137 million tracked for clean cooking solutions in 2019.[50] While the institutional clean cooking sector, such as in schools, hospitals, and prisons, is an important part of meeting SDG 7.1.2, it is not tracked in this analysis.

FIGURE 24
Total Commitments for Residential Clean Cooking in HICs, 2013–2019 (USD mn)



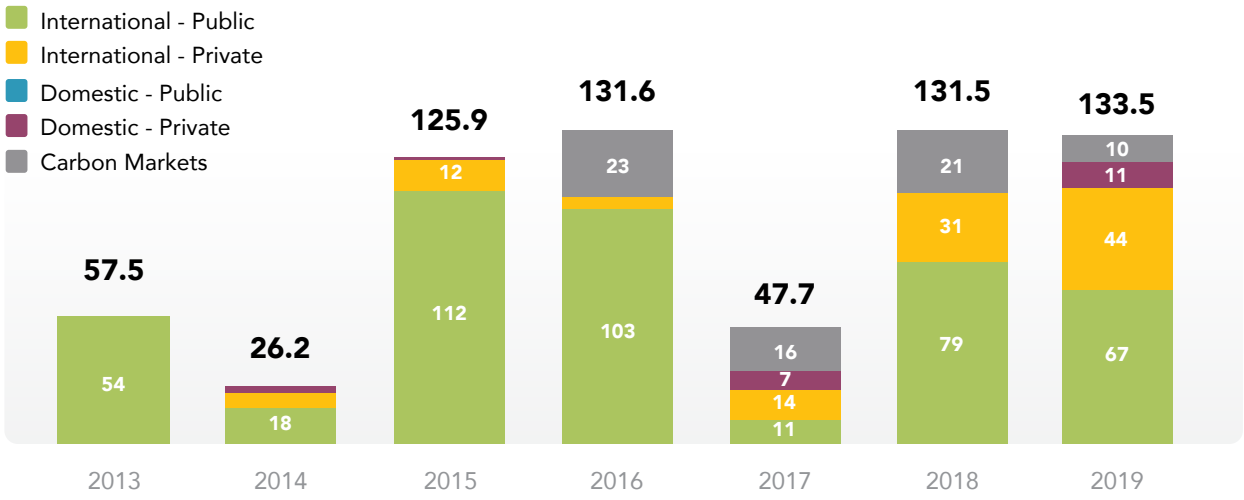
Note: Carbon finance estimates from the UNFCCC and Gold Standard are only included for 2016-2018 (see Methodology).

[48] Recent research by ESMAP and MECS indicates that an annual average of USD 9.8 billion would be needed to achieve an improved cooking scenario, which corresponds to achieving at least tier 2 access (ESMAP & MECS 2020). In contrast to the IEA-required investment numbers, the ESMAP-MECS figures also include public financiers' expenditure such as that for fuel subsidies, which is not tracked in the report.
[49] The IEA's Sustainable Development Scenario estimates that USD 4.5 billion is needed annually to achieve clean cooking access. The IEA's Net-Zero Scenario estimates USD 7 billion annually is necessary.
[50] The remainder is estimated to benefit non-residential sectors, such as the industrial and commercial sectors.

SOURCES OF FINANCE

In 2019, public finance commitments for the clean cooking sector only accounted for half of total commitments, down from 60 percent in 2018 (Figure 25). Finance commitments for clean cooking largely came from public sources between 2013 and 2016, while in 2017 private sources of capital (45 percent of the total) comprised the largest portion of overall finance commitments due to a significant dip in finance from DFIs. Similar patterns were observed in 2019, as finance commitments from DFIs decreased and they focused their funding on non-high-impact countries (HICs)[51]. As such, nearly half (49.5 percent) of total finance committed in 2019 came from private sources and in the form of carbon finance. This report has tracked carbon finance, a mechanism through which clean cooking project developers sell credits for verified emissions reductions (VERs), from 2016 onwards.

FIGURE 25
Clean Cooking Commitments in HICs by Source (2013–19, USD mn)



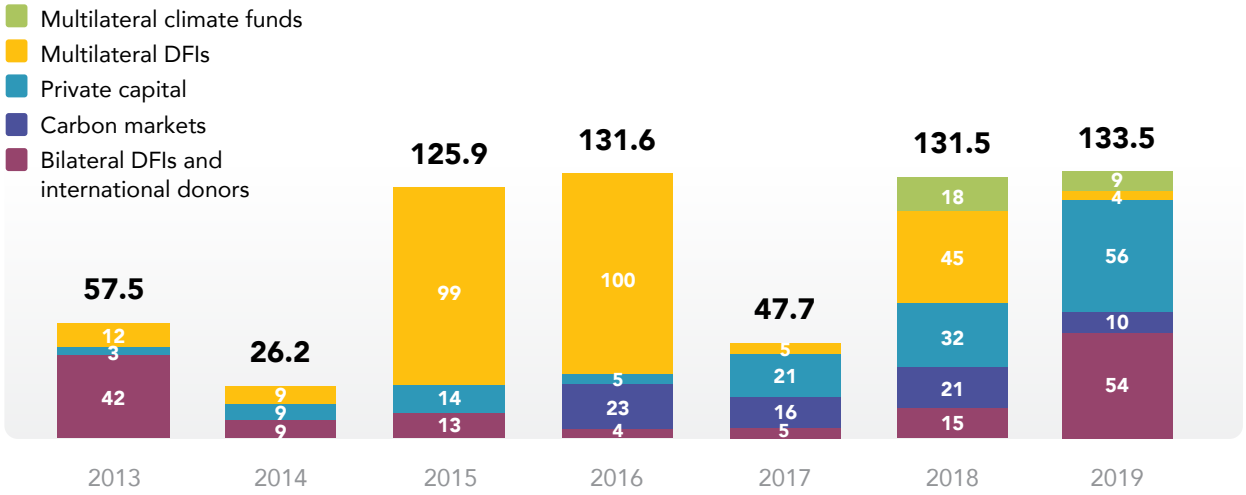
Note: Carbon finance estimates from the UNFCCC and Gold Standard are only included for 2016-19 numbers and were categorized separately from the private/public and domestic/international classifications.

No large-scale finance commitments from multilateral DFIs were tracked in 2019. Overall commitments by multilateral DFIs reached USD 4.5 million in 2019, down from USD 45 million in 2018, and accounted for only 7 percent of total public finance. The World Bank's Energy Sector Management Assistance (ESMAP) Clean Cooking Fund, announced in 2019 and operational in 2020, is expected to increase multilateral DFI clean cooking finance commitments in future years. Unlike the recent past, however, there were no large commitments from the World Bank or other multilateral DFIs in 2019. The largest multilateral DFI finance commitment identified in 2019 was a USD 2 million World Bank commitment to improved cookstove (ICS) distribution in Bangladesh. The remaining multilateral DFI commitments tracked were all well under USD 1 million per project and focused on a mix of ICS, liquefied petroleum gas (LPG) stoves and fuel, and advanced biomass stoves and fuel.

International governments, including bilateral DFIs, made 80 percent of all public finance commitments for clean cooking in 2019. Unlike previous years, there is a wider spread of finance committed across projects and HIC geographies, including 10 projects with over USD 1 million committed to each in Bangladesh, Ethiopia, Ghana, Kenya, Nigeria, Tanzania and Uganda. The two largest finance commitments by international governments, including bilateral DFIs, were over USD 12 million for LPG stoves and fuel in Bangladesh committed by the German Government and the Swedish International Development Cooperation. Much of the remaining finance committed was directed towards ICS across the HICs and provided by international governments, including bilateral DFIs.

[51] Outside the HICs, the World Bank also committed to projects in Burundi, Lao (PDR) and Mongolia.

FIGURE 26
Clean Cooking Commitments in HICs by Source and Financial institution, 2013–2019 (USD mn)



Note: Domestic government contributions are excluded from this graphic as the level of commitments tracked was lower than USD 1 million each year (see Appendix I). Bilateral DFIs and international donors includes bilateral DFIs and international donor governments; Private capital includes institutional investors, impact investors, venture capital and private equity, commercial banks (including multilateral finance institutions (MFIs), angel investors and entrepreneurs.

Private finance commitments almost doubled in 2019, comprising 42 percent (USD 56 million) of total commitments. A significant portion of these commitments came from commercial financiers, including institutional investors, impact investors, venture capital and private equity. Commitments from philanthropic foundations remained low at USD 1.4 million, similar to the USD 1.6 million committed in 2018. 83 percent (USD 45 million) of total private finance commitments in 2019 were directed to Kenya alone, primarily in LPG and ethanol stoves and fuel. Overall, in 2019 private finance was committed primarily to LPG stove and fuel markets, comprising 55 percent of total private finance commitments, followed by improved biomass stoves (19 precent), and ethanol stoves (18 percent). This is a slight change from 2018, when private finance commitments were directed mostly towards ethanol, biogas and LPG.

Estimated carbon market finance commitments decreased by 50 percent to USD 10 million in 2019, down from USD 21 million in 2018.[52] This decrease is due to fewer offsets purchased and a lower offset unit price (see Methodology for more details). The total estimated quantity of offsets decreased by 10 million, from 28 million to 18 million, while the estimated average offset price fell from USD 5 per unit in 2018 to USD 3.5 per unit in 2019 (Ecosystem Marketplace 2020a). There were, however, more unique, individual offset purchases in 2019 for projects in the HICs, but the overall volume was lower than in previous years.

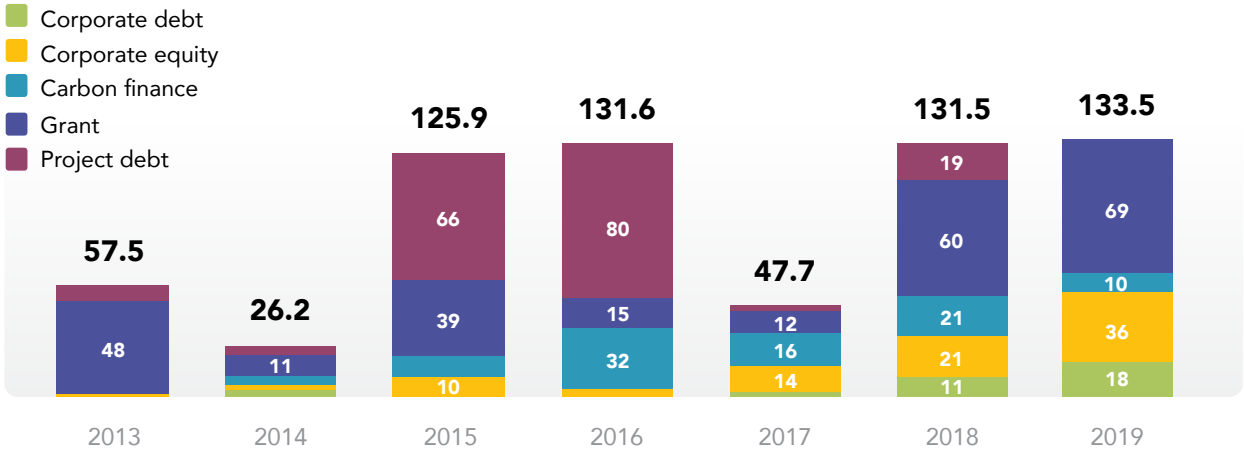
Clean cooking investment from domestic government entities continues to be underrepresented due to tracking limitations. Domestic governments' expenditure on clean cooking through national public budgets, and transfers from central government to national and central government, including subsidies to address consumer affordability gaps, are not included in this report's tracking methodology.[53] Other policy instruments not tracked in the report are levies, taxes and import duties, behavioural change campaigns, and high-level political commitments, which can have a significant impact on clean cooking access. The lack of transparency around domestic clean cooking solutions has led to difficulties in data collection and challenges with double counting.

[52] Due to the opacity of available data and complexity of carbon pricing, data include available voluntary market credits from the Gold Standard Impact Registry and mandatory market credits from the UNFCCC, verified against the data available on the Allied Offsets database, which collects and categorizes projects and credits traded under offset programmes.
[53] Revenue-support mechanisms such as subsidies are excluded to avoid double counting, as these tools are often used to pay back investment costs. The methodology tracks only primary investments in clean cooking technologies and fuels.

FINANCIAL INSTRUMENTS

Grants continued to play an important role in clean cooking finance commitments in 2019, reaching USD 69 million and accounting for 52 percent of total committed finance. In previous years, significant grant commitments were limited to a handful of projects. For example, in 2018, only five projects received finance commitments in the form of grants over USD 1 million and four of these were in Bangladesh and Kenya. In 2019, 12 projects across Bangladesh and six Sub-Saharan African countries each received over USD 1 million in grant commitments, which represents a slightly more equitable geographic distribution compared to previous years. A significant portion was committed by the governments of Norway and the Netherlands for ICS. Two of the largest grant commitments in Bangladesh, totalling USD 8 million, were directed to humanitarian assistance, and designated for LPG stove and fuel access at the refugee settlement in Cox's Bazar.

FIGURE 27
Clean Cooking Commitments in HICs by Financial Instrument, 2013–2019 (USD mn)



Note: Carbon finance estimates from the UNFCCC and Gold Standard are only included for 2016–19 numbers. Carbon finance figures recorded for 2014 and 2015 consist of World Bank carbon finance projects collected separately, while 2016 includes both World Bank and estimated carbon finance projects (which were checked for double counting).

Clean cookstove commitments through corporate debt and corporate equity instruments amounted to USD 54 million in 2019, a sizable increase from USD 32 million in 2018. USD 10 million was committed to Kenya in the form of corporate finance for ethanol stoves and fuel, which formed 99 percent of the total finance commitments for ethanol stoves across all HICs. An additional USD 30 million was committed for LPG stoves and fuel, and USD 4 million went to biogas digesters exclusively in India and Kenya.

Project debt finance decreased drastically to less than USD 1 million, limited to one advanced biomass stoves and fuel project in Bangladesh. In 2018, project debt finance commitments reached USD 18 million, although a single International Finance Corporation project comprised 90 percent of that amount. Project debt finance reached an unprecedented high of USD 80 million in 2016, but this was also limited to a single World Bank commitment for biogas digesters in China. Similarly, the bulk of project debt finance in 2013–2015 was earmarked for one or two large projects.

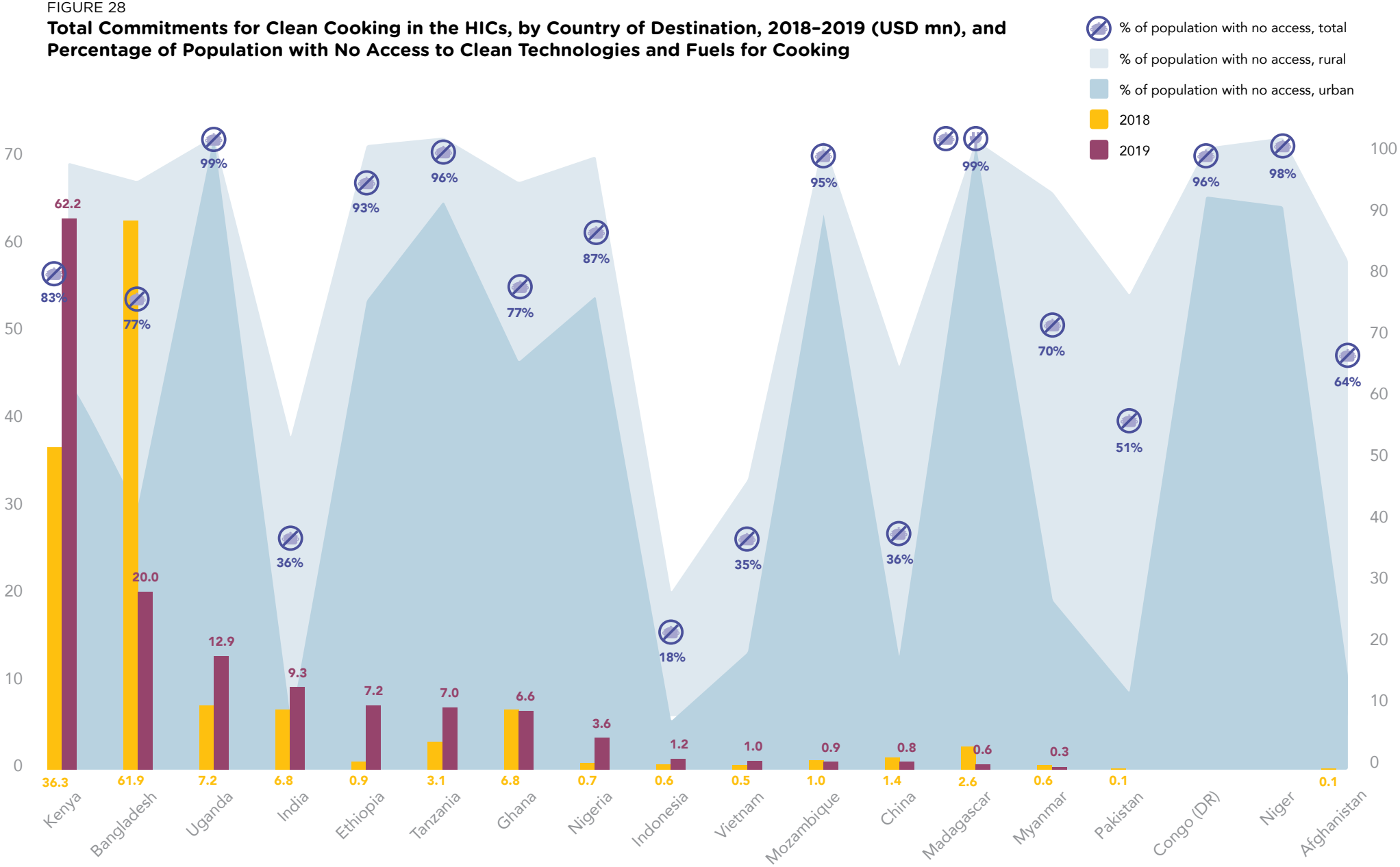
RECIPIENT COUNTRIES

Finance for clean cooking was committed slightly more evenly across HICs in 2019 than in 2018. Total finance commitments for clean cooking projects in Bangladesh and Kenya were 62 percent of all committed finance tracked in 2019, compared to 75 percent in 2018, as neither was the recipient of significant finance commitments from DFIs. Kenya received 47 percent of total 2019 commitments, with USD 62 million committed by commercial financiers – fund managers, private equity, and institutional investors – directed primarily to LPG and ethanol companies. Bangladesh received 15 percent (USD 20 million) of total finance commitments tracked in 2019, primarily for LPG stove and fuel solutions. Several other countries saw an increase in finance commitments, most notably Ethiopia, where commitments increased eight-fold compared to 2018, to over USD 7 million. This increase is due to both a single ICS project valued at over USD 5 million and an overall increase in the number of ICS and biogas projects. China, Madagascar and Mozambique all saw a decrease in committed finance from 2018 levels. As in previous years, many HICs such as Myanmar, Niger and Pakistan, each received well below USD 1 million in committed finance for clean cooking in 2019.

