ENERGIZING FINANCE
RESEARCH SERIES

SUSTAINABLE ENERGY FOR ALL

Dalberg

ENERGIZING FINANCE

Taking the Pulse 2021

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ACKNOWLEDGEMENT

This report was commissioned by Sustainable Energy for All (SEforALL). The SEforALL team was led by Olivia Coldrey, Christine Eibs Singer, Annette Aharonian and Tamojit Chatterjee, who worked in close collaboration with a team from Dalberg Advisors that researched and wrote this report: Kanishka Bhattacharya, Puranjay Chandel, Alexandre Cheval, Monika Fanous, Arianna Freschi, Aly-Khan Jamal, Parth Madan and Michael Tsan.

We are grateful for substantive inputs received from the Steering Committee as this research effort evolved from inception through publication: Jacqueline Kimeu (Access Coalition), Jillene Belopolsky (CCA), Dirk Roos (EIB), Hendrik Engelmann-Pilger (EIB), Alex Evans (GLPGP), Oliver Reynolds (GOGLA), Drew Corbyn (GOGLA), Katrina Pielli (Independent Consultant), Ed Brown (MECS), Mark Correnti (Shine Invest), Wim Van Nes and Rianne Teule (SNV), Usha Rao (UNDP), David Stonehill (USAID/PowerAfrica), Rebekah Shirley (WRI).

We would like to thank the many entrepreneurs, sector experts, and government officials in Ghana, Mozambique and Vietnam who provided knowledge, data, and insights that were critical to the production of this report.

Valuable guidance and oversight were provided by Damilola Ogunbiyi, CEO and Special Representative of the UN Secretary-General for Sustainable Energy for All.

We would like to thank all SEforALL staff for their support, especially Stephen Kent, Meriam Otarra, Tracey Crowe, Emi Mizuno and Ugochukwu Nwadiani. We also thank Jenny Nasser (editor).

SEforALL acknowledges with gratitude the financial assistance provided by the Charles Stewart Mott Foundation that made this report possible. We also acknowledge the Austrian Development Agency, the Ministry for Foreign Affairs of Iceland, and the IKEA Foundation for their core support to our work.

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FOREWORD

Achieving universal access to clean, affordable energy, as called for by Sustainable Development Goal 7 (SDG7), is not possible without significant investment in electricity access and clean cooking solutions. The estimated amount for achieving universal access is over USD 45 billion per year (2019-2030).

Providing countries the finance they need for universal energy access requires a detailed understanding of national contexts. Specifically, the scale of their energy access gaps, current levels of finance, existing energy infrastructure, expected population trends, and much more.

Now in its third edition, the biennial *Energizing Finance: Taking the Pulse 2021* report provides crucial insights into how national contexts shape finance flows for electricity and clean cooking access. It drills down into these contexts to assess each country's finance needs to achieve universal energy access through mini-grids, stand-alone solar and various tiers of clean cooking solutions. It also considers the costs of overcoming energy affordability gaps, which, if left unfilled, will leave many people behind.

This year's report offers deep-dives into what it will take to achieve SDG7 targets in Ghana, Mozambique and Vietnam, using universal access scenarios to forecast the volume and type of capital needed by enterprises and households.

The report finds that achieving universal access to electricity and to clean fuels and technologies will cost at least USD 38 billion across Ghana, Mozambique and Vietnam cumulatively from 2021 to 2030. A more incremental pathway of achieving access to electricity and improved cookstoves, will be considerably less costly at USD 2.1 billion.

By comparing these finance needs to current levels of committed finance identified for these countries in *Energizing Finance: Understanding the Landscape 2021*, we gain a clear picture of how far we need to go. For example, Understanding the Landscape tracked only USD 32.3 million for clean cooking in the three countries over a six-year period, or an annual average of USD 1.7 million per country. With the cost of universal Tier 4 clean cooking access being at least USD 37 billion over the next 9 years, there is a huge finance gap to fill.

Meanwhile, although universal Tier 1 electricity access is an important target to hit, the development of the studied countries' economies and critical services like health facilities will require access at higher tiers, demanding much greater finance than what is identified in this report.

Importantly, *Energizing Finance: Taking the Pulse 2021* provides a set of country-specific recommendations to help fill current finance gaps. Many of these solutions are ones Sustainable Energy for All (SEforALL) advocates for and works with countries to implement, including providing results-based finance for energy project developers and adjusting policies around demand-side subsidies and taxes on solar equipment.