Since 2013, the three countries with the lowest total volumes of clean cooking finance commitments have been Afghanistan, Myanmar and Pakistan; these received USD 1 million combined over the seven years from 2013 to 2019. In contrast, the three countries with the highest volume of commitments — Bangladesh, China and Kenya — received USD 412 million combined over the same period, highlighting the drastic variations across the HICs. Most finance committed to these three countries went to large-scale, multilateral DFI-sponsored projects, which highlights the sector's reliance on this source of funding.

FIGURE 28

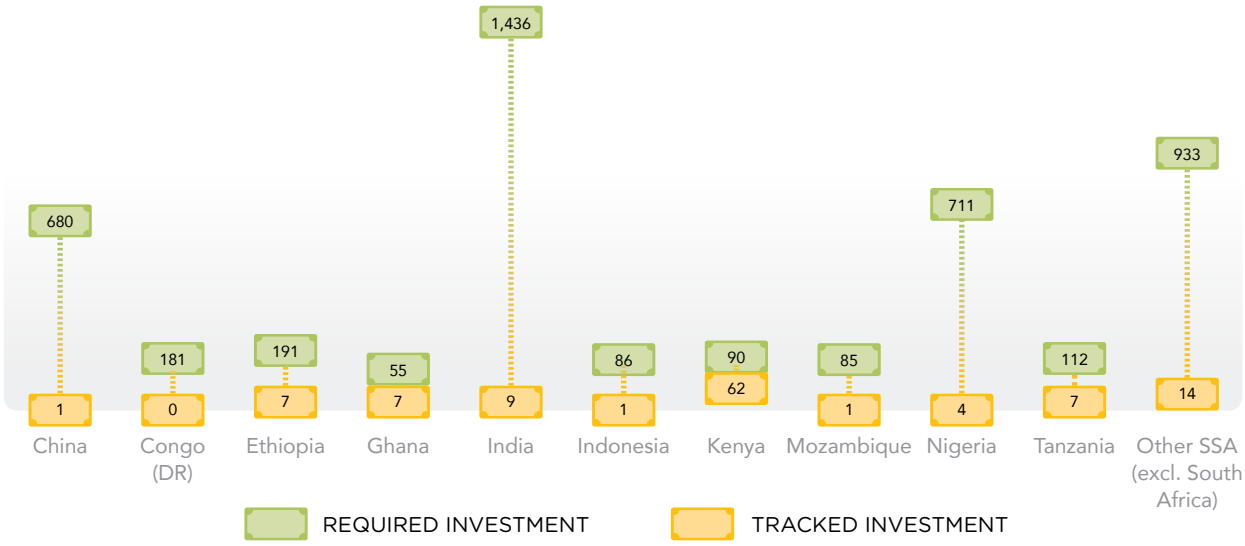
Total Commitments for Clean Cooking in the HICs, by Country of Destination, 2018–2019 (USD mn), and Percentage of Population with No Access to Clean Technologies and Fuels for Cooking



Note: North Korea and the Philippines are excluded from this graphic as no finance for clean cooking was recorded in 2018. Carbon finance estimates from the UNFCCC and Gold Standard are only included for 2016–18 numbers.

Sub-Saharan Africa continued to attract significantly less finance than required to achieve universal clean cooking access by 2030. Congo (DR), Madagascar and Mozambique all received minimal finance commitments in 2019, despite 95 percent or more of their populations living without clean cooking access. The International Energy Agency (IEA) has estimated that Mozambique requires USD 85 million annually to realize universal access to clean fuels and technologies for cooking by 2030 as set by SDG 7.1.2 (IEA et al. 2020). This lack of even minimal finance commitments compounds the lack of clean cooking access and the continued finance needs, year on year, with resultant negative impacts on gender inequality, health and the climate.[54]

FIGURE 29
Total Commitments for Clean Cooking in HICs Compared to Investment Needs, 2019 (USD mn)



Niger counts 98 percent of its population as lacking access to clean cooking fuels and technology and was added to the list of HICs in 2019. No public or private finance commitments for clean cooking were recorded in Niger in 2019.

Access to clean cooking fuels and technology increased most prominently in India and Kenya. India, which has already achieved 90 percent access in urban areas, continued to expand its efforts among rural populations, raising rural access from 28 percent to 48 percent[55]. The estimated finance associated with this increase is not reflected in this report, as the available data is unable to capture domestic government spending on clean cooking. There are significant domestic government programmes in place in both countries, particularly to encourage the increased use of LPG for cooking. The Kenyan government included clean cooking as a policy priority and has improved access in urban areas from 24 percent to 38 percent. However, clean cooking access in rural communities in Kenya remains low at 5 percent, despite finance increasing in the last two years. Indonesia continues to benefit from its 2007 government-led programme promoting LPG, as total clean cooking access in both rural and urban areas remains comparatively high at 82 percent.

[54] Required investment data sourced from IEA reports.
[55] 2019 Clean cooking access according to the World Health Organization, 2020, aligned with MTF tier 4 and above. For further details, see WHO, 2016.

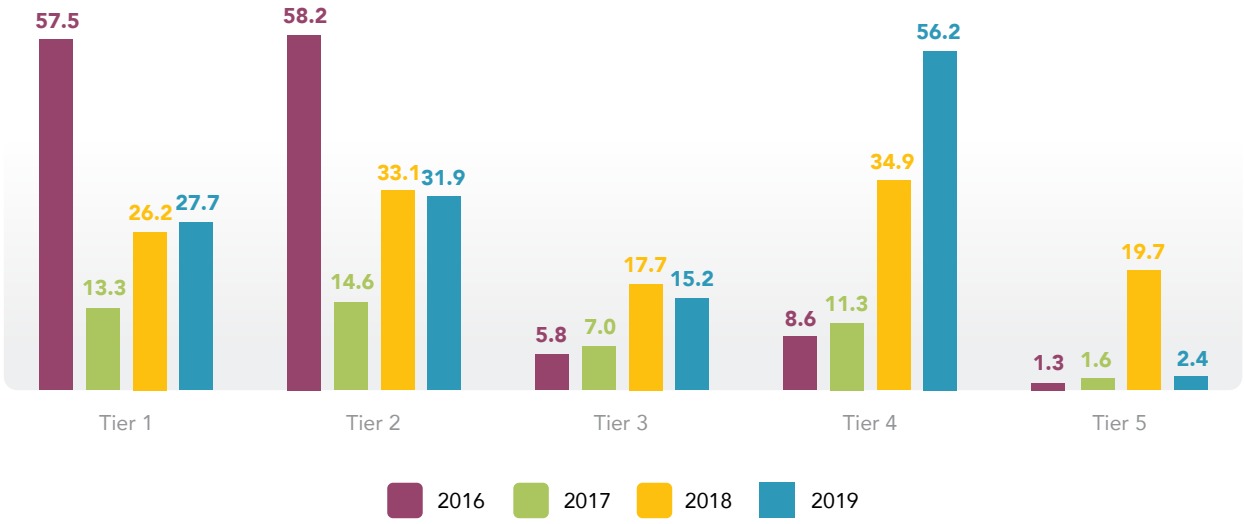
TECHNOLOGY: STOVES AND FUELS

The clean cooking solutions tracked in this report are allocated to tiers ranging from 1 to 5, following the World Bank's Multi-Tier Framework (MTF) (see the Methodology for a more in-depth description).

ESMAP qualifies MTF tiers 4 and 5 as Modern Energy Cooking Services (MECS), due to their low level of particulate exposure, high levels of safety, easy fuel accessibility, and ease of use. Technologies that fulfill the requirements of tiers 4 or 5 are electric stoves, LPG stoves and fuel, natural gas access, and solar stoves. Tiers 2 and 3, which are considered transition tiers, include cooking stoves and fuels with higher amounts of particulate exposure and less accessibility. This includes advanced biomass stoves and fuel. Ethanol stoves and fuel and biogas digesters are considered to provide a combination of tier 3 and tier 4 access. ICS, which encompasses all common forms of improved cookstoves, are split between tier 1 and tier 2. This is due to the marginal benefits that ICS have over traditional three-stone fires, as tier 1 does not qualify as either modern or transition clean cooking (ESMAP 2020a).[56]

It should be noted that a commitment to deploy a certain technology does not automatically provide household access to that tier due to fuel stacking, which is when a household uses a combination of cooking methods, including traditional fires. The adoption of clean cooking solutions faces considerable social challenges, such as entrenched consumer cooking habits and cultural norms, which often results in fuel stacking. As such, funding for education and training on the use of clean cooking solutions, and their many benefits, is a vital part of clean cooking finance commitments.

FIGURE 30
Total Commitments for Clean Cooking in HICS by Tiers of Access, 2016-2019 (USD mn)



[56] Tier 1 access numbers are still included in the total finance tracked as they correspond to a portion of investment for ICS, and data sources do not generally include details on the type of ICS or tier achieved by the project.

Finance commitments were more evenly distributed across clean cooking solutions in 2019. In previous years, most commitments were directed towards a single fuel or technology, rather than diversifying support for the full suite of clean cooking solutions. In 2019, LPG stoves and fuel and ICS attracted almost equal levels of finance commitments, at USD 49 million and US 45 million respectively. From 2016 to 2018, ICS attracted the most finance commitments of any clean cooking solution, receiving 64 percent of total finance during that period. Biogas digesters, alcohol stoves and fuel, and advanced biomass stoves and fuel each attracted slightly more than USD 10 million. While finance commitments for biogas digesters have occasionally peaked due to large-scale projects, such as a USD 94 million commitment to one project in 2015, the technology has only received 12 percent of total finance since 2016. Electric-based cooking solutions, which include electric stoves and solar cookstoves, attracted USD 5 million in committed finance in 2019, the largest volume tracked since this report's inception but far below amounts committed to other clean cooking solutions.

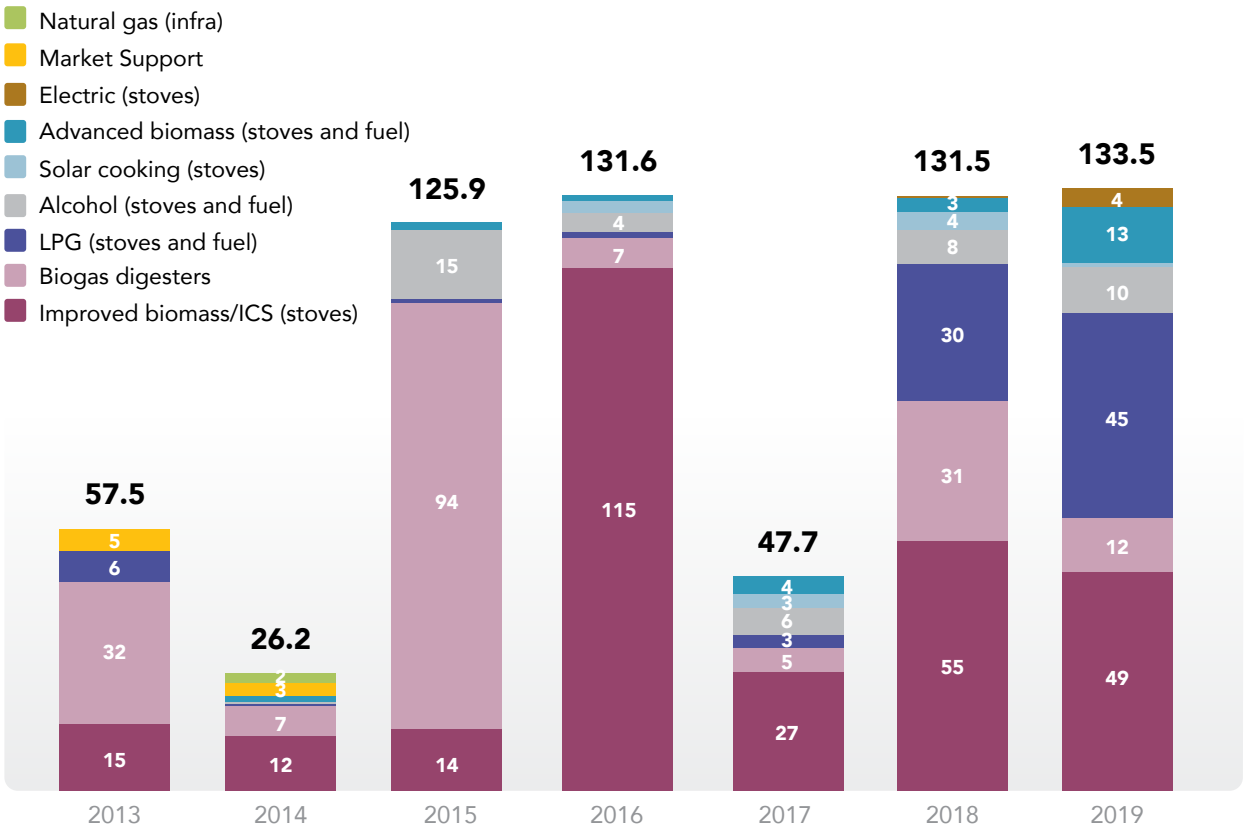
Finance commitments for LPG stoves and fuel increased from USD 30 million in 2018 to USD 45 million in 2019, a significant increase from the USD 3 million committed in 2017, suggesting enhanced interest in LPG as a clean cooking solution. Commercial finance for LPG stoves and fuel increased to USD 30 million in 2019, up from USD 6 million in 2018 and comprising 55 percent of total private finance in 2019, more than any other fuel or technology. Only USD 15 million of public finance was committed to LPG stoves and fuels, despite LPG's role in increasing urban and peri-urban clean cooking access. This suggests the public sector is concerned about fossil fuel investment, particularly as the IEA and others have called for an end to public finance for fossil fuels (IEA 2021).

These numbers suggest differing opinions on LPG as a clean cooking solution. It is a mature technology that renders substantial health benefits by significantly reducing exposure to household air pollution when compared to solid fuels and kerosene, even though it is a fossil-based fuel. National policies around any potential transition to LPG should carefully calibrate its costs and benefits considering fuel supply, regulations, climate impact, availability of finance, and affordability. Consumer demand for LPG, as discussed in Energizing Finance: Taking the Pulse 2021, is also a driving factor in volumes of committed finance.

Total finance commitments for LPG stoves and fuel from 2013 to 2017 only reached USD 12 million, while total finance committed for LPG for 2018 and 2019 reached USD 75 million in aggregate. 34 percent (USD 13 million) of the 2019 figure came from a privately financed project in Kenya. Additionally, only Bangladesh, Kenya, Tanzania and Uganda received finance commitments for LPG for cooking in 2019. While trade associations have pushed for increased LPG investment, citing its technical performance and emissions efficiency, these same associations stress that government regulation and oversight are needed to ensure quality control for LPG use and distribution. While not included in the landscape, this report explores alternative approaches to tracking finance for fuels that require large-scale distribution infrastructure, such as LPG (Box 7).

ICS continued to receive more committed finance than any other clean cooking fuels or technologies, accounting for 55 percent (USD 246 million) of all finance over the 2016 to 2019 period. In 2019, 36 percent (USD 49 million) of total tracked finance commitments supported ICS. While ICS are considered less advanced on the MTF than other fuels and technologies, the stoves are considerably more affordable than more advanced stove or fuel options like LPG, ethanol, or electricity. ICS are considered transition solutions, as they emit fewer pollutants than traditional cookstoves, but they are not as advanced as gas or electric cookers. Importantly, they do not contribute towards meeting SDG7, which only considers "clean fuels". MTF tier 2 access received 24 percent of total 2019 finance (USD 32 million), largely led by investments in ICS, which is considered a tier1/2 technology.

FIGURE 31
Clean Cooking Commitments in HICs by Technology, 2013–2019 (USD mn)



Lower commitments for biogas digesters — from USD 31 million in 2018 to USD 12 million in 2019 — show that biogas projects depend on large-scale, public finance commitments. The relatively high levels of finance in 2013, 2015 and 2018 were driven by a handful of commitments by multilateral DFIs and international governments for projects in Bangladesh, China, Ethiopia, Kenya and Vietnam. While the amount of total biogas finance decreased by 61 percent in 2019, the number of small-scale (under USD 1 million) projects that include biogas for the clean cooking sector more than doubled. Over one-third of these projects received commitments from carbon markets, totalling USD 0.8 million in carbon finance.

Electric and solar cooking continued to receive low volumes of committed finance in 2019. Commitments for solar cookstoves dropped precipitously to USD 0.6 million from a high of USD 4 million in 2018. Commitments from carbon markets accounted for most of the solar cooking finance commitments in 2018, and commitments in 2019 fell in part due to the decrease in carbon market finance discussed earlier. Commitments for electric stoves increased to USD 4 million in 2019, up from USD 0.4 million in 2018, primarily driven by the first ESMAP initiatives that researched modern energy cooking opportunities in Bangladesh and Sub-Saharan Africa. There has also been an increase in electric cooking appliances, such as electric kettles, that is difficult to track[57]. The launch of ESMAP's Clean Cooking Fund (see Box 5) in 2019 and the predicted increase in funding for the clean cookstove sector, including electric cookstoves, will include efforts to take advantage of technology synergies with the greater finance effort for increased electrification (ESMAP 2020b).

[57] Due to fuel stacking, many households that utilize an electric appliance still list less efficient cooking fuels and technology as their primary cooking method (ESMAP, 2020b).

WAY FORWARD FOR THE CLEAN COOKING SECTOR

Diversity in sources of finance, technologies, geographies, and finance structures is necessary to make progress in the clean cooking sector. Positive indicators from the 2019 analysis suggest that a combination of international governments, including bilateral DFIs, and commercial finance compensated for the sharp decrease in large-scale projects, with finance commitments from the World Bank and other multilateral DFIs, though this will potentially shift given the 2020 launch of ESMAP's Clean Cooking Fund.

There is a shortage of sustainable, investable projects and companies in the clean cooking sector, particularly in HICs. Many of the HICs have few tracked finance commitments for market development, although that can be difficult to accurately measure. In risky sectors, such as clean cooking, where public finance can leverage its broader mandate, public capital has a key role to play in mitigating risk and paving the way for increased private finance. As public finance commitments have varied significantly over the years, it is challenging to create deal flow for commercial capital.

To meet the levels of investment needed to reach the SDG7 target of global access to clean cooking by 2030, finance commitments need to increase drastically — by orders of magnitude — and be diversified across financiers, technologies and geographies.

Technology – Significantly more finance needs to be committed to clean cooking solutions, regardless of whether the commitment provides access to tiers 2 and 3 or tiers 4 and 5 on the MTF scale. Progress in clean cooking solutions is often made incrementally, improving along with cultural norms and consumer behaviours. Public and private financiers need to diversify their commitments across technologies to maximize clean cooking access across populations and geographies. Finance commitments for fuels and technology that provide access to MTF tiers 3 and above, such as ethanol stoves and fuel, need to increase drastically. The ultimate "clean" cooking solution involves no greenhouse gas emissions, for example solar thermal cooking or electric cookstoves powered by renewable energy, but that does not discount the progress afforded by transitional fuels and technologies, particularly considering the 2030 deadline to achieve SGD 7.1.2.

The application of innovative pay-as-you-go technology to ethanol and LPG fuel distribution has shown commercial potential, and to scale it up, the PAYG model needs to be supported by innovative financing mechanisms. It must also be backed by the same best-practice government regulations that enforce safety and ownership of non-PAYG LPG cylinders. Solar cooking technology has struggled to receive significant investment despite its climate-friendly impact, but there is an increased interest in electrification, particularly the use of low-voltage electric cooking appliances like pressure cookers and rice cookers. Future clean cooking finance should take advantage of potential synergies with finance committed to increased electrification.

Geography – There was an improvement in distribution of finance commitments across HICs in 2019, as countries that usually receive little finance like Ethiopia and Nigeria saw upticks in clean cooking commitments. This positive indicator is tempered by the handful of countries that continue to receive little to no finance year after year, despite considerable need. As this is the second consecutive year that Bangladesh and Kenya have received most of the available finance, it highlights the need for public finance sources in particular to diversify clean cooking programmes to other HICs.

Sources – Multilateral DFIs contributed less finance in 2019 than in previous years. While private investment, particularly commercial investment, was able to make up that finance deficit for 2019, the lack of funding highlights the historical reliance of clean cooking solutions on a handful of large-scale projects. Apart from multilateral DFIs, which must exceed 2018 investment levels in the future, there is also a vital role for national governments. These must provide greater support to foster holistic clean cooking solutions, such as sustainable and cost-effective programmes for vulnerable populations and accessible finance for small

and medium-sized enterprises (SMEs). Clean cooking targets must be included in the Nationally Determined Contributions (NDCs) and national energy plans of HICs, as is the case in Bangladesh, Ethiopia and Ghana, among other countries. While commercial finance commitments increased in 2019, significant funding is necessary to create markets that attract more commercial investment.

Instruments – Carbon markets and market mechanisms for offsets will be a key focus at COP26 in November 2021. The increased role of carbon offsets in corporate and national transition plans is likely to drive increased traffic to carbon markets. This presents an opportunity for financiers of clean cooking fuels and technology to increase their investments via carbon market mechanisms, particularly to projects with a small carbon footprint like solar cooking and biogas digesters. The key to this financial instrument and its tracking in this report will be the estimated offset unit price, which was particularly low in 2019.

ESMAP'S CLEAN COOKING FUND

In 2019, the World Bank's Energy Sector Management Assistance Program (ESMAP) announced the Clean Cooking Fund at the UN Climate Summit. The Fund has a target of USD 500 million and plans to reach USD 2 billion in total commitments by leveraging private finance through the World Bank's lending operations. It is the first fund of its kind to focus on increasing investments in the clean cooking sector and, at its launch, had received commitments from the Netherlands, Norway and the United Kingdom.

The Fund operates via two pillars; the first is a country/regional investment programme that co-finances projects with a view to catalyzing public and private finance for clean cooking. This is a results-based financing (RBF) programme, in that it includes incentive payments with verified results at multiple levels to ensure cookstove access increases. One such result is gender equality, by measuring the value of gender-equitable outcomes like time savings from fuel gathering and downstream impacts like enhanced participation of women in the labour force.

The second pillar is the Global Platform for Knowledge, Innovation, and Policy Coordination. The platform aims to be a vehicle for high-level political commitments, knowledge and best practice sharing, and policy coordination across countries and regions. This pillar includes a recently announced USD 56 million partnership with Loughborough University in the UK (the Modern Energy Cooking Services initiative), focused on a challenge fund for inventing alternative stove and fuel technologies and finance methods to increase clean cookstove access.

The Clean Cooking Fund became operational in January 2020 and recently committed to finance the Rwanda Energy Access and Quality Improvement Project (EAQIP). Together with the International Development Association (IDA) the Fund committed USD 20 million with the goal of providing clean cookstove access to more than 500,000 people in Rwanda, building off the Rwandan Ministry of Infrastructure's ambitious Biomass Energy Strategy and the Rwandan government's new Nationally Determined Contributions (NDCs). Future projects are being planned in Burundi, Ghana, Mozambique, Myanmar, Niger and Uganda, countries with historically low clean cooking finance.

While there were no finance commitments to include in 2019, future clean cooking finance will potentially be much higher due to the Fund.

6 RESULTS-BASED FINANCING FOR CLEAN COOKING SOLUTIONS

Summary

Results-based financing (RBF) is a finance instrument that links the extension of finance to the verified delivery of pre-defined results. Although RBF has been used extensively in other aid sectors such as sanitation and health services, it has only been used to finance the clean cooking sector for the past half decade. DFIs have expressed interest in applying RBF approaches instead of grants or other direct investments in clean cooking companies; the World Bank's ESMAP Clean Cooking Fund (see Box 5) and the Energising Development Programme (EnDev) are key programmes implementing RBF schemes.

RBF has the potential to increase both blended finance, which is sorely needed in the clean cooking sector, and commercial finance. The instrument is intended to attract private finance by delivering reliable returns while delivering the results required by the private sector. For private finance, it shifts the risk to the project implementer rather than the financier, as payments are made only after the results are achieved.

By shifting the risk to the implementer, however, RBF requires the implementer to be able to access upfront finance to get the project off the ground. This is difficult to achieve in nascent markets, as they lack the established agencies that can develop and complete the work necessary to pass the outside verification. Overall, if verifiable and achievable metrics can be developed and agreed upon, RBF provides a potential solution for the underfunded clean cookstove sector.

Case Study - Uganda

As of 2019, 99 percent of Ugandan households lacked access to clean cooking solutions. The World Bank has funded a USD 2.2 million pilot programme for advanced biomass stoves in Uganda, applying a results-based grant mechanism, since 2016. The goal of the programme is to establish market incentives for manufacturer-distributor partnerships, introduce new high-efficiency, quality-assured biomass stoves, and facilitate the delivery and long-term adoption of over 45,000 stoves to Ugandan households (Hyseni 2020).

By June 2020, most of the programme's targets had been achieved, with just over 64,000 stoves sold. Impact assessment estimated average fuel savings of 36 percent per month and that women saved 30-90 minutes of time each day. The programme also achieved a 30 percent emissions reduction rate compared to the baseline (Hyseni 2020). Operations are expected to continue under ESMAP's Clean Cooking Fund (Box 5), with an expanded suite of clean cooking solutions and potential finance for off-grid solar. The Rwandan project being funded by ESMAP, mentioned in Box 5, is also an RBF programme.

Way Forward

There are many opportunities for clean cookstove commitments to increase through RBF instruments and there are efforts to integrate RBF into broader impact-funding programmes. There is also a call to use RBF to integrate electricity-access and clean-cookstove approaches. By better integrating cookstove access into broader electricity-access strategies, programmes can increase access to electric cooking and reduce the emissions and health impacts associated with traditional and transition fuels.

7 CAPTURING CLEAN COOKING INVESTMENT FROM THE LPG SUPPLY CHAIN

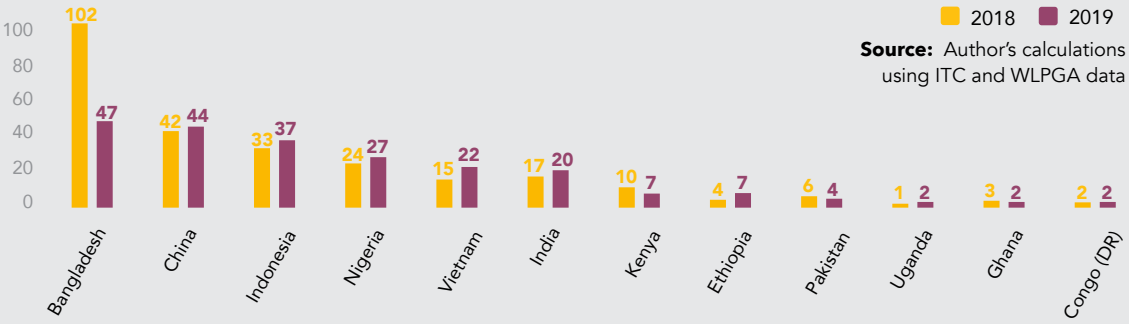
This analysis of the LPG supply chain provides an order of magnitude estimate to complement the tracked finance commitments data in this report. While finance commitments for LPG stoves and fuel from private finance, carbon markets, and public finance are included in the report analysis, investments in infrastructure within HICs that provide access to LPG fuels are not. This methodology follows the value chain of fuels to isolate LPG data at the residential level through estimated cylinder imports.

LPG cylinder imports continue to be a relevant data point in the LPG value chain. Based on the 2018 methodology and interviews conducted in 2019, LPG cylinder imports remain the most appropriate proxy for finance for residential LPG use for cooking. Using International Trade Centre (ITC) data, country USD values of LPG cylinder imports were used as a proxy for investment into the fuel and technology. This approach is complemented with the consumption patterns of LPG to estimate the residential proportion of these imports (WLPGA 2020).[58]

The analysis estimates that USD 222 million was spent on importing cylinders for residential clean cooking use in HICs (Figure 32). Bangladesh, which has a relatively high LPG adoption rate, remained the highest importer in 2019, spending USD 47 million. This is a substantial drop, however, from the estimated USD 102 million spent in 2018 and corresponds to a 1 percent decrease in estimated clean cooking access within rural communities. Vietnam, which has also encouraged LPG stove and fuel adoption in recent years, increased its spending on cylinders by almost 50 percent from 2018, reaching USD 22 million in 2019.

These estimates suggest that LPG use for residential clean cookstove access has increased in seven of the 12 HICs where import data are available, with the largest increases in China, Uganda and Vietnam, although clean cooking access levels have remained relatively static. According to the consumption estimates provided by the World LPG Association (WLPGA) for the countries tracked in this analysis, an average of 78 percent of LPG cylinders were used by the residential sector.

FIGURE 32
Total Value of LPG Cylinder Imports for Residential Use, 2018 and 2019 (USD mn)



This methodological framework does come with limitations. By adopting imports of LPG cylinders as proxies for investments in residential clean cooking, the data are incompatible with the larger analysis due to concerns of both double and over-counting LPG investments, and the inability to take domestic production into account.

[58] Data can be used to identify the percentage of total LPG that is used by the domestic sector, which includes "residential and commercial use for LPG as a cooking and heating fuel primarily from cylinders and bulk tanks."

CHAPTER

5

CLEAN COOKING INVESTMENT IN GHANA AND VIETNAM

SUMMARY

Despite progress over the first decades of the 21st century, tens of millions of people in Ghana and Vietnam still lack access to clean cooking, with thousands — primarily women and children — dying each year from household air pollution (HAP). To close the gap, government targets and national roadmaps should be leveraged towards increasing the availability, affordability and accessibility of clean cooking solutions. This case study provides a deep dive comparative analysis of liquefied petroleum gas (LPG) in Ghana and biogas in Vietnam with a view to understanding financing strategies and pathways that have been employed to increase access to these different clean[59] cooking fuel solutions in each country. Since the two countries are now pursuing divergent approaches to achieve clean cooking access, they provide a useful comparative case to assess how varied financing and policy approaches tailored to clean cooking technology solutions can function in different contexts.

In Ghana, under a government policy target aiming to reach 50 percent of households using the fuel by 2030, LPG has gained traction in recent years. However, the past five years have witnessed stagnation in levels of residential LPG consumption. The LPG value chain expansion required to meet the 2030 policy target demands approximately USD 400 million in total,[60] mostly dedicated to cylinders and other infrastructure including bottling plants, pallets and cages (GLPGP, KfW & EU 2018). Set against the USD 2 million in finance commitments estimated for residential LPG cylinders in 2019, the (estimated) tracked finance falls well short of investment needs. Moving forward, a branded cylinder recirculation model (BCRM) for Ghana's LPG industry is well placed to achieve the 50 percent policy target and can be paired with pay-as-you-cook solutions to close both the affordability and accessibility gaps. Market restructuring towards a more integrated and bankable LPG ecosystem should, in turn, help attract and catalyze investment.

In Vietnam, following strong uptake of LPG, on-site (residential) biogas has become a commercially and technically viable clean cooking solution for rural and peri-urban farming households. A long-running public-private Biogas Programme, spearheaded by the Dutch development organization SNV, has facilitated the creation of a commercially sustainable biogas market in Vietnam, along with technical capacity and quality control. The programme has demonstrated the innovative potential of harnessing waste-to-energy clean cooking solutions for decarbonization and achieving the country's Nationally Determined Contribution (NDC) targets.[61] Moving forward, Vietnam should seek to improve its regulatory framework regarding carbon finance — a key pool of capital — and look towards larger-scale (urban) applications alongside on-site, household biogas.

In both Ghana and Vietnam, the viability of (renewable) bio-LPG is yet to be fully explored but could, in time, provide for a new addition to the clean cooking mix; a drop-in solution that leverages existing LPG infrastructure. Nonetheless, with nine years remaining, meeting SDG7 will demand a whole suite of clean cooking solutions — from improved cookstoves (ICS)[62] to electric stoves – to move households up the energy ladder and towards universal clean cooking.

[59] Acknowledging LPG is a fossil fuel, it is clean relative to baseline "cooking-as-usual".[59] Data can be used to identify the percentage of total LPG that is used by the domestic sector, which includes "residential and commercial use for LPG as a cooking and heating fuel primarily from cylinders and bulk tanks."
[60] Across the entire period 2019–2030.
[61] Vietnam's NDC includes a target of constructing 500,000 biodigesters by 2030.
[62] Providing tier 1/2 access under the Multi-Tier Framework (MTF).

COUNTRY CONTEXT

Ghana and Vietnam are both lower-middle income countries with similar levels of GDP per capita. Approximately 77 percent of Ghana's population lack access to clean cooking fuels and technology while in Vietnam 35 percent lack access, a substantial improvement on the 86 percent at the beginning of the century (Tracking SDG7 2019; CSIS 2020). Despite higher clean cooking adoption rates in Vietnam, available data indicate that both countries continue to exhibit similar rates of annual household air pollution (HAP)-induced deaths, a silent global pandemic that disproportionately affects women and children (see Table 4). In rural areas, the prevalence of "free"[63] wood fuel for cooking continues to inhibit households from entirely[64] making the switch to cleaner fuels, while being a key driver of deforestation.

TABLE 4
Country Profiles

Indicator	Ghana	Vietnam
Population (million)	30.4	96.5
% living in rural areas	43	63
GDP per capita (USD)[65]	2,202	2,715
Population without access to clean cooking (million)	23.42	33.76
% without access to clean cooking[66]	77	35
% without access to electricity[67]	16	1
Annual household air pollution (HAP)-induced deaths[68]	16,600	45,502
Decrease in tree cover since 2000 (%)[69]	19	19

This case study focuses on these two lower-middle income countries on their respective trajectories towards achieving universal access to clean cooking, especially through LPG in Ghana and biogas in Vietnam – two key fuels in the (cooking) energy mix. Following comparative analysis of these two technologies as they relate to cooking, a deep dive into each country's clean cooking policy and financing landscape is provided, concluding with key barriers and pathways to increase access. The environmental, health, monetary and time benefits associated with transitioning to clean cooking fuels and technology are clear. However, further progress on three key policy pillars — availability, affordability and accessibility — is key to increasing access to clean cooking in both countries, albeit to different degrees.