Through this report, SEforALL and Dalberg Advisors have provided a clear view of the potential pathways to SDG7 in Ghana, Mozambique and Vietnam so that stakeholders have the evidence they need to act. Yet the value of this work extends far beyond these countries' borders. The lessons and recommendations found in *Energizing Finance: Taking the Pulse 2021* can be applied in many other countries facing energy access deficits.

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

ALY-KHAN JAMAL
Partner, Dalberg Advisors

ABBREVIATIONS

AfDB	African Development Bank
AMER	Mozambican Renewable Energy Association
BAU	Business-as-usual
CAGR	Compound annual growth rate
CDC	UK development finance institution
CDM	Clean development mechanism
DHS	Demographic Health Survey
EDM	Electricidade de Moçambique
EIA	Energy Information Administration
EnDev	Energising Development
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FUNAE	Fundo de Energia
GIZ	German Corporation for International Cooperation
GLPGP	Global LPG Partnership
GOGLA	Global Off-Grid Lighting Association
ICS	Improved cookstove
IEA	International Energy Agency
IMF	International Monetary Fund
ISSER	Institute of Statistical, Social and Economic Research, Ghana
kW	Kilowatt
LPG	Liquefied petroleum gas
MECS	Modern Energy Cooking Services
MICS	Multiple Indicator Cluster Survey
MTF	Multi-Tier Framework
MW	Megawatt
NGO	Non-governmental organization
PAOP	Power Africa Off-grid Project
PAYG	Pay-as-you-go
RBF	Results-based financing
REEEP	Renewable Energy and Energy Efficiency Partnership
REMP	Renewable Energy Mitigation Programme (Ghana)
RISE	Regulatory Indicators for Sustainable Energy
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
SHS	Solar home system
SNV	Netherlands Development Organization
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VAT	Value-added tax
WHO	World Health Organization

EXECUTIVE SUMMARY

Despite recent progress made on the path to Sustainable Development Goal 7 (SDG7)[1] — affordable, reliable, sustainable and modern energy for all by 2030 — current prospects of reaching that goal appear dim. In the past decade, over 812 million people around the world have gained access to electricity and 443 million have gained access to clean cooking fuels and technologies (*Tracking SDG7: The Energy Progress Report 2021*). However, about 760 million people remain without access to electricity, and nearly 2.6 billion are without access to clean cooking fuels and technologies, with Covid-19 only exacerbating these inequities. Based on the current, business-as-usual (BAU) trajectory, SDG7 will not be achieved.

A transformation of the energy sector is desperately needed. This will require an integrated approach that combines centralized and decentralized energy solutions, national energy planning and market based-opportunities, substantial commercial and non-commercial finance, and targeted non-financial support. *Energizing Finance: Taking the Pulse 2021* focuses primarily on decentralized energy solutions – in particular, it suggests that demand-side and supply-side subsidies will be key to unlocking access.

This report updates and extends the biennial Taking the Pulse report, first published in 2017 by Sustainable Energy for All (SEforALL) as part of its Energizing Finance research series.[2] It seeks to (i) estimate the total volume and type of finance needed by decentralized energy

***Energizing Finance: Taking the Pulse 2021* focuses primarily on decentralized energy solutions – in particular, it suggests that demand-side and supply-side subsidies will be key to unlocking access.**

(clean cooking and electricity) enterprises, (ii) estimate unmet finance needs (the affordability gap) for end-use customers, (iii) provide high-level recommendations on the use of funding to unlock private sector capacity and deliver energy access solutions at scale, and (iv) suggest enabling policies and regulations for governments.

Like previous editions, *Energizing Finance: Taking the Pulse 2021* relies heavily on an empirically based model to estimate future finance needed in three countries: this year, Ghana, Mozambique and Vietnam, which represent three distinct levels of electricity and clean cooking access and market maturity. The report uses the World Bank's widely recognized Multi-Tier Framework (MTF) to classify different levels of electricity and clean cooking access for households. For electricity, it measures the gap to achieving universal Tier 1 access[3] and examines past trends with respect to grid, mini-grid, and standalone solar home system (SHS)

[1] The first target of SDG7 is Target 7.1: "By 2030, ensure universal access to affordable, reliable and modern energy services". This target has two indicators: Indicator 7.1.1: Proportion of population with access to electricity. Indicator 7.1.2: Proportion of population with primary reliance on clean fuels and technology. "Clean fuel" in this context is defined by the emission rate targets and specific fuel recommendations (i.e., against unprocessed coal and kerosene) included in the normative guidance by the WHO for indoor air quality.)

[2] Other reports published by SEforALL as part of the Energizing Finance series include Understanding the Landscape, which focuses on finance commitments for energy access in twenty countries with large energy access deficits, and Missing the Mark, which examines gaps and lags in disbursement of development finance for energy access.

[3] This corresponds to a minimum 12 watt-hour of electrical energy per person per day and lighting performance of 1,000 lumen-hours per person per day, which provides enough power to illuminate three to four

growth and penetration, based on a review of policy documents and wide-ranging stakeholder interviews in each focus country. The report then develops two scenarios: (i) a business-as-usual (BAU) scenario that determines a realistic view of the universal energy access gap in 2030; and (ii) a forecast scenario that models the expected contributions grid, mini-grid, and standalone solar solutions would make to achieve universal access. For clean cooking, this report estimates the deficit to both universal Tier 2/Tier 3 levels through industrially manufactured improved cookstoves (ICS) (which rely on traditional biofuels but are cleaner and more efficient than artisanal cookstoves)[4] and Tier 4 modern energy cooking services (MECS) (through liquefied petroleum gas (LPG), ethanol and electricity).[5] It then models forecast scenarios for the uptake of Tier 2/Tier 3 solutions and Tier 4 solutions to achieve universal access. Finally, the report uses the electricity and clean cooking universal access scenarios to forecast the volume and type of capital needed by enterprises and households.[6] *Energizing Finance:: Taking the Pulse 2021* breaks down the cost of universal access between private finance needs (in grant, debt and equity) as well as the affordability gap for Tier 1 electricity and Tier 2/Tier 3 clean cooking. Tier 4 clean cooking costs are split by fuel and stove costs, infrastructure investments, and required behavioural change campaigns to convince households to switch to "clean" fuels.

The cost of achieving universal energy access in Ghana, Mozambique and Vietnam

Achieving universal Tier 1 electricity and Tier 4 clean cooking access will cost USD 38-48 billion across Ghana, Mozambique and Vietnam. A more incremental pathway of Tier 1 electricity and Tier 2 / Tier 3 clean cooking access will be considerably less costly at USD 2.1 billion (Figure 1).

Achieving universal **Tier 4 cooking access** across all three countries will cost about USD 37-47 billion, depending on the technology used (Figure 2).[7] Current utilization levels of Tier 4 solutions are low across all three countries and not expected to rise significantly, other than in Vietnam. Transitioning with LPG will cost about USD 38 billion (in all three focus countries) and will require substantial fuel subsidies and infrastructure investment as well as funding for large-scale awareness and marketing activities to change consumer behaviour. Transitioning with ethanol is expected to cost about the same,[8] with comparatively lower infrastructure costs offset by higher fuel costs (relative to LPG). Transitioning with electric cooking solutions would be expensive for consumers — even with current subsidized electricity tariffs — and would require additional grid- or mini-grid-based electricity generation, costs that are not included here.[9] Other solutions exist but are currently limited in scale. For example, pellets (biofuels made from compressed organic matter or biomass), while not examined in detail in this report, could be a lower-cost solution in urban areas.

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[4] The report discusses a particularly efficient improved cookstove (ICS) option which can provide access up to Tier 2/ Tier 3, as opposed to improved cookstoves in general, which only provide Tier 1/Tier 2 access. Yet Tier 2/Tier 3 cookstoves, although less carbon intensive than traditional biomass alternatives, are not zero-carbon and have negative health implications for users.

[5] Tier 4 access is a composite metric that incorporates higher levels of air quality, efficiency, convenience, and health and safety of the cookstove and greater affordability and availability of clean and high-quality fuel. Tier 4 access is typically only achieved by widespread use of "clean" fuels like electricity, LPG, ethanol, gas pellets, and biogas, most of which are not used at scale in most developing countries. It should be noted that access to a "clean" fuel is a necessary, but insufficient condition of Tier 4 access.

[6] Further details on the methodology are provided in Section V Introduction and under Methodology in Section IX of the Appendix.