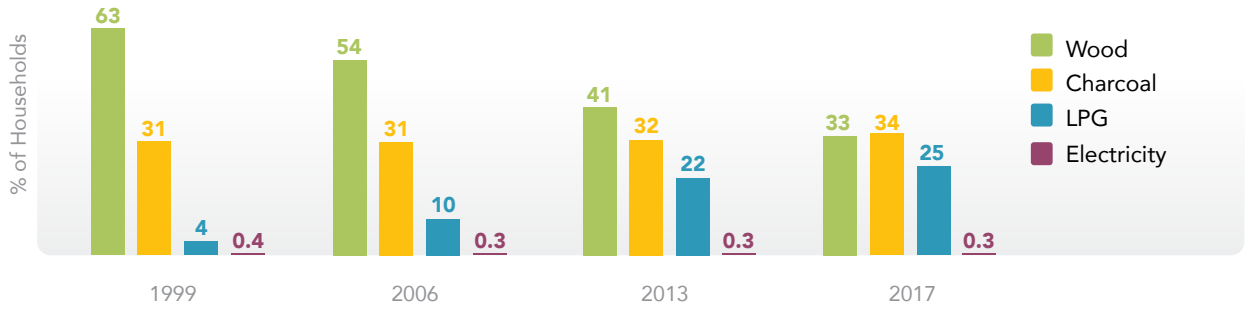
Closing the clean cooking access gap in Ghana and Vietnam requires a comprehensive approach that considers three key policy pillars - availability, affordability and accessibility.

The clean cooking transition in Ghana and Vietnam has, to date, primarily been a story of switching from wood fuel to LPG (see Figures 33 and 34). In Ghana, the household fuel mix at national level is split almost evenly between charcoal (34.1 percent) and wood (33.3 percent), followed by LPG (24.5 percent).[70] As in other developing countries, LPG comprises a greater segment of the urban market (34.8 percent) than in rural settings (8.7 percent), where wood fuel use dominates.

When compared to Ghana, or indeed other lower-middle income countries, the Vietnamese LPG market is considerably more advanced: the fuel[71] was first introduced in 1993 and its use spread quickly, with 70 percent of households now owning an LPG stove and fuel (SEforALL & Dalberg 2021). Despite the less pronounced rural-urban LPG split in Vietnam compared with Ghana — see Table 5 — Vietnamese provinces that continue to have low LPG access rates have a higher prevalence of poverty on average (CSIS 2020). Indeed, as is well established in research literature, energy poverty is both a cause and consequence of wider economic poverty (GCEEP & MITei 2020).

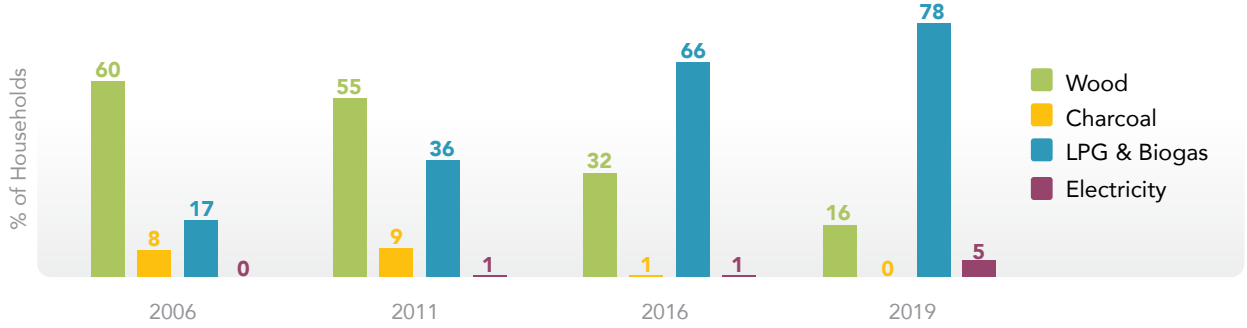
While the policy conversation continues to revolve around widening access to LPG in Ghana, Vietnam has expanded into biogas as a viable clean cooking solution – at least for rural and peri-urban (farming) households.[72] With an extensive agriculture and husbandry sector, the country is well positioned to utilize livestock manure (amounting to nearly 100 million tons of solid waste per year) as feedstock for anaerobically-produced biogas fuel (UNEP DTU & FIRM 2016).

FIGURE 33
Cooking Fuel Usage Trends in Ghana, 1999-2017



Source: Ghana Living Standards Survey (GLSS 4/5/6/7)

FIGURE 34
Cooking Fuel Usage Trends in Rural Vietnam, 2006-2019



Source: Compiled from Results of the Rural, Agricultural and Fishery Census (2016) and Vietnam General Statistics Office dashboard (2019). Data availability determined the years of analysis for figures/tables; there was no exact match across countries nor was there disaggregation for LPG & Biogas in Vietnam.

[70] Household usage of LPG is difficult to determine precisely given the tendency to fuel- and stovestack, depending on cooking tasks.
[71] Although not necessarily consistent access.
[72] The Ministry of Agriculture and Rural Development (MARD) estimates that there are 8.5 million farming households in the country.

TABLE 5
Rural and Urban Fuel Usage in Ghana (2017) and Vietnam (2019)

% households by fuel use and region	Fuel	Urban	Rural
Ghana	Wood	11	63
	Charcoal	44	22
	LPG	35	9
	Other	10	6
Vietnam	Wood	1.6	16
	Charcoal	0.3	0.4
	Gas	81.4	78.3
	Other	16.7	5.3

Source: Ghana Living Standards Survey (GLSS 7), 2017 and Vietnam General Statistics Office (2019). Data availability determined the years of analysis for figures/tables; there was no exact match across countries.

COMPARING CLEAN COOKING TECHNOLOGIES

LPG is the clean cooking fuel[73] used most predominantly in Ghana and has gained traction throughout the country in recent years, while biogas has become part of the cooking energy mix in Vietnam since its introduction in the 1960s (FIRM 2020). A comparative analysis of those two technologies in Ghana and Vietnam allows for a better understanding of financing strategies and pathways that have been employed to increase access to different fuel technologies, helping to pave the way forward towards universal clean cooking.

LPG – GHANA

Comprised of propane, butane, or a blend thereof, LPG is a powerful, portable, and versatile energy source with a high energy-to-volume yield ratio. Currently in global surplus, it is a by-product of oil or gas production and is, therefore, a fossil fuel. As a by-product, LPG is supply-driven and must be disposed of, with its best use being clean cooking. In addition to cylinder and fuel expenses, first-time LPG users must purchase the stove and, preferably, a regulator for the cylinder valve along with a hose connecting fuel to stove. LPG, therefore, has high upfront costs for households aspiring to use it for cooking. The average rural Ghanaian household spends less per month on housing, water and residential energy combined (USD 15) than the cost of a month's supply of LPG (USD 16.8) (Asante et al. 2018). Therefore, the steep financial barriers for rural households aspiring to transition to LPG necessitates policy intervention and innovative company and consumer financing models.

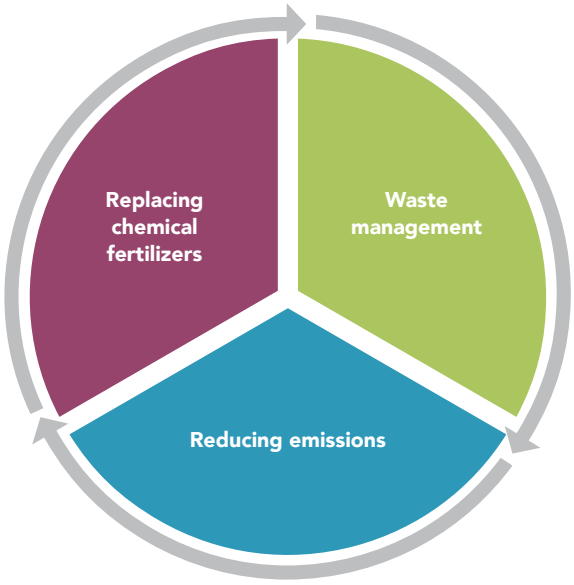
In Ghana, the majority of LPG is imported (60 percent)[74] while the remaining 40 percent is sourced domestically from oil and gas refineries (Norad 2020). The so-called marketing companies (see Box 8) are the sole licensed sellers of LPG in Ghana. Under the current consumer controlled cylinder model (CCCM), the marketing companies sell to consumers directly or to roadside micro stations who then fill the cylinders for them while they wait. A well-developed LPG ecosystem involves extensive road networks for tankers and cylinder trucks, along with storage facilities, bottling plants, jetties for imports and bulk loading bays.

BIOGAS - VIETNAM

Produced from the anaerobic fermentation of organic matter,[75] in Vietnam biogas is primarily made from pig waste, earning it the name "pig power." Like LPG, it is a highly versatile fuel, used in cooking, heating and lighting. When upgraded in methane content, it can even be used for transport applications or injected into the grid. Biogas is one of the most environmentally friendly cooking fuels, especially when life cycle assessments consider the foregone emissions that would otherwise result from biomass decay (IRENA 2017). While traditionally seen as a solution specific to rural areas, biogas can be produced from various feedstocks (including municipal waste) in rural and urban areas. Particularly important in the context of Vietnam, the byproduct — bioslurry — can be used by households as an organic fertilizer. User surveys indicate that crop yields increased by 5–20 percent with sustained use of bioslurry, thereby increasing incomes and providing a concrete incentive for Vietnamese farmers to install biodigesters (myclimate 2021).

[73] Acknowledging LPG is a fossil fuel, it is clean relative to baseline "cooking-as-usual".
[74] From a host of countries, primarily Equatorial Guinea, Nigeria, Spain and the USA.
[75] Including, but not limited to, livestock manure, agricultural residues, food waste, sewage and landfill waste.

FIGURE 35
Biogas and Deep Decarbonization



Different biogas plants are available on the market, ranging from small-scale, on-farm digesters to larger commercial plants. Different biodigester designs are also suitable for different geographies: in southern Vietnam, for example, the flexible balloon digester is most common, previously supported by a 25 percent construction subsidy, while in the north of the country, fixed-dome digesters are more suitable for the typically smaller landholdings there and require less maintenance (IRENA 2017). As is the case with LPG, a biogas system (digester plus stove) demands high upfront costs for first-time users, typically around USD 612 in Asia (REN21 2015). However, the longer-term economics are more favourable, capable of saving Vietnamese households on average of USD 120 a year,[76] with an accompanying reduction of 5 tons of CO2 emissions (SNV 2015). Operating (excluding maintenance) costs are comparatively very low given that the feedstock and fuel is effectively free, with upfront investment typically paid back within two and a half to three years (SNV 2011).

COMPARATIVE ANALYSIS

While there are baseline similarities in terms of high upfront costs, the contexts in which each clean cooking fuel and technology are most viable differs. Biogas, given the nature of feedstock, is a free fuel for farming households (assuming away time, opportunity and maintenance costs) and, once biodigesters have been installed on-site, provides for a very decentralized clean cooking solution. LPG, on the other hand, requires vast infrastructure networks, planning and logistics to move the product from upstream producers to downstream consumers. The cost therefore reflects both the fuel and the many components in the value chain. These baseline differences in turn make for different financing strategies and appropriate policy frameworks to increase clean cooking access.

TABLE 6
Comparative Analysis of Biogas and LPG

Characteristic	LPG	Biogas
Ease of use	Controlling, igniting, and storing LPG is viable at the household or stove level.	There is a need for consistent maintenance of a biodigester; the technology is dependent on continuous supply of feedstock and consistent daily operation; and small land area and access to water is required for biodigester use.
Versatility	Highly versatile (cooking, heating, transport, power generation).	Highly versatile (cooking, heating, lighting, power generation).

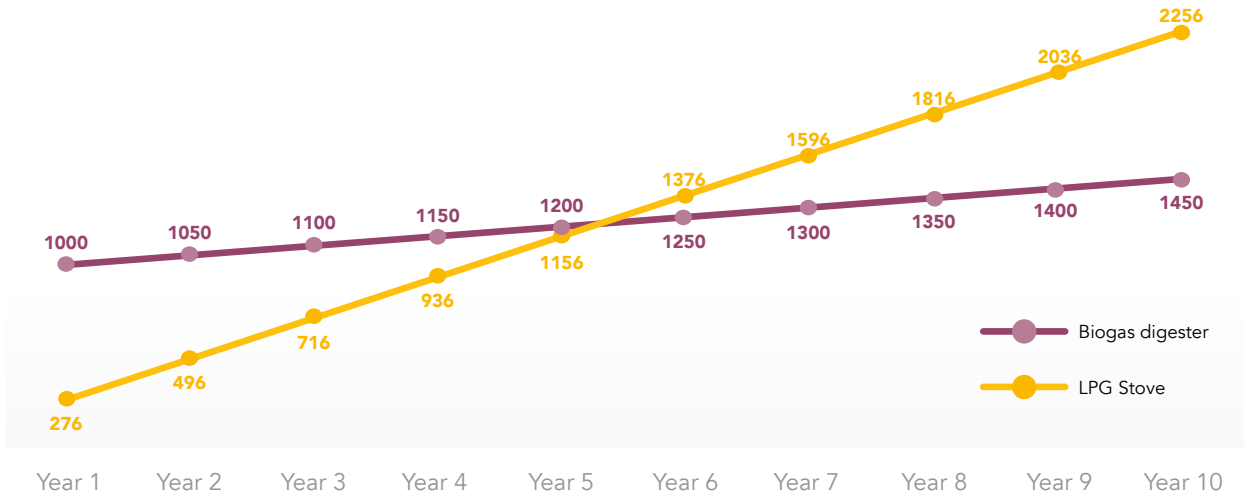
[76] Replacing expenditure on traditional fossil fuels and purchased wood fuel.

Characteristic	LPG	Biogas
Safety	In a consumer-controlled cylinder model (CCCM) there are serious safety concerns in relation to cylinders and frequent accidents/explosions; in a branded cylinder recirculation model (BCRM) the incidence of explosions is far lower due to regular inspection and maintenance of cylinders. At the household-level, additive odorants can help detect leaks; the stove should be placed on an elevated platform above cylinders to avoid accumulation near the ground.	Biodigesters are generally considered safe to use and operate, with lower incidence of explosions/fires.
Portability	Cylinders facilitate portability at least within the supply chain but can be heavy to carry for end users (though advances have been made in portability recently). The LPG ecosystem is holistically very capital-intensive and dependent on extensive logistics and infrastructure.	On-site biodigesters pipe biogas directly into the kitchen. The technology is a highly decentralized solution given the nature of on-site production.
Human toxicity potential (HTP) (Afrane & Ntiamoah 2011)	37 kg DCB equivalent – this is restricted to the upstream stage and thus does not affect households.	1.68E-0.5 kg DCB equivalent.
Cultural perception	Continues to be viewed as a 'rich man's fuel' in some HICs and under a CCCM, LPG is rightly perceived as dangerous.	Behavioural and social acceptance is generally an issue, at least in countries without a history of using the technology.
Co-products	N/A	Waste management and bioslurry fertilizer byproduct.
Life Cycle Energy Efficiency (KfW Development Bank 2017)	45 percent	43.3 percent

A key comparative point regards how much higher the upfront costs are for a biodigester (average USD 950) relative to an LPG stove (average USD 56)[79] – even though the latter is, itself, considered expensive for households aspiring to use LPG. However, with the reverse true in terms of annual operating costs (averaging USD 50 for biogas vs. USD 220 for LPG), the cost profiles level out, becoming almost equivalent five years into the lifecycle (IRENA 2017). The lifecycle costs of biogas as compared to LPG indicate that biogas requires longer-term policy frameworks, planning and foresight for it to become a viable household clean cooking solution.

[77] DCB is 1,4-dichlorobenzene.
[78] This does not apply to Vietnam where an effective marketing campaign on the part of provincial agricultural extension services ensured a hospitable environment for, and favourable attitudes to, biogas.
[79] This comparison does not consider the cost of the biogas stove itself, which typically ranges from USD 50–100, with some low-cost alternatives available at USD 25; see ESMAP 2015.

FIGURE 36
Combined Upfront and Operating Costs of Biogas and LPG (USD)

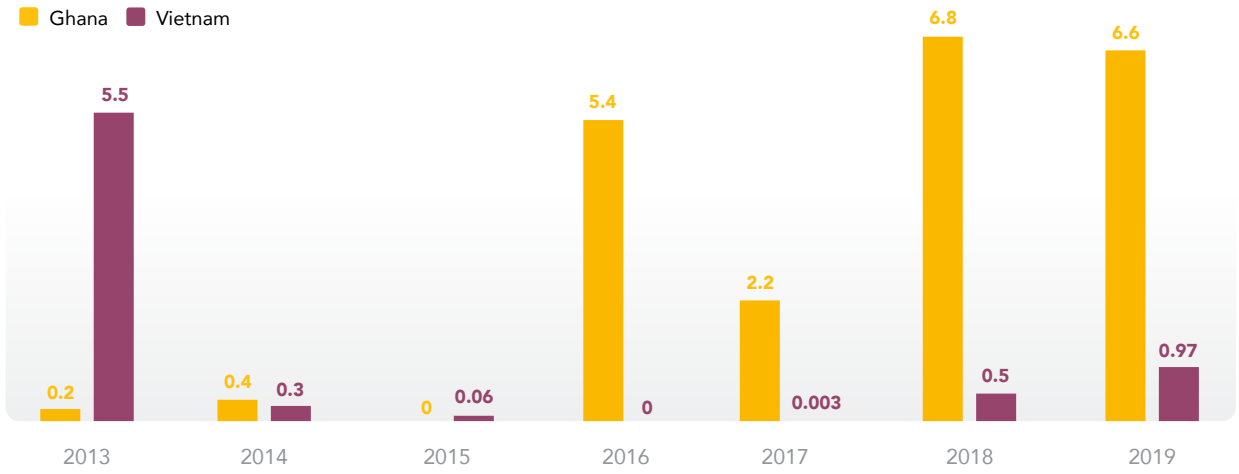


Source: IRENA, (2017). "Biogas for Domestic Cooking. Technology Brief"

POLICY AND FINANCE LANDSCAPE

As discussed in further detail in the country-specific sections that follow, Vietnam saw a substantial decline in finance tracked for clean cooking from 2013 to 2019, while Ghana saw an increase over the same period. Vietnam received more than USD 5.5 million in finance commitments in 2013 but has not received more than USD 1 million in any year since. Ghana by contrast received less than USD 500,000 in both 2013 and 2014 but has since seen a significant uptick in finance ranging from USD 2.2 million in 2017 to USD 6.8 million in 2018. The individual country analysis that follows points to policy and financial market reasons for these trends. The levels of investment seen in Ghana and Vietnam reflect both genuinely low volumes of finance commitments and challenges in tracking domestic finance for clean cooking access.