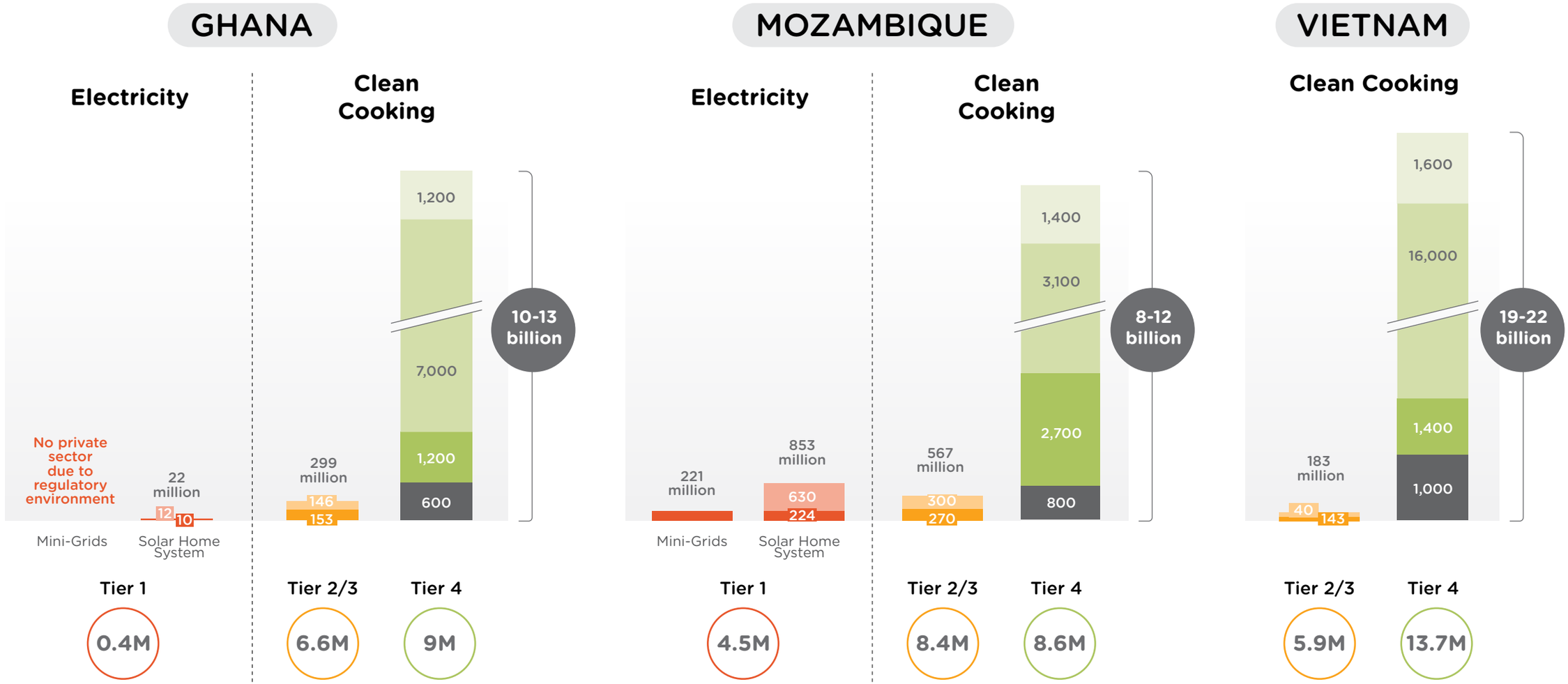
[7] This report assumes that 10 years are required to achieve full displacement of basic cooking technologies and practices.

[8] These costs are based on July 2021 LPG retail costs obtained from stakeholder interviews and national reporting statistics. LPG prices have moved in the past along with oil prices and can be volatile. Current LPG prices are not reflective of long-term average prices and do not represent a forecast of 2030 fuel prices. Unlike LPG, which is an established fuel, there are also multiple variables of uncertainty around ethanol prices because the technology is not used at scale. Therefore, this report relied on industry experts' expectations to determine a range of potential ethanol cost of USD 0.6 to 0.8 per liter – without any carbon finance subsidies.

[9] Universal Tier 4 clean cooking is achievable in Vietnam where the entire population could be equipped with induction stoves, since most of the country is grid-electrified. In Ghana and especially in Mozambique, electricity would not provide universal access, given that 10 percent and 62 percent of households, respectively, have electricity access through SHSs and mini-grids, which are not powerful enough for induction stoves.

FIGURE 1

Cost of universal access to electricity and clean cooking in focus countries (USD millions)



LEGEND

TIER 1 ELECTRICITY
- Affordability Gap
- Private sector finance needs

TIER 2/3 CLEAN COOKING
- Affordability Gap
- Private sector finance needs

TIER 4 CLEAN COOKING
- Stove cost
- Fuel cost
- Infrastructure
- Behavioural change

Number of 2030 households without access (million)

FIGURE 2

Estimated cost of universal Tier 4 access by cooking fuel and technology in Ghana, Mozambique and Vietnam (USD billion)[10]

	LPG				Ethanol				Electricity			
USD Billion	GH	MZ	VT	**Total**	GH	MZ	VT	**Total**	GH	MZ	VT	**Total**
Stove costs	1.2	1.4	1.6	**4**	0.7	0.8	0.9	**2**	0.9	0.6	1.5	**3**
Fuel costs	11.3	14.6	17.3	**43**	13.0-14.8	18.7-21.4	17.7-20.5	**49-57**	12.0	4.4	17.0	**33**
Infrastructure	1.2	2.7	1.4	**5**	0.4	0.5	0.5	**1**	27% Additional grid generation need (vs. 2030 generation)	10%	2%	**N/A**
Behavioural change	0.6	0.8	1	**2**	0.6	0.8	1	**2**	0.6	0.8	1	**2**
Sub-Total	14.3	19.5	21.3	**55**	15-17	21-24	20-23	**56-64**	13.5	5.8	19.5	**39**
Avg. Cost per household (USD)	1,600	2,150	1,570	**N/A**	1,760	2,460	1,580	**N/A**	1,720	1830	1,440	**N/A**
Cost of fuel saved	(4.4)	(11.6)	(0.9)	**(17)**	(4.4)	(11.6)	(0.9)	**(17)**	(4.0)	(3.0)	(0.9)	**(8)**
Total Cost	10	8	20	**38**	11-13	9-12	19-22	**39-47**	9	3	19	**31**
% of Households with Tier 4 Access	100%	100%	100%	**N/A**	100%	100%	100%	**N/A**	90%	38%	100%	**N/A**

Achieving universal **Tier 2/Tier 3 cooking access** by 2030 — which only requires households to upgrade to cleaner, more efficient cookstoves, with no changes in fuel and infrastructure — will cost about USD 1 billion. The need is highest in Mozambique (54 percent of total Tier 2/Tier 3 transition costs), followed by Ghana (about 28 percent) and Vietnam (18 percent).

Achieving universal **Tier 1 electricity access** by 2030 in Ghana and Mozambique will require about USD 1.1 billion in additional capital. This report's model forecasts that the grid will service about 90 percent of households in Ghana, 50 percent in Mozambique, and 100 percent of households in Vietnam in 2030. Mozambique — which has the highest forecast electricity access deficit — will require nearly all (about 98 percent) of the USD 1.1 billion, with Ghana requiring just USD 22 million to close the gap to universal Tier 1 access. It should be noted that this report does not factor in finance needs requirements related to grid expansion, which was beyond its scope.

[10] Cost of fuel saved is calculated by multiplying total charcoal/wood consumed annually by the average coal/wood price and forecasting it for the next 10 years. Assuming households transition to LPG, ethanol, or electricity by 2030, these are the fuel savings from no longer using charcoal/wood.