FIGURE 37
Finance for Clean Cooking in Ghana and Vietnam (USD mn)



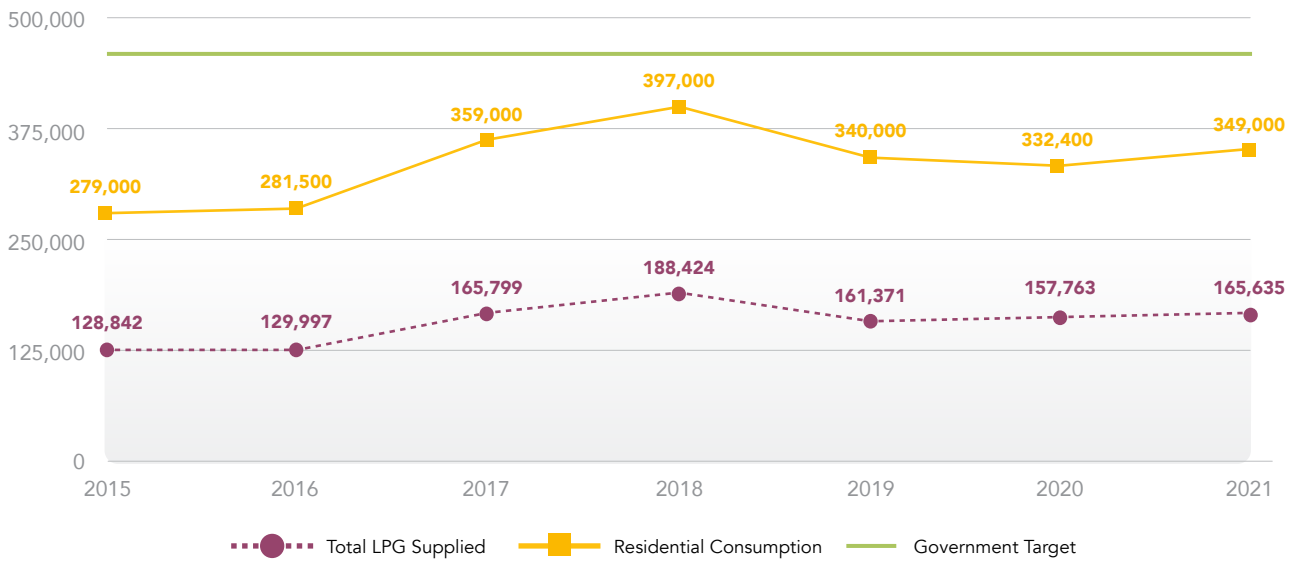
GHANA

The Government of Ghana set a national policy goal in 2018 to reach 50 percent of the population using LPG for cooking by 2030. This is the third iteration of an initial 50 percent by 2015 target established in 2010. Under the direction of the Ministry of Energy, in 2018, the National Petroleum Authority devised a roadmap to achieve the 50 percent target, with an implementation committee to plan and deliver the transition to a BCRM. The roadmap focuses on creating appropriate regulatory frameworks along with cylinder recall, decommissioning high-risk filling stations, and providing training opportunities for key stakeholders to address safety and other issues (ModernGhana 2018). Long-term planning, predictable policy, and bankable market structures are essential conditions for attracting investment, sending concrete market signals to public and private investors.

Currently, the LPG market in Ghana is supply constrained: to meet existing demand, investment in LPG infrastructure and equipment must be substantially scaled up. The government estimates that to achieve the 50 percent target, assuming a 31–32 million base population, 450,000 tons of LPG must be supplied per year. Figure 38 illustrates the gap between total LPG supply and the level compatible with the government's 50 percent target; residential consumption therein has stagnated over the past five years, hence the revised timeline of 50 percent by 2030. In 2020, international LPG prices dropped temporarily in response to the effects of Covid-19 on global and regional LPG demand, however, the lower LPG import price appears to have had no meaningful effect on residential consumption. It is anticipated that urbanization in Ghana will be a key driver increasing residential LPG demand in the coming years.

FIGURE 38

LPG supply in Ghana, 2015-2021 (tons)



Source: Compiled from Ghana Energy Outlook Reports, 2015-2021 & WLPGA, 2019. "Statistical Review of Global LPG"

A national LPG feasibility study conducted by the Global LPG Partnership (GLPGP), with support from KfW, estimates that the capital investment required to achieve this 50 percent policy goal is approximately USD 400 million, 70 percent of which would need to be directed towards cylinders (see Table 7). This estimate is consistent with the infrastructure and equipment costs experienced by other lower-middle income countries that have already executed major LPG scale-up programmes (GLPGP, KfW & EU 2018).[80] However, set against this report's tracked estimate of USD 2 million in 2019 for residential LPG cylinders (see Table 8), the current commitments fall well short of investment needs.

[80] In Cameroon, for example, it was estimated that EUR 400m would be invested over fifteen years for scaling up LPG.

TABLE 7
Investment Needs to Achieve Ghana's LPG Policy

Investment needs	2019-2030 (USD mn)	Tranche 1, 2019–2022 (USD mn)
Cylinder	278.5	124.9
Bottling Plants/ Storage	102.7	62.5
Pallets	6.7	4.5
Cages	8.6	5.8
Total Capital Investment	396.5	197.7

Source: Adapted from GLPGP, KfW & EU, (2019). "LPG for Clean Cooking in Ghana: Investment and Implementation" and GLPGP, KfW & EU, (2018). "National Feasibility Study: LPG for Clean Cooking in Ghana".

TABLE 8
Tracked Finance to LPG, Ghana

Investment needs	2019-2030 (USD mn)
Value of total 2019 LPG cylinder imports	4.05
Percent residential consumption of LPG cylinder imports (WLPGA report)	49 percent
Total value of imports for residential use	1.98

a. Branded Cylinder Recirculation Model (BCRM) Transition

The LPG policy conversation in Ghana today continues to revolve around the prospective transition to a BCRM. Following a series of accidents under the CCCM, notably a major explosion in Accra in 2017,[81] the government decided to transition to a disciplined LPG market in line with international best practice. In the BCRM, LPG marketing companies invest in, and become the owners of, branded cylinders that are the companies' responsibility to inspect, maintain, refill and retire as appropriate (see Box 8). A proven success in other countries, including Vietnam, the BCRM — by fostering superior safety at each node of the LPG supply chain — provides for lower-risk profiles and a far more integrated, bankable sector. This is particularly important for Ghana, which currently exhibits a uniquely disintegrated LPG ecosystem. Other countries, for example, Colombia, have showcased the benefits that result from transitioning to the BCRM, with foreign direct investment starting to flow soon after successful implementation.

MARKETING COMPANIES, GHANA

In Ghana, as of 2017, 152 licensed marketing companies were in operation – including both general oil marketing companies (OMCs) and LPG-specific marketing companies (LPGMCs). The latter have been more active in the residential LPG market while the former also handle various other petroleum products. Both receive their LPG from bulk storage facilities, owned by bulk distribution companies. OMCs and LPGMCs can either build and operate microfilling stations of their own or develop and utilize networks of third-party distributors to serve end users; or employ a hybrid system. Ghana is unique, both regionally and globally, in its disintegrated value chain and in its number of OMCs. With regard to the BCRM, the decisive factor is whether the marketing companies can be fully compensated for the changes demanded of them. However, relieved of the burden of continuous refilling infrastructure (which is to be consolidated into regionalized bottling plants) they are free to invest in other areas and stand to benefit from greater revenue streams.

[81] Discussions regarding transitioning to the BCRM in Ghana began in 2013 but it was not until a tanker delivering LPG to the capital exploded, killing seven and injuring more than 100, that the momentum for government action intensified.

In an effort to finance the transition to the BCRM, the government — which provides for full LPG cost recovery pricing — authorized a cylinder recirculation recovery margin in 2020 such that marketing companies would be able to charge GHp13.5 for each kilogram of LPG (Ghana News 2020). However, faced with pushback from the Chamber of Petroleum Consumers and the Consumer Protection Agency, this margin was later withdrawn. The challenge is engaging with, and catering to the interests of, multiple stakeholders, and efforts are being directed by the National Petroleum Authority towards providing safety nets (compensation) for the small-but-high-risk micro stations whose activities will be subsumed under the marketing companies' node of the supply chain.

On the consumer side, a recovery margin will increase LPG prices and reduce affordability. However, efforts are being directed towards reducing the hydrocarbon-specific taxes imposed on LPG to counterbalance the cost burden associated with the BCRM transition. Moreover, once established, the BCRM will help to alleviate affordability constraints for end users since they will no longer have to pay for and purchase a cylinder but instead provide a smaller deposit to the marketing companies. In essence, the BCRM can go a long way, in and of itself, towards widening access to LPG for residential consumption and thus clean cooking, while ensuring far better safety practices across the entire LPG ecosystem.

b. International Donors

Ghana's domestic financial sector does not have the capacity to finance the entire value chain expansion outlined in the GLPGP-KfW report (Table 7). International capital, particularly concessional capital from development financiers, is needed. However, as a fossil fuel, LPG is ineligible for carbon-financing projects under the Clean Development Mechanism (CDM) and therefore cannot monetize the avoided emissions caused by households switching from wood fuel or charcoal to LPG. Despite these barriers, smaller LPG projects have succeeded in tapping into the voluntary carbon market.[82]

In light of the LPG-specific impact-investing funds recommended by the GLPGP, in conjunction with KfW (GLPGP Investing 2011), it would be advisable for Ghana to seek capital for LPG infrastructure and distribution from institutional investors, development finance institutions (DFIs) and other impact investors, with an eye towards investigating bio-LPG (see Box 9). Additionally, a fund to help support low-income households acquire LPG equipment or to expand access to (micro)credit could work to alleviate end-user affordability constraints. The emergence of the World Bank's Clean Cooking Fund, launched in 2019, could possibly be a key pool of capital moving forward.

Integrated energy planning, predictable policy and bankable market structures are essential conditions for enabling viable and scalable business models in the clean cooking sector.

[82] For example, the Low Smoke Stoves project in Darfur, Sudan, which provided clean-burning LPG stoves to low-income households, sold carbon credits at USD 15/ton (Gold Standard).

c. Consumer Financing

Consumer finance for LPG via microfinance institutions is still rather nascent in Ghana, inhibited by stringent capital requirements imposed by the Bank of Ghana and a history of non-performing loans amongst households. Currently 65 percent of Ghanaians are excluded from the formal banking sector, disproportionately women and low-income households (GLPGP, KfW & EU 2018). The microfinance sector in Ghana is much harder to navigate than it is in Cameroon or Kenya, for instance, where LPG-microfinance programmes have been piloted.

A more promising prospect involves extending microcredit to street food vendors for LPG uptake. This informal sector is dominated by women who are constantly exposed to the hazardous impacts of cooking with dirty fuels. In the course of the multi-stakeholder microfinance programme, Bottled Gas for Better Life, Ghanaian microfinance institutions indicated their willingness to lend to vendors who presented lower risk profiles, as the LPG would be used for income-generating purposes (GlobalGiving 2018). Given the dual responsibility to cook at home as well as at work, targeting these vendors may, in turn, help to catalyze the uptake of LPG in domestic settings.

BIO-LPG

Produced from renewable feedstocks such as agricultural residues and solid (municipal) waste, bio-LPG is not yet a realistic alternative to fossil LPG in Ghana, however, studies are underway to assess its commercial viability and technical potential. Most importantly, bio-LPG — when it does become available — is a drop-in solution, meaning that it can utilize existing infrastructure and equipment for fossil LPG. Thus, infrastructure investment sunk today need not become redundant tomorrow.

d. Pay-as-you-cook

Another nascent albeit promising opportunity to expand LPG access is through pay-as-you-go (PAYG) financing models. LPG cylinders are embedded with smart meters such that users can pay for small quantities of LPG, via mobile money, which is then released until the pre-paid quantity is used up. Rather than purchase a smaller (3kg) cylinder — another (inefficient) way of reducing upfront costs — the PAYG model helps tackle affordability, increase accessibility (via home delivery of cylinders) and indeed can go hand-in-hand with a transition to the BCRM given the nature of direct cylinder exchange.

Installation by PAYG companies into customers' homes can also help ensure safety standards are met. However, the upfront cost of utilizing PAYG can be almost double that of business-as-usual, given the service and technology costs involved. Until those costs decline substantially — when PAYG companies can serve a critical mass at the bottom of the pyramid — it does not seem a viable solution for low-income households. Indeed, companies operating in this sector are, currently, focusing on low-hanging fruit in urban areas – fringe households that cook with LPG sometimes but continue to stove stack with charcoal or wood fuel.

From both an end-user and supplier perspective, the model certainly has promise but may require governments to offer targeted demand-side subsidies to enable wider scale-up, along with further efforts to exploit possible cost efficiencies. A noteworthy development (out of Ghana) in 2020 was Circle Gas Limited's acquisition of Tanzania-based KOPAGAS's PAYG technology in a transaction worth USD 25 million, to date the largest purely private equity investment in the clean cooking technology sector (GSMA 2020). The momentum behind pay-as-you-cook continues to build and is a sector worth watching for public and private actors alike.

VIETNAM

Vietnam is strongly committed to fulfilling its Intended NDC within the context of the Paris Agreement and has declared unconditional commitments to reduce greenhouse gas emissions by 8 percent relative to business-as-usual by 2030. It is predicted to be one of the

countries most vulnerable to, and significantly impacted by, climate change (IFAD 2011) and the development of biogas is explicitly embedded in Vietnam's NDC as a means of achieving these country-wide emissions reductions.

The biogas policy landscape in Vietnam has been dominated by the Biogas Programme since its inception in 2003, spearheaded by the Dutch development organization SNV, amongst others (see Table 9). The programme, which is moving into its fourth phase later in 2021, aims to tackle availability, affordability, and accessibility specifically in relation to biogas for clean cooking, thus far resulting in the creation of more than 250,000 on-site biodigesters.

However, Vietnam's Ministry of Agriculture and Rural Development (MARD) estimates that only one-fifth of the 8.5 million farming households in Vietnam had installed biogas generators as of 2017 and, of the 18,000 livestock farms, only 60 percent of them treat waste with the help of biodigesters (MARD 2010). The low installation rate exists in spite of the fact that livestock farmers are obliged to collect and treat livestock effluent under the (2018) Livestock Law; failing to do so results in a fine of between USD 21 and 43.

Subject to the financial situation of each issuing province, subsidies of at least USD 154 were provided to farmers to alleviate up-front costs of biodigesters; a relatively small subsidy in the context of average upfront costs of USD 612 in Asia. Nonetheless, these demand-side subsidies were initially a very significant component of the Biogas Programme, particularly in some northern Vietnamese provinces. The subsidies were withdrawn in phase III of the programme (2016–2020) as the focus pivoted to ensuring market and commercial sustainability.

In terms of general awareness of biogas technology, effective communications campaigns orchestrated by provincial agricultural extension services ensured biogas became a familiar and sought-after clean cooking solution amongst farming households keen to benefit from the bioslurry.

TABLE 9
The Biogas Programme 2003-2020: A Public-Private Partnership

Stakeholder	Contribution
GIZ, EnDev	Results-Based Financing (aimed at facilitating sector transformation away from subsidies towards market-based, commercially sustainable biogas enterprises) Collaboration with financial institutions to leverage opportunities for microcredit to households
SNV	Programme design & leadership Market building (demand- & supply-creation, quality control)
Ministry of Agriculture and Rural Development	Demand-side subsidies (for equipment costs/biodigester installation) decided and provided at the provincial level Invested USD 100 million up until 2018 (for household biodigester installation) (MARD 2020)
ADB	Low Carbon Agricultural Support Project loan, which added USD 19 million for biogas infrastructure expenses and facilitating access for low-income families (ADBI 2019) Gender targeting component via training schemes (at least 20 percent of mason trainees were women)
Nexus for Development	Monitoring and certification of carbon credits (to cover the programme's operational costs)
Effective communications campaigns ensured biogas became a familiar and sought-after technology throughout Vietnam, helping to tackle awareness - often a key barrier to untraditional clean cooking solutions	

a. Carbon Finance

Gold Standard carbon credits provide a key pool of capital for the Biogas Programme, monetizing the avoided emissions from households switching to biogas from unclean fuels. This process was monitored and certified by the non-profit Nexus for Development. As of 2020, the revenue generated from carbon credits was approximately USD 8 million, covering more than 50 percent of the programme's operational costs. Moreover, the hope was that the programme's continuation after 2020 would be based solely on the revenue from carbon finance. However, due to a lack of appropriate legal and regulatory frameworks, it is unclear how carbon revenues should be redistributed by the government that receives them; the carbon market is still a very new concept within local and national governance structures and the carbon revenue is fungible. Despite these regulatory and bureaucratic constraints, the programme has demonstrated the potential for carbon finance to help Vietnam fulfil its NDC (estimated at over 480,000 tCO2 per year) while simultaneously working to improve clean cooking access in line with SDG7 (SNV 2015).

b. Planned Future of the Biogas Programme

Moving forward, the Biogas Programme — which has become deeply embedded within local governance structures — hopes to move away from small-scale, on-site digesters towards medium- and large-scale commercial plants, with a new focus on bioslurry processing and marketing. Ultimately, the bioslurry carries the most potential leverage to incentivize farmers to switch to biogas. There is also scope for upgrading biogas[83] to generate on-site electricity for larger farms, especially as this sector moves from smallholder to industrial-sized pig farming. Indeed, large pig farms have high electricity requirements for cooling systems and ventilators, and would therefore benefit greatly from access to on-site, pig-powered electricity.

While biogas has to date been a relatively niche rural or peri-urban clean cooking solution, attempts were made to utilize municipal (solid) waste in urban areas as feedstock for biodigesters. However, the processing technology in Vietnam is too immature for this purpose and technology imported from more economically advanced countries was ill-suited to local conditions. Under the Ministry of Science and Technology, efforts are being made at Vietnam's National Agency for Technology Entrepreneurship and Commercialization Development to establish working relationships with international partners to induce technology transfer to domestic biogas enterprises. They are also seeking to engage investors to finance urban biogas technology installed in restaurants and hotels, as is practiced in other countries like Denmark, which would, in turn, further augment the role of biogas in the country's cooking mix.

COMPARATIVE ANALYSIS – LPG MARKET IN VIETNAM

Introduced in the early 1990s, the current LPG market size in Vietnam is approximately 1.3 million tons per year, with half of national demand fulfilled via imported LPG. The Petro Vietnam Gas Corporation (PVGAS) is Vietnam's largest LPG supplier and the dominant actor in the market with a distribution network that spreads throughout the country. While the country operates the BCRM, LPG suppliers cannot completely stave off counterfeit products and the poaching of branded cylinders.

The Vietnam Gas Association continues to channel efforts into investigating and handling violations, however, they are restrained by the heterogeneity in regulatory and enforcement policy across provinces. On the consumer-side, studies indicate the presence of so-called 'lower-income urbanites' in Vietnam who do have access to LPG but cannot afford to use it on a frequent basis and instead use it only for quick cooking tasks. In short, whilst developed compared to other lower-middle income countries, the LPG market in Vietnam is still evolving towards full maturity and broad-based access.

[83] Biogas contains a high methane content (75–99 percent) that can be further upgraded to natural gas quality and then injected into a natural gas grid.

BARRIERS AND PATHWAYS TO INCREASE ACCESS

The two cases — LPG in Ghana and biogas in Vietnam — exhibit certain similarities but also several particularities with regard to barriers and pathways for access; a consequence of the technologies being prioritized and local policy and financing landscapes. Widely recognized amongst stakeholders, there is no one-size-fits-all approach to increasing clean cooking access, which requires localized solutions tailored to the country- (and cultural-) specific context.

GHANA

By completing the transition to a disciplined BCRM, in line with international best practice, Ghana will create a more integrated and bankable LPG ecosystem, helping to attract and catalyze investment:

While fuel and stove stacking is and will continue to be a landmark feature of the road towards SDG7, there is little doubt LPG can play a key (transitional) role in widening access to clean cooking and reducing HAP-induced deaths in Ghana. Establishing a disciplined LPG market therein will:

- Ensure better safety across the entire LPG ecosystem, from upstream producers to downstream consumers.
- Reduce affordability constraints for consumers who need not purchase a cylinder but, instead, provide a smaller deposit to marketing companies.
- Increase accessibility for consumers who, previously, would have to travel large (prohibitively expensive) distances to reach microfilling stations but will be able to access more localized cylinder exchange points.

Moreover, market restructuring can go hand-in-hand with pay-as-you-cook financing models:

- Since cylinder control is centralized within the marketing companies' node of the supply chain, the BCRM can be made compatible with other consumer financing models. With appropriate, well-targeted government support, this symbiotic relationship can be leveraged to expand access to LPG for cooking, from fringe users to bottom-of-the-pyramid households.

Critical steps moving forward include ensuring tight regulation and penalties for non-compliance (i.e., cylinder theft) within the bounds of the BCRM; reducing the hydrocarbon-specific taxes on LPG to counterbalance any price increase that results from the BCRM transition, and acceptance amongst a range of actors that LPG is a key transitional fuel for households moving up the clean cooking energy ladder. Indeed, with nine years remaining, meeting SDG7 in Ghana will require a whole suite of different clean cooking solutions, thus ICS — providing tier 1/2 access — will also feature (particularly in the context of rural last mile distribution), parallel to LPG policy targets and waste-to-energy initiatives. Integrated energy planning, including a clear and comprehensive clean cooking strategy, could help to operationalize these recommendations.

VIETNAM

The biogas landscape reflects a very centralized, singular Biogas Programme offering a decentralized household solution for clean cooking and waste management: The enduring success of the programme has been its creation of a market for, and establishing the commercial viability of, biogas throughout the country, developing the relevant technical expertise and know-how for biogas mason enterprises to exist independently of donor support.

Moving forward, stakeholders should seek to pursue regulatory reform, foster technology transfer, and scale up biogas to increase clean cooking access:

- Consolidate and clarify the regulatory and legal framework regarding carbon finance revenues so that the country is best placed to capitalize on this pool of finance. Establishing a national carbon finance plan would allow governments to enter into agreements with carbon buyers for large-scale contracts, the revenues of which could be redistributed as targeted demand-side subsidies to help alleviate affordability constraints amongst lower-income households seeking to install a biodigester.

- Foster technology transfer from countries with advanced biogas sectors to develop urban biogas opportunities and diversify feedstocks for biodigesters; currently feedstock availability can undermine the incentive to invest in a biodigester, particularly since the price of pork is prone to fluctuating and farmers will, in turn, sell off their pigs.
- Scale-up biogas via investment into medium- and larger-scale (commercial) biodigesters, in turn, augmenting the role of this fuel in the country's (cooking) energy mix.

COMMONALITIES

In both Ghana and Vietnam, policies must tackle availability, affordability and accessibility to ensure growth in the use of clean cooking.

- *Availability:* In both countries, latent demand exists for both fuels; it is a question of investing in the value chain and providing capacity, policy and regulatory support to make these clean cooking solutions fully available.
- *Affordability:* In both countries, lower-income households struggle to overcome the high upfront costs of what are, comparatively, more economical fuel choices (at least for households who purchase, rather than gather, their cooking fuel). There is space for targeted demand-side subsidies to help jumpstart the market without necessarily creating market distortion and/or preferential tax treatment, applied to both fuels and accompanying equipment, to reduce prices for consumers. Households who need consumer financing the most are often those with the least access to it (SEforALL & Dalberg 2021).
- *Accessibility:*
  - In Ghana, rural last-mile distribution continues to be prohibitively expensive for LPG companies and, lacking the necessary investment in road and distribution networks, this market segment will continue to require ICS for clean cooking. Households can only make the switch to LPG if it is reliable and easily accessible.
  - In Vietnam, 80 percent of 8.5 million farming households are yet to install biodigesters and are likely to be the focus of biogas mason enterprises operating independently as a result of the Biogas Programme. Provided there is also demand-side, targeted financial support, on-site biogas — and thus clean cooking — can become a reality for these households.

Both countries should capitalize on certain frontier technology opportunities for clean cooking access moving forward.

- In Vietnam the scope for medium- and large-scale biodigesters is yet to be explored, as is the possibility of harnessing biogas to small- and medium-sized enterprises (SMEs) (for example restaurants). Moreover, given the country's familiarity with anaerobically produced biogas, its large agricultural sector, and its well-developed LPG market, Vietnam might now consider the technical feasibility of bio-LPG as another, even cleaner fuel in its (cooking) energy mix.
- In Ghana, it has already been acknowledged that there is potential for biogas[84] but this will require concerted policy planning and biogas champions to lead such waste-to-energy initiatives. There is a need for finance and pilots to assess the technical and commercial viability of these other clean cooking solutions, hinted at in the latest draft of the National Energy Policy. Moreover, given that 84 percent of the population now have access to electricity, there appears also a strong case for investigating and promoting electric stoves and the accompanying delivery and consumer financing models. Until then, on the LPG front, potential synergies to be exploited include targeting (women) street vendors with LPG access campaigns and (rural) households with off-grid electricity access packages that bundle solar home systems together with PAYG LPG. Coordinated electricity access, clean cooking access, and climate change strategies — crafted with a gender lens — offer synergies for simultaneously meeting SDG7 along with several other (SDGS).

[84] Potential to develop 80,000–270,000 household biogas plants.

APPENDIX I: ELECTRICITY LANDSCAPE: DATA IMPROVEMENTS AND GAPS

While the report aims to provide the most comprehensive analysis of finance for energy access, several data gaps can have implications on the report's findings (Figure A1).

FIGURE A.1
Electricity Finance Captured by the Report

IMPROVEMENTS AND/OR ADDITIONS IN THE CURRENT EDITION

International Energy Agency (IEA): This year's edition has substantially benefitted from collaboration with the IEA. The IEA provided the energy access investment requirements for several high-impact countries (HICs) tracked in its World Energy Outlook 2020 and the Africa Energy Outlook 2019 reports. The IEA also shared its 2019 electricity consumption estimates by country, published in the World Energy Balances report (IEA 2021), which improves accuracy of this report's estimates for residential and non-residential investments.

GOGLA: GOGLA is the global association for the off-grid solar energy industry. Established in 2012, GOGLA now represents over 180 members as a neutral, independent, not-for-profit industry association. Since 2017, GOGLA has improved the coverage of overall financing activity for the solar off-grid solutions captured in the report by providing data on the financial transactions of companies selling pico-solar products, solar home systems and off-grid solar appliances targeted towards residential access (GOGLA's Deal Investment Database). This dataset includes information both on publicly disclosed transactions, and confidential ones shared by investors and off-grid solar companies since 2012. However, due to the confidentiality of the latter, only the publicly disclosed transactions have been shared for the purpose of this report, and as such the figures outlined in the main body of text represent a conservative view of overall financing activity for solar off-grid solutions.

Carbon finance: Understanding the Landscape 2021 uses the project registry data from Gold Standard to capture carbon finance projects on the voluntary market, in addition to the UNFCCC's Clean Development Mechanism (CDM), which publishes details on annual issuance online. This approach covers around 40 projects per year. This is considerable when compared to the projects included in the previous reports, which included three carbon offset projects financed by the World Bank in the headline numbers, and only covered five UNFCCC projects in the carbon finance estimation.

DATA GAPS IN THE CURRENT EDITION

Domestic public finance: Data tracking for domestic public finance, such as spending through national public budgets, transfers from national government to local government, and infrastructure investment in state-owned enterprises, remains largely limited. Collecting such information is challenging due to a lack of consistent methodologies and guidelines across countries, difficulty in distinguishing between different budget items (operational and investment), and in many cases insufficient institutional capacity of national governments and their agencies. For clean cooking in particular, domestic public finance may have significant impacts on access to clean cooking solutions that are not tracked in the data.

Private-sector investment in energy efficiency: Energy efficiency investments are often components within larger projects, requiring additional information that private actors are unlikely to report voluntarily. Consequently, this report provides limited information on energy efficiency except for transactions reported by public actors.

Fuel subsidies: Fuel subsidies are not included in the Methodology as they are revenue support mechanisms that often pay back investment costs, as opposed to the primary asset investment tracked in this report. These subsidies are addressed in greater detail in the Understanding the Landscape report series through country case studies, where applicable. In many cases, such as subsidies for LPG fuel to replace kerosene, the subsidies can have a significant impact in promoting clean cooking solutions.

Fuel infrastructure: Investment or expenditure in infrastructure for fuels such as LPG or ethanol are not included in the numbers reported due to data gaps and opacity of the available data, unless there is enough evidence on their benefitting residential consumers. Box 7 addresses this data limitation in more detail.

APPENDIX II: DEFINING CLEAN COOKING

While there are no universally accepted definitions of clean cooking solutions, several institutions and definitions are guided by the "ISO[85] Tiers of Performance" of stoves/fuels, and consider either: indoor air quality, solid versus non-solid, or traditional versus modern approaches (outlined in Methodology).

FIGURE A.2
Different Perspectives and Definitions of Clean Cooking

Perspective	Description/ Definition	Source/ Organization
Solid vs. non-solid	Solid fuels, such as wood, charcoal and biomass (with the exception of processed biomass), are polluting and dangerous when compared to their non-solid counterparts, such as LPG, kerosene and electricity, which are considered clean. This definition does not consider the role played by the stove technology efficiency. UN Statistics indicates that while this notion has been used to collect data, technical guidance from the WHO recommends pairing fuel with stove to qualify clean cooking solutions (UNSD and WHO 2020).	
Indoor air quality	This definition focuses on the health impact of the stove and fuel, where a clean solution is defined by an emission rate target from household fuel combustion for particulate matter (PM2.5) and carbon monoxide (CO) depending on whether the stove is vented. In addition to this, specific normative guidance for fuels such as processed coal and kerosene (solid but polluting fuel) is included.	WHO (WHO 2014)
Tier approach	The Clean Cooking Alliance categorizes stoves and fuels as "efficient" or "clean," and applies a tiered performance to them. Under this definition, stoves/fuels are efficient if they meet minimum tier 2 for efficiency and are clean if they meet tier 3 for indoor or overall emissions.[86]	Clean Cooking Alliance (CCA 2020)
Country baselines	The World Bank definition refers to "clean cooking solutions" as a combination of stove technologies and clean fuel cooking solutions that produce lower particulate and carbon emissions levels compared to the current baseline in a specific country. These emission levels and efficiency are defined by the ISO Tiers of Performance for the indoor emissions indicator. In contrast to the other perspectives, RISE has shown that standards and definitions of "clean" can thus depend on the country's context.	ESMAP (RISE 2018)
Modern energy cooking services (MECS) and Improved Cooking Services	ESMAP refers to Modern Energy Cooking Services (MECS) for households that reach tier 4 or higher level of access to clean cooking for the six attributes of the MTF (exposure, efficiency, convenience, safety, affordability and availability). Households that satisfy tier 2 or 3 standards of access across these attributes are categorized as having Improved Cooking Services and are considered to be in transition.	ESMAP, World Bank Group, MECS (ESMAP 2020a)

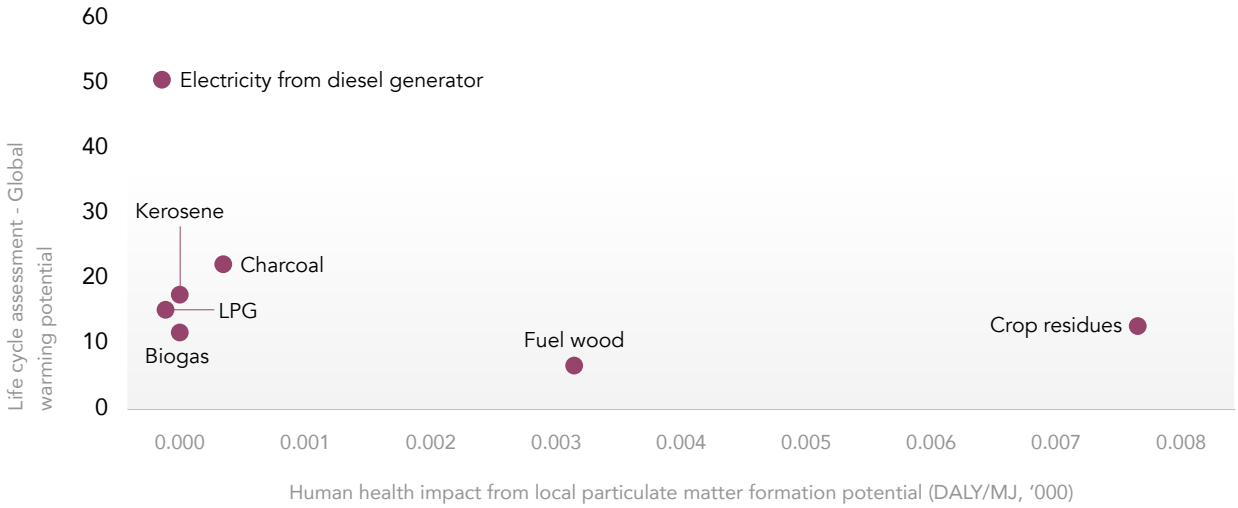
[85] Potential to develop 80,000–270,000 household biogas plants.
[86] "Clean" can relate either to potential health or environmental impacts.

Another important aspect to be considered is the trade-off between the different perspectives. One study compared the local emission level for several cooking solutions with their life cycle assessment (LCA),[87] which depends on the electricity supply mix, in contrast with the common approach of measuring the local health impact only (Aberilla et. al 2020). Based on the grid supply of rural communities in the Philippines, the study shows that while cooking with LPG has no adverse impact on the user's health, the global warming potential is relatively high when compared to other fuels.

There are also data gaps that occur when using any of these approaches. Common behaviours such as "fuel stacking" — when a household uses a variety of cooking methods, fuels, technologies, and appliances — are difficult to capture in the data. As such, the increased use of electric appliances or LPG and ethanol stoves for certain tasks, in conjunction with ICS or three-stone fires, is often unaccounted for.

FIGURE A.3

Local and Global Impacts of Clean Cooking Solutions



Note: Adapted from Aberilla et. Al (2020). Impact is measured per MJ at stove. DALY corresponds to disability-adjusted life years. Both local and global impacts are calculated from assumptions based on rural communities in the Philippines for electricity supply mix and other inputs.