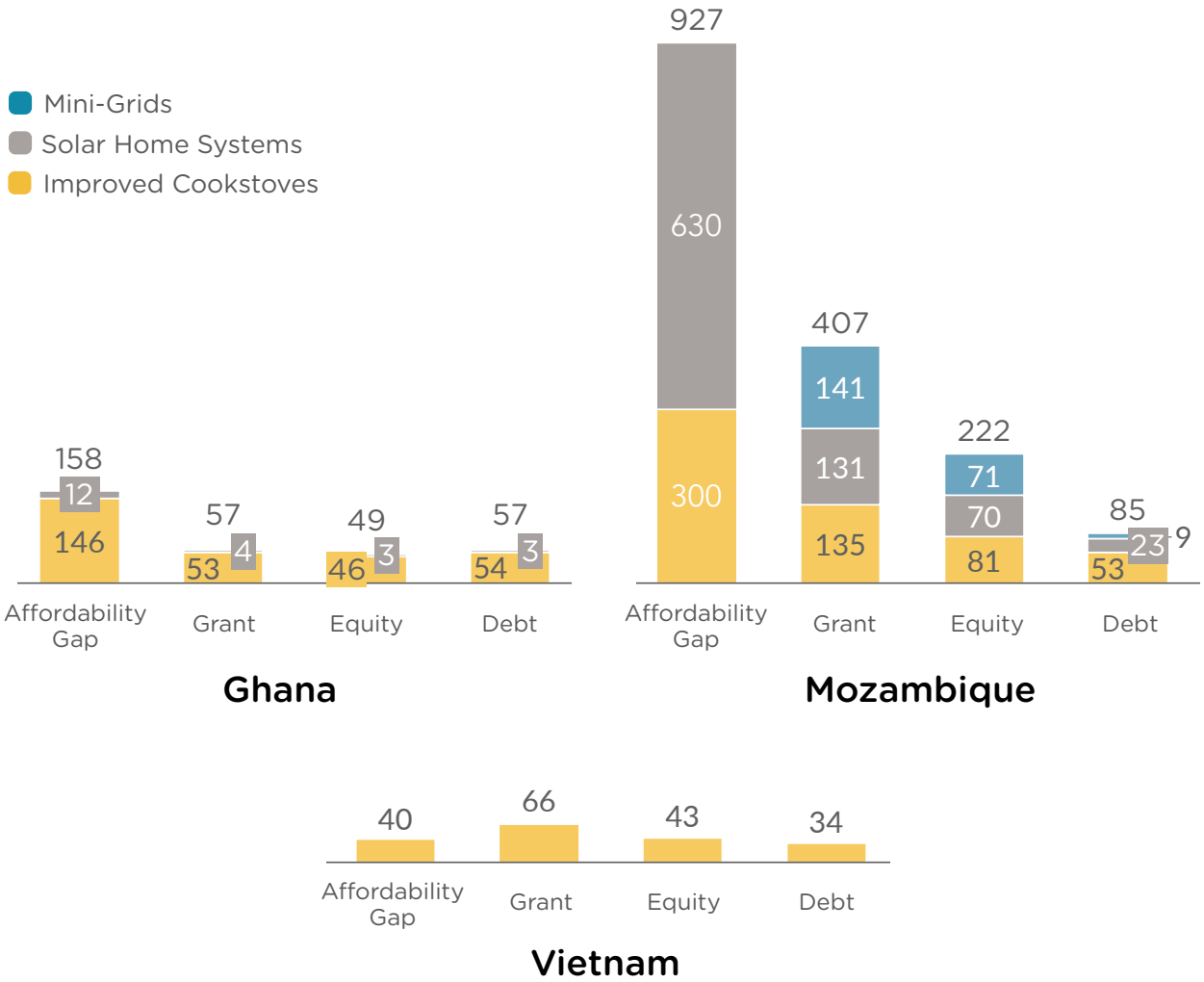
Private sector finance needs for Tier 1 electricity and Tier 2/Tier 3 cooking access[11]

Of the USD 2.1 billion in total costs to transition households to universal access by 2030, about 47 percent (USD 1 billion) will be needed in finance to support enterprises, both in ICS (USD 568 million) and decentralized standalone solar (USD 455 million). In comparison, the *Energizing Finance: Understanding the Landscape 2021* report identifies total commitments of just USD 32 million for clean cooking in Ghana, Mozambique and Vietnam from 2013 to 2019, and USD 118 million in Mozambique for mini-grid and SHSs across the same seven-year time period (SEforALL 2021).

Approximately USD 530 million (52 percent of the total enterprise finance need) will be in the form of grants to electricity and clean cooking enterprises (Figure 3). Most of this grant funding will be needed in Mozambique as its private sector is the least mature and established. A further USD 314 million (31 percent of the total) will be needed in the form of equity and the remainder, USD 176 million (17 percent), will take the form of debt. The high ratio of equity to debt largely reflects the energy sector's early stage of development, especially regarding clean cooking fuels and technology. Debt is likely to make up a larger proportion of the finance mix in Ghana (relative to Mozambique and Vietnam), reflecting a more mature energy enterprise landscape.