The results from this study are contingent on characteristics of the analyzed countries and would vary when considering other baseline scenarios and electricity supply breakdowns.

[87] A life cycle assessment (LCA) considers the impact at all stages of a product, from production to use. For example, in this study, the LCA of cooking with LPG takes into account oil and gas extraction and refining, while the impact of electric cooking includes electricity generation (Aberilla et al. 2020).

APPENDIX III: CARBON FINANCE ESTIMATES

As a sector with significant impact in net emissions reduction, compared to the baseline inefficient cooking scenario, the financing of clean cookstoves has been enabled through carbon markets for at least 12 years (Ecosystem Marketplace 2019). Recent strenuous negotiations concerning the Paris Agreement's Article 6, by which countries could meet their Nationally Determined Contributions (NDCs) through the purchase of another country's emission reductions, have brought carbon markets back into the spotlight (IISD Reporting Services 2019). This international mechanism, which boasts significant catalytic potential for climate mitigation finance, foresees a transition from the Kyoto Protocol Clean Development Mechanism (CDM) to the Sustainable Development Mechanism (SDM), where established methodologies for the design of carbon credit projects are likely to persist.

Under these mechanisms, project developers develop Emissions Reductions Purchase Agreements (ERPAs), specifying the terms of sale and monitoring of carbon offset projects, following certified carbon-accounting methodologies that have evolved over the past 20 years. However, while information on the number of credits generated by a project — corresponding to the incremental emission abated compared to the carbon intensive baseline — is publicly available, there is less transparency on the financial terms of the transactions. The following key points illustrate the challenge in tracking carbon finance as a source of clean cooking finance commitments:

1. **Lack of transparency:** ERPAs are negotiated between two or more parties and may include terms that do not directly concern the volume of emission reductions. The ultimate value of the transaction is therefore difficult to deduce using publicly available impact reports. This lack of transparency and general information asymmetry between project developers and buyers is especially problematic as it can create negotiating power imbalance for local project developers as the "market" price is often unknown (ADEME et. al 2012).
2. **Carbon pricing:** While prices may not be publicly disclosed, carbon offset projects have extensive documentation on the reduction impact. However, the range of carbon prices can vary from below USD 1 to USD 100, adding to the fact that financial transactions can hardly be extrapolated from the detailed monitoring reports of emissions avoided (SEforALL & CPI 2019).
3. **Monitoring:** Carbon projects must be regularly monitored to implement the methodology and ensure that the estimated emission reductions have taken place. This is a challenge for the distribution of stoves as consumer usage must be closely monitored for the volume of credits to be confirmed, especially considering proven fuel stacking. Recent progress in monitoring either at the fuel distribution level or in technological improvements in stove usage tracking can ensure that the project has generated the credits, thus significantly reducing the burden of monitoring for project developers and making the process more efficient.[88]

In *Understanding the Landscape 2019*, an initial estimate was made by applying carbon pricing to five clean cooking projects provided by the UNFCCC, yielding estimates in the range of USD 2.5–51 million. This year's approach, while still an estimation, offers a significant improvement in methodology from the previous report, for the following reasons:

1. **Improved project coverage:** *Understanding the Landscape 2021* uses the project registry data from Gold Standard to capture carbon finance projects on the voluntary market, in addition to the UNFCCC's CDM, which publishes details on annual issuance online. This approach covers around 40 projects per year. This is considerable when compared to the projects included in the previous reports, which included three carbon offset projects financed by the World Bank in the headline numbers, and only covered five UNFCCC projects in the carbon finance estimation.

[88] Both SEforALL and the Clean Cooking Alliance have advanced or supported research to improve the monitoring of stove use to track adoption of cooking solutions (SEforALL 2018).

2. **Carbon price estimates:** The report uses the price estimates produced by Forest Trends' Ecosystem Marketplace, which surveys over 105 voluntary carbon market participants such as project developers, traders and other intermediaries on their activities. While project-level data are not available, the report states that the price for clean cooking projects averaged USD 5 in 2018, only a slight decrease from the average of USD 5.1 and USD 6.2 recorded by respondents in 2016 and 2017, respectively.[89] This provides more accurate estimates than using the wide range of potential CO2 prices.

3. **Granular information:** Project-level data from the Gold Standard Impact Registry provide granularity on the amount of verified emission reduction (VER) issuances occurring in a given year, allowing a more accurate estimate than the previous approach, where the total VER for a project spanning multiple years was divided by the number of years of issuances.

Through this methodological improvement, USD 20 million of carbon finance was added to the report's clean cooking tracking inventory for 2018, and USD 10 million of carbon finance was included in the tracking inventory for 2019. A significant portion of this figure consists of carbon offset projects in the voluntary carbon market, as the report used an average price obtained through the Ecosystem Marketplace report to estimate transactions from detailed issuance data from Gold Standard. In contrast, this analysis only included data from the UNFCCC CDM when data on both capital investment and annual issuance volume were available. While the graphs in this section include numbers resulting from both approaches, the report details its approach and results for both mandatory and voluntary markets.

APPENDIX IV: METHODOLOGY FOR ESTIMATING LPG INVESTMENTS

Capturing investments for residential clean cooking access for LPG and ethanol fuels, which require heavy infrastructure investment, is a consistent challenge for this tracking exercise, for the following reasons:

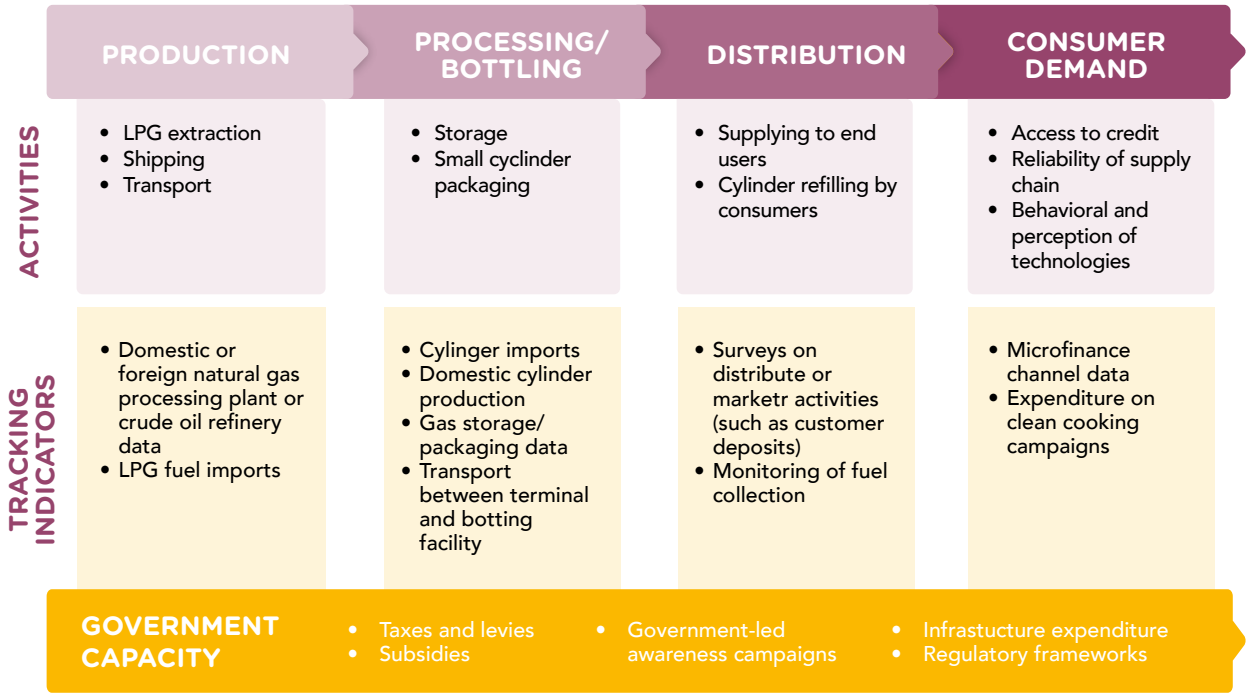
1. In contrast to the other clean cooking solutions tracked in this report — such as improved cookstoves, biogas digesters and solar cookers — LPG and ethanol solutions require significant industry and infrastructure investment. While investment for stoves is captured in this report, the bulk of investment for these technologies concerns large-scale infrastructure provided by private project developers or small and medium-sized enterprises (SMEs) that do not report to the data sources used in this report. However, in the case where enough evidence is available that a large infrastructure LPG investment is specifically targeting clean cooking access, the project is included in the analysis. The imported LPG cylinder estimates discussed below are excluded from the landscape numbers due to data limitations.
2. Similarly, domestic government-led fuel subsidies, which can amount to billions of dollars in annual expenditure (SEforALL and CPI/2019), cannot be included as it cannot be ensured that the end use is directed toward primary asset investment rather than revenue-building activities. Furthermore, the investment need number of USD 4.5 billion used in this report does not include fuel subsidies (IEA 2020), although price incentives are likely to be part of the solution to displace the use of traditional stoves in HICs.

[88] The Forest Trends report conducts a survey for market participants on the voluntary market only. Prices reported thus correspond to verified emission reduction (VER) credits rather than certified emission reduction (CER) credits, the latter of which refers to carbon offsets issued under the CDM. Both are equivalent to one ton of CO2 emission avoided.

3. Infrastructure investments that can be tracked are usually multi-million-dollar transactions for which the residential clean cooking use can be difficult to demarcate. Furthermore, large capital investments, as opposed to project-level data usually tracked in this report, encompass wider revenue-building activities that may not correspond to primary asset investment.

Despite these methodological challenges, addressing data gaps remains a priority for the report. Figure A-4 illustrates a proposed tracking framework for tracking investments for these fuels, based on the LPG value chain.

FIGURE A.4
Proposed Framework for Capturing LPG Investments



Source: Information gathered and adapted from WLPGA (2019), DLPGOVP (2020), Puzzolo et al. (2019)

Considering the goal of tracking primary asset investment in LPG as a clean cooking solution for households in HICs, a trade-off between accuracy and accessibility of data can be observed. While data on upstream activities may be more readily available, this report's methodology generally excludes projects that finance terminals for the import of LPG, due to the opacity and disconnect between the upstream and the financing's end use. For the same reason, upstream data on LPG extraction are completely excluded, due to the irrelevance to end-user cooking use, especially given that most HICs import the fuel.

In contrast, downstream data points could potentially capture the investment numbers relevant for this report but are lacking in availability. Investments could potentially be obtained from activity-level data from LPG distributors or through consumer surveys like the World Bank's Multi-Tier Framework (MTF) survey, and data on other activities such as microfinance loans or demand-side awareness campaigns could capture relevant investment in advancing access to clean cooking. However, these downstream indicators are limited and generally provided at the country level only.

ABBREVIATIONS

BCRM	Branded cylinder recirculation model
CCCM	Consumer controlled cylinder model
CDM	Clean Development Mechanism
CPI	Climate Policy Initiative
CRS	Creditor Reporting System (of the OECD)
DAC	Development Assistance Committee (of the OECD)
DFIs	Development finance institutions
ERPA	Emissions Reduction Purchase Agreement
ESMAP	Energy Sector Management Assistance Program
GLPGP	Global LPG Partnership
GW	Gigawatts
HICs	High-impact countries
ICS	Improved cookstoves
IEA	International Energy Agency
IMF	International Monetary Fund
kWh	Kilowatt-hours
LCA	Life cycle assessment
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LPGMC	LPG marketing company
MARD	Ministry of Agriculture and Rural Development (Vietnam)
MECS	Modern Energy Cooking Services
MFIs	Multilateral financial institutions
MTF	Multi-Tier Framework
MW	Megawatts
NDC	Nationally determined contributions
ODA	Overseas development assistance
OECD	Organisation for Economic Co-operation and Development
OMC	Oil marketing company
PAYG	Pay-as-you-go
RBF	Results-based financing
SDG	Sustainable Development Goal
SDM	Sustainable Development Mechanism

SEforALL	Sustainable Energy for All
SME	Small and medium-sized enterprises
Solar PV	Solar photovoltaic
SSA	Sub-Saharan Africa
T&D	Transmission and distribution
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars
VER	Voluntary emissions reduction
WLPGA	World LPG Association

GLOSSARY OF TERMS

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, ethanol stoves, biogas digesters, electric stoves, improved biomass stoves (referenced here as ICS), liquefied petroleum gas (LPG) stoves, natural gas stoves, 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 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.

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.

Domestic finance: Finance where the funding institution (either publicly- or privately-owned) is primarily based in the country where the project is being developed or constructed.

Disbursements: Funds that are transferred to a project after a commitment is made. For example, when a funder commits to invest in a project in 2017, but the project can only commence construction in 2018, funds transferred to the projects' builders and consultants in 2018 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 generation plants, electricity transmission and distribution infrastructure, and mini-grid and off-grid solutions.

High-impact countries (HICs): 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 Tracking SDG7: The Energy Progress Report 2020 (IEA et al. 2020). (See Box 1 for more details.)

Finance for residential clean cooking access: The estimated portion of finance for clean cooking for which the residential sector is the ultimate end user, that is, 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. For example, 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.

Modern Energy Cooking Services (MECS): Refers to a household context that has met the standards of tier 4 or higher across all six measurement attributes of the Multi-Tier Framework (MTF): convenience, (fuel) availability (a proxy for reliability), safety, affordability, efficiency and exposure (a proxy for health related to exposure to pollutants from cooking activities).

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 (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 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 Methodology.

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

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

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 Organisation for Economic Co-operation and Development (OECD) definition, finance qualifies as public if it is provided by central, state, or local governments and their agencies at their own risk and responsibility.

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

DETAILED METHODOLOGY

List of HICs

Much has changed since the first edition of this report. To better reflect the evolving realities of the energy access landscape, this year's report captures the HICs as reported to be the 20 top energy-deficient countries in *Tracking SDG7: The Energy Progress Report 2021* (IEA et al. 2021). The HIC list therefore has now been updated to include South Sudan for electricity; it no longer includes Yemen. For clean cooking, Niger has been added and Sudan is no longer tracked.

FIGURE A.5
HICs Analysed in the Report

Country	ELECTRICITY	COOKING	Region	Population without electricity access (in million)	% of population without access to electricity	Population without clean cooking access (in million)	% of population without access to clean cooking solutions
Afghanistan			South Asia			24	68%
Angola			Sub-Saharan Africa	17	54%		
Bangladesh			South Asia	13	8%	131	79%
Burkina Faso			Sub-Saharan Africa	17	82%		
Chad			Sub-Saharan Africa	15	92%		
China			East Asia and Pacific			532	38%
Congo (DR)			Sub-Saharan Africa	70	81%	77	95%
Ethiopia			Sub-Saharan Africa	58	52%	99	95%
Ghana			Sub-Saharan Africa			23	78%
India			South Asia	30	2%	589	44%
Indonesia			East Asia and Pacific			66	25%
Kenya			Sub-Saharan Africa	16	30%	42	85%
Korea (DPR)			East Asia and Pacific	13	51%	23	90%
Madagascar			Sub-Saharan Africa	19	74%	25	99%
Malawi			Sub-Saharan Africa	17	89%		
Mozambique			Sub-Saharan Africa	21	70%	28	95%
Myanmar			East Asia and Pacific	17	32%	40	74%
Nepal			South Asia				
Niger			Sub-Saharan Africa	19	81%	21	98%
Nigeria			Sub-Saharan Africa	90	45%	173	91%
Pakistan			South Asia	56	26%	106	54%
Philippines			East Asia and Pacific			58	55%
South Sudan			Sub-Saharan Africa	10	93%		
Sudan			Sub-Saharan Africa	20	46%		
Uganda			Sub-Saharan Africa	26	59%	43	99%
United Republic of Tanzania			Sub-Saharan Africa	36	62%	55	99%
Vietnam			East Asia and Pacific			36	38%

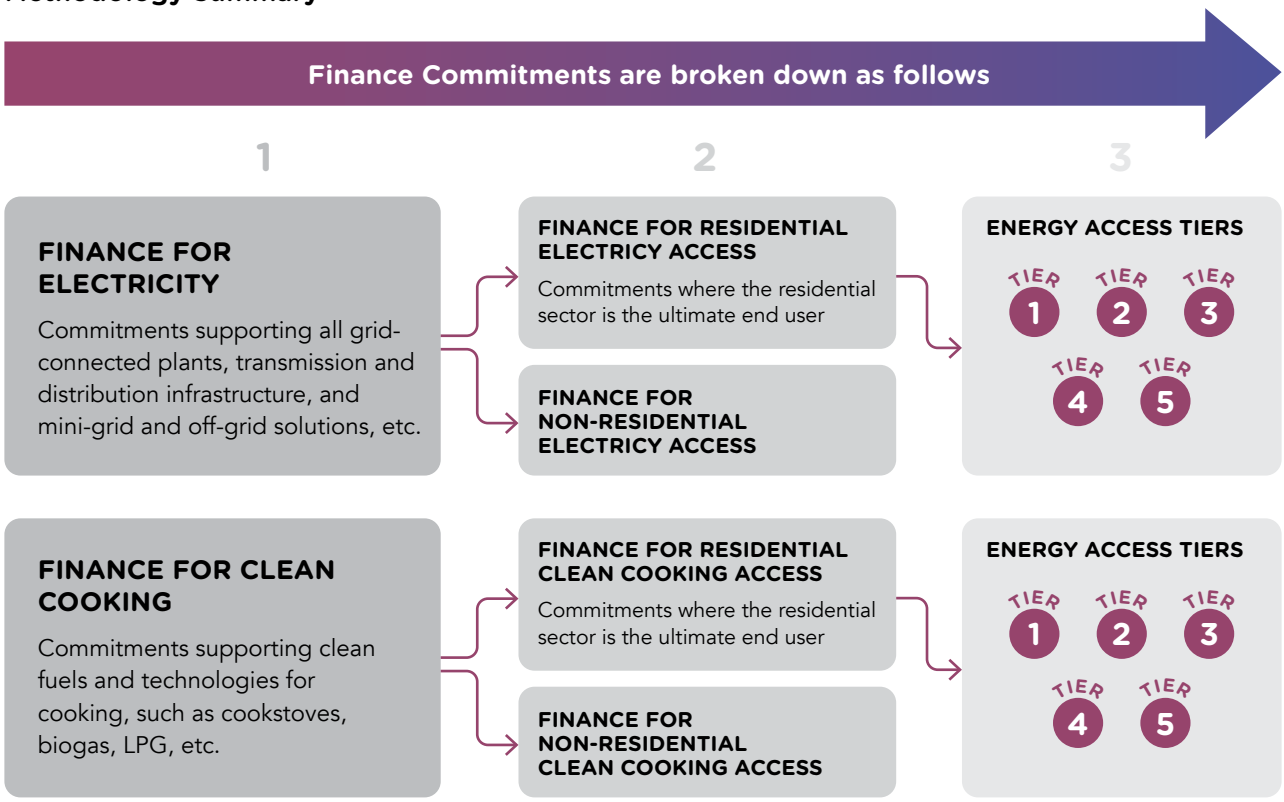
Source: Tracking SDG7: The Energy Progress Report 2021

TRACKING METHODOLOGY

The report follows a three-step approach to map commitments intended to increase access to electricity and to clean cooking solutions across the 20 HICs (Figure A.6):

1. Tracking finance for electricity and clean cooking, with a focus on commitments.
2. Estimating the portion of finance for residential energy access
3. Applying the MTF to identify the type of energy access provided.

FIGURE A.6
Methodology Summary



STEP 1: TRACKING FINANCE FOR ENERGY ACCESS FOR ELECTRICTY AND CLEAN COOKING

Building on the methodology developed by Sustainable Energy for All (SEforALL), Climate Policy Initiative (CPI) and the World Bank in the first edition of Understanding the Landscape and CPI's Global Landscape of Climate Finance 2019 methodology, the report begins by tracking public and private finance commitments[90] to any project that enhances energy access to 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. The report considers only collected information that was available at the project level, disregarding aggregate (regional or global), unverifiable figures, and top-down estimates, which may lead to underreporting of total finance received by the HICs.

[90] 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.

The report tracks commitments according to the following dimensions:

A) TECHNOLOGIES

Electricity technologies tracked in the report include electricity generation technologies and the transmission and distribution network.[91] Specifically, the following technologies are included, as either electricity generating or facilitating the final 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)
- Off-grid assets including solar (solar home systems, solar lanterns) and non-solar technologies.
- Market support activities, including capacity building, technical assistance, and institutional support for energy reforms, amongst other activities
- Energy efficiency investments that support energy conservation and demand reduction, including building and industry upgrades, clean transport, smart grids, metering, tariffs, improvements in lighting, appliances and equipment

Terminology in the clean and improved cooking sector is variable. This report considers the following technologies and initiatives:

- Stoves and fuels – advanced biomass, ethanol, biogas, ICS, electric, LPG, natural gas.
- Fuel infrastructure – investments in clean cooking fuel infrastructure (LPG, natural gas, and ethanol-cooking technologies) that target no more than two distribution levels away from end use. This includes LPG storage facilities and cylinder bottling plants.

B) SOURCES

Public sector institutions include:

- Multilateral development finance institutions (DFIs) including climate funds and EU institutions, where the institution has multiple shareholder countries
- Bilateral DFIs, where a single country owns the institution
- National DFIs, including public banks and local public sector providers of debt instruments
- Export credit/promotion agencies
- Government international, refers to bilateral Official Development Assistance (ODA) and Other Official Flows (OOF)
- Government domestic, domestic financing through public budgets carried out by central, state or local governments and their agencies

Private-sector institutions include:

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

C) FINANCIAL INSTRUMENTS

The report tracks:

- Grants
- Project-level debt (both concessional and commercial), where debt relies on a project's cash flow for repayment
- Project-level equity, equity investment relying on the project's cash flow for repayment

[91] Infrastructure and pipelines for supplying liquefied natural gas (LNG) to power generation plants are excluded.

- Balance sheet financing (i.e., a direct debt or equity investment by a company or finance institution)
- Other instruments like crowdfunding

The report does not track disbursements and policy-induced revenue support mechanisms such as feed-in tariffs, secondary market transactions, or other public subsidies (except in the case studies). Feed-in tariffs, for example, pay back investment costs, so including them would constitute double counting. Similarly, guarantees are only exercised in particular circumstances, and there might never be any outflow from the guarantor. Secondary-market transactions, such as the reselling of stakes, are only tracked if they do not constitute double counting with other areas of the data collection.

STEP 2: ESTIMATING THE FINANCE COMMITMENTS FOR RESIDENTIAL ENERGY ACCESS

Once finance commitments for energy access are identified, the portion specifically referring to residential energy access is determined. 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.

Unless project-specific information is available, assumptions are made at country/technology level, 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 (commercial, industrial, public sector). From a methodological standpoint, it would be preferable to use the marginal consumption, for example, 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, available from the International Energy Agency (IEA).

Commitments towards market support activities and energy efficiency are excluded from this step as they render benefits to both residential and non-residential users, and it is difficult to isolate the impact on each category.

STEP 3: ALLOCATING THE ESTIMATED FINANCE COMMITMENTS FOR RESIDENTIAL ENERGY ACCESS TO TIERS

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 may produce limited power. Recognizing the reality of different energy access service levels,[92] the World Bank developed the MTF to measure 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 allows the report to rate energy access from tier 0 (no access) to tier 5 (very high level of access) (Bhatia and Angelou 2015).

The report uses technology-specific ranges of attribution as an initial starting point for allocating technologies to energy access tiers. Figure A.7 and Figure A.8 illustrate those used for electricity and cooking, respectively. Where a technology covers more than one tier, specific attributes based on the MTF are used to determine specific allocation. For example, in the case of central grid-connected plants — ranging between tiers 3 and 5 — country-specific data were applied on the reliability of the grid in that country to determine the final tier of allocation. Figure A.9 summarizes technology-specific assumptions used for the estimates of consumption shares across sectors and allocation to tiers.

For this edition of the report, World Bank and ESMAP teams have provided the results of the MTF surveys about the existing status of electricity access in four HICs: Bangladesh, Ethiopia, Kenya and Myanmar. Replacing the simplified methodology (summarized in Figure A.6) with real-world information collected through household surveys ensures greater accuracy in quantifying the impact of different financing types across service levels (energy access tiers), and across the various consumer sectors (residential and non-residential).

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

FIGURE A.7
The MTF for Measuring Access to Electricity

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Capacity	Power capacity ratings (W or daily Wh)	Less than 3 W	At least 3 W	At least 50 W	At least 200 W	At least 800 W	At least 2 kW
		Less than 12 Wh	At least 12 Wh	At least 200 Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2 kWh
	Services		Lighting of 1,000 lmhr per day	Electrical lighting, air circulation, television, and phone charging are possible			
Availability	Daily Availability	Less than 4 hours	At least 4 hours and less than 8 hours	At least 4 hours and less than 8 hours	At least 8 hours and less than 16 hours	At least 16 hours and less than 23 hours	At least 23 hours
	Evening Availability	Less than 1 hour	At least 1 hour and less than 2 hours	At least 2 hours and less than 3 hours	At least 3 hours and less than 4 hours	4 hours	4 hours
Reliability		More than 14 disruptions per week				(More than 3 and up to 14 disruptions per week) or less than or equal to 3 disruptions per week with more than 2 hours of outage	At most 3 disruptions per week with total duration of less than or equal to 2 hours
Quality		Voltage problems does damage to appliances				Voltage problems do not affect use of appliances	
Affordability		Cost of a consumption package of 365 kWh per year is more than or equal to 5% of household income			Cost of a consumption package of 365 kWh per year is less than 5% of household income		
Formality		Bill is not paid				Bill is paid to the utility, prepaid card seller, or authorized representative	
Health and Safety		Electricity-related accidents in last one year				No electricity-related accidents in last one year	

Source: World Bank, ESMAP, SREP, SEforALL 2020 updating Bhatia and Angelou 2015.
Note: Colours signify tier categorization.

FIGURE A.8
The MTF for Measuring Access to Modern Energy Cooking Solutions

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Cooking Exposure	**Emission** Stove desi SO›s voluntary performance targets (Default Ventilation) PM2.5 (mg/Mjd) CO (g/Mjd) gn	>1030 >18.3	≤1030 ≤18.3	≤481 ≤11.5	≤218 ≤7.2	≤62 ≤4.4	≤5 ≤3.0
	High Ventilation PM2.5 (mg/Mjd) CO (g/Mjd)	>1489 ≥26.9	≤1489 ≤26.9	≤733 ≤16.0	≤321 ≤10.3	≤92 ≤6.2	≤7 ≤4.4
	Low Ventilation PM2.5 (ng/Mjd) CO (g/Mjd)	>550 >9.9	≤550 ≤9.9	≤252 ≤5.5	≤115 ≤3.7	≤32 ≤2.2	≤2 ≤1.4
Cookstove Efficiency	ISO's voluntary performance targets	≤10%	>10%	>20%	>30%	>40%	>50%
Convenience	Fuel acquisition and preparation time (hours per week)	≥7		<7	<3	<1.5	<0.5
	Stove preparation time (minutes per meal)	≥15		<15	<10	<5	<2
Safety		Serious Accidents over the past 12 months				No serious accidents over the past year	
Affordability		Fuel cost ≥5% of household expenditure (income)				Fuel cost <5% of household expenditure (income)	
Fuel availability		Primary fuel available less than 80% of the year				Available 80% of the year	Readily available throughout the year

Source: World Bank, ESMAP, SREP, SEforALL 2020 updating Bhatia and Angelou 2015.

FIGURE A.9
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 (INCL. RURAL/URBAN SPLIT)
RESIDENTIAL ELECTRICITY		
GRID-CONNECTED FOSSIL FUELS AND RENEWABLES	**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 year 2018 using IEA (2020) for the majority of HICs, examining export data, as well as consumption data from the residential and non-residential sectors. For countries not covered by IEA, other sources were used. Sector-specific figures and export figures are then presented as a % of domestic generation.	**Tier allocation:** Grid-connected capacity typically ranges between tiers 3 and 5 according to the IEA and World Bank (2015) and World Bank (2020). 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
TRANSMISSION AND DISTRIBUTION (EXTENSIONS AND UNSPECIFIED)		
MINI-GRIDS, FOSSIL FUELS AND RENEWABLE/ HYBRID	**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 (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 research 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. Project-specific data also confirm this finding.[93]	**Tier allocation:** Mini-grid capacity ranges between tiers 3 and 4 according to the 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

[93] For example, in Nigeria, the overwhelming majority of the identified capacity additions for 2013–15 consist of mini-grid capacity for coastal refineries, presumably with little or no surplus generation available for residences.

	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 the national level.	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.
OTHER OFF-GRID	**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 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 that observed at national level.	**Tier allocation:** Off-grid capacity ranges between tiers 1 and 4 according to the IEA and World Bank (2015, Figure A2.1 and Figure A2.3). • Tier allocation is defined by technology types, following the approach suggested for mini-grids. 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.
OFF-GRID: SOLAR HOME SYSTEMS AND SOLAR LANTERNS	**Residential shares:** GOGLA impact metrics use a conservative estimate of 10 percent as the default coefficient indicating the proportion of customers using solar for business purposes – with the balance of 90 percent of output used for residential purposes.	**Tier allocation:** The report allocates investments to tiers per GOGLA practices and the Tracking SDG7 report, which notes that: "Tier 1: To estimate tier 1 energy access, an 'SEforALL factor' is applied to the sales numbers. This is where a calculator tool developed under the SEforALL initiative is used and has been added to the database to estimate the service-level impact of smaller technologies. This tool reviews the system size and capacity of each product and estimates whether a product has helped to unlock either 'partial' or 'full' tier 1 access. It then calculates the total number of people who have achieved 'partial' or 'full' tier 1 access, to provide an overall estimate of the number of people with tier 1 access. Tier 2: Products that have a capacity of over 50Wp or are over 20Wp and come packaged with a television, are deemed to provide tier 2 energy access. This approach is designed to align product specifications or energy service with the requirements for tier 2 access included in ESMAP's MTF. Please note that products that have enabled a household to achieve tier 2 access are not included in the final tier 1 estimates."
ENERGY EFFICIENCY	Case-by-case analysis to allocate to the specific sector. When information was missing, assumed targeting the residential sector by default.	Not allocated. Further work is needed to develop an adequate methodology for the sector.
MARKET SUPPORT (INCL. TECHNICAL ASSITANCE)	Not applicable.	Not applicable.

COOKING		
ADVANCED BIOMASS (STOVES AND FUEL AND INFRASTRUCTURES)	**Determination 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 indications, 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: split between tiers 2, 3 and 4.
ETHANOL (STOVES AND FUEL AND INFRASTRUCTURES)	**Determination 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.	Same approach as above. 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: split between tiers 3 and 4.
BIOGAS DIGESTERS	**Determination 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.	Same approach as above. 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: split between tiers 3 and 4.

ELECTRIC STOVES	**Determination 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.	Same approach as above. 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: split between tiers 4 and 5.
IMPROVED BIOMASS STOVES (ICS)	**Determination 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).	Same approach as above. 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: split between tiers 1 and 2.
LPG (STOVES AND FUEL & INFRASTRUCTURES)	**Determination of % units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to LPG were allocated to the residential sector by reviewing the details of each project. When available, IEA consumption shares for LPG were used (IEA 2020).	Same approach as above. 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: 4.
NATURAL GAS (STOVES AND FUEL)	**Determination of % units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments were allocated to the residential sector based on a share of consumption (in TJ) as provided by IEA indicators.	Same approach as above. 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: 4
SOLAR COOKING (STOVES)	**Determination of % units (# individual assets) applied to residential vs. non-residential sector:** Financial commitments to solar cooking stoves were approximated at 100 percent to the residential sector based on market knowledge and in consideration of the data source.	Same approach as above. 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: split between tiers 4 and 5.
MARKET SUPPORT	Not applicable.	Not applicable.

DATA SOURCES AND TREATMENT

Figure A.10 provides a list of various public and private data sources used for tracking commitments in the 20 HICs in 2019, followed by a discussion on data treatment issues.

FIGURE A.10
List of Data Sources Used to Track Financial Commitments

Source name	Description	Sector relevance	International/ Domestic	Additional comments
Organisation for Economic Co-Operation and Development (OECD)	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 and Cooking	International	As information was not directly available, a "key words" search was performed to identify and separate off-grid, smart grid and clean cooking activities
Bloomberg New Energy Finance (BNEF)	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 VC/PE financing deals for solar companies located in the 20 HICs
Climate Policy Initiative (CPI)	Project-level data from DFIs (MDBs and IDFC members) collected during the Global Landscape of Climate Finance	Electricity and Cooking	International	Additional data for bilateral and multilateral DFIs that include guarantees, risk mitigation instruments and non-concessional finance not reported in OECD DAC CRS
Climate Funds Update	Additional data on national and multilateral Climate Funds' commitments	Electricity – grid-connected and off-grid renewable generation	International	Complements data on international and domestic public finance for electricity projects
Clean Cooking Alliance	Venture investment database	Cooking	International and domestic	Contributes data on financing raised by clean cooking companies
GOGLA	GOGLA Investment Database on capital flows (debt, equity and grants) into the off-grid solar market.	Electricity – off-grid solar	International and domestic	Financing raised by solar off-grid companies located or operating in HICs
IJGlobal	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

Boston University China Global Energy Finance	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	Complements coal finance data
S&P Global Market Intelligence	Tracks private equity investments in Asia-Pacific and Africa in the Energy and Utilities sectors	Electricity – mini-grids and grid-connected renewable generation	International	Complements mini-grid and grid-connected renewable finance data
Foundation Grant Self-Reporting	Tracks grant funding from philanthropies to energy access	Electricity – mini-grids, off-grid, market support and energy efficiency	International	Complements CPI tracking of foundation finance flows (DOEN Foundation, IKEA Foundation, Shell Foundation. Mott Foundation, and Fundación Netri)
International Trade Centre	Tracks LPG cylinder imports by HICs	Cooking – LPG	International	Captures the financial value of LPG cylinder imports
UNFCCc CDM Registry	Tracks issuance of carbon finance projects	Cooking – all	International	Captures carbon finance projects under the official regime
Gold Standard impact registry	Tracks issuance of carbon finance projects	Cooking – all	International	Captures carbon finance projects for the voluntary markets
International Energy Agency (IEA)	Data on energy access investment requirements for several HICs and country-level electricity consumption estimates	Electricity investment requirements	N/A	Complements financial flow data to assess investment required

Addressing double counting and data treatment across different databases: To avoid double counting when aggregating data from different sources, 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 or IJ Global.

Multi-country or regional level projects: these projects are often marked as regional or global in the data sources, which makes it difficult to identify what portion flows to the 20 HICs. Two approaches were taken to address this:

- OECD CRS: to be conservative in tracking, financing attributed to 'Africa and Asia, regional' and 'global' (some of which is plausibly going to the HICs) was not included in the analysis.
- Data from GOGLA and other surveys: funds going to companies that operate regionally were allocated equally across the countries of operations.

Private-sector transactions: assumptions were taken to estimate a realistic debt-to-equity ratio for projects with undisclosed financial information. For most renewable energy projects, a gearing ratio of 70:30 (debt to equity) was assumed, except for wind projects in China, assumed 80:20. For transactions with multiple debt and/or equity providers with limited information on financing provided, the financing amount was split equally.

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