FIGURE 3

Private sector finance needs split across debt, equity, and grants for Tier 1 electricity access and Tier 2/Tier 3 clean cooking access (USD million) as well as affordability gap funding



[11] Note that private sector finance needs are only examined for electricity access and Tier 2/Tier 3 clean cooking access. The overall cost of Tier 4 clean cooking access corresponds to a combination of public, private, and household investments, and this report does not take a position on how the cost of universal access should be split between these stakeholders.

The relative proportions of grants, equity and debt finance needed in the three focus countries reflect the overall nascency of private enterprise in these sectors. Smaller businesses are typically unable to secure affordable commercial finance on reasonable terms, which leads to the relatively high proportion of grant funding required. Stakeholders from the three countries confirmed this dynamic in interviews. In more mature markets, early-stage enterprises can typically rely on equity to finance growth. However, this type of capital is difficult to come by in the focus countries given the limited number of equity providers and the perceived risk of energy access enterprises. These companies have therefore relied on grants to enable them to operate and grow their businesses and reach customers.

Affordability gap for Tier 1 electricity and Tier 2/Tier 3 cooking access

About USD 1.1 billion will be needed in affordability gap finance across Ghana, Mozambique and Vietnam. Unsurprisingly, given its high poverty levels (46 percent compared with 23 percent in Ghana and 7 percent in Vietnam) (World Bank)), Mozambique will account for the overwhelming share (82 percent) of the need across the three focus countries, mostly to drive standalone solar uptake in poor, rural households. Most of Ghana's affordability gap finance (92 percent) will be needed in the service of household ICS purchases, with only USD 12 million needed to support standalone solar purchases. Vietnam will require about USD 40 million to support household purchases of ICS solutions. The use of targeted end-user subsidies through, for example, vouchers and results-based financing (RBF) instruments, will be an important tool in addressing the affordability gap in all three countries.

Achieving universal access to clean cooking

Achieving universal access to clean cooking is the most challenging aspect of meeting SDG7 by 2030, with low rates of access and limited progress in Ghana and Mozambique, and trends of good progress only in Vietnam.

GHANA

Under a BAU scenario, access to clean cooking will fall far short of universal access targets, both in terms of Tier 2/Tier 3 access (40 percent estimated access by 2030) and Tier 4 access (18 percent access by 2030). Universal Tier 4 access will cost USD 10–13 billion. This is largely due to the cost of fuel (USD 7.6 billion) and is driven by the number of households that are not able to afford Tier 4 solutions. Universal Tier 2/Tier 3 access to ICS requires a much smaller investment of USD 299 million. This is driven by a USD 146 million affordability gap for households and private-sector finance needs of USD 153 million. Many ICS companies are small companies with limited scale, no access to low-cost international finance, and limited local commercial funding. As a result, grants will remain a core source of funding for many companies until 2030 to support the expansion of private companies.

MOZAMBIQUE

Under a BAU scenario, access to clean cooking will largely stay at current levels until 2030 both in terms of Tier 2 /Tier 3 access (7 percent estimated access by 2030) and Tier 4 access (4.4 percent access by 2030). Universal Tier 4 clean cooking access will cost USD 8–12 billion, with fuel subsidies accounting for about 90 percent of the total. Universal Tier 2/Tier 3 access to ICS will require USD 570 million, mainly driven by a USD 300 million affordability gap. The remainder, USD 270 million, will be needed for private-sector clean cooking solution providers. Half will be in the form of grants (USD 135 million) as the ICS sector remains small and sub-commercial.

VIETNAM

Vietnam has made significant progress in access to clean cooking, primarily driven by growth in LPG usage and electric cooking. Under a BAU scenario, access to clean cooking will continue to increase until 2030 both in terms of Tier 2/Tier 3 access (79 percent estimated access by 2030) and Tier 4 access (51 percent access by 2030). Despite these increases, the estimated number of

households without access in 2030 will be large (14 million). As a result, transition costs, especially for universal Tier 4 access, USD 19–22 billion, remain substantial. Universal Tier 2/Tier 3 access to clean ICS will require USD 185 million. This is driven by a consumer affordability finance need of USD 40 million and private-sector finance needs of USD 145 million. Donor and private finance have remained low in Vietnam, partially driven by the country having achieved universal electricity access and reaching middle-income status. Stakeholder interviews also suggest that commercial debt is unobtainable by ICS enterprises, due to their small size and perceived risk. As a result, some level of grant finance is required to help the private sector scale by 2030.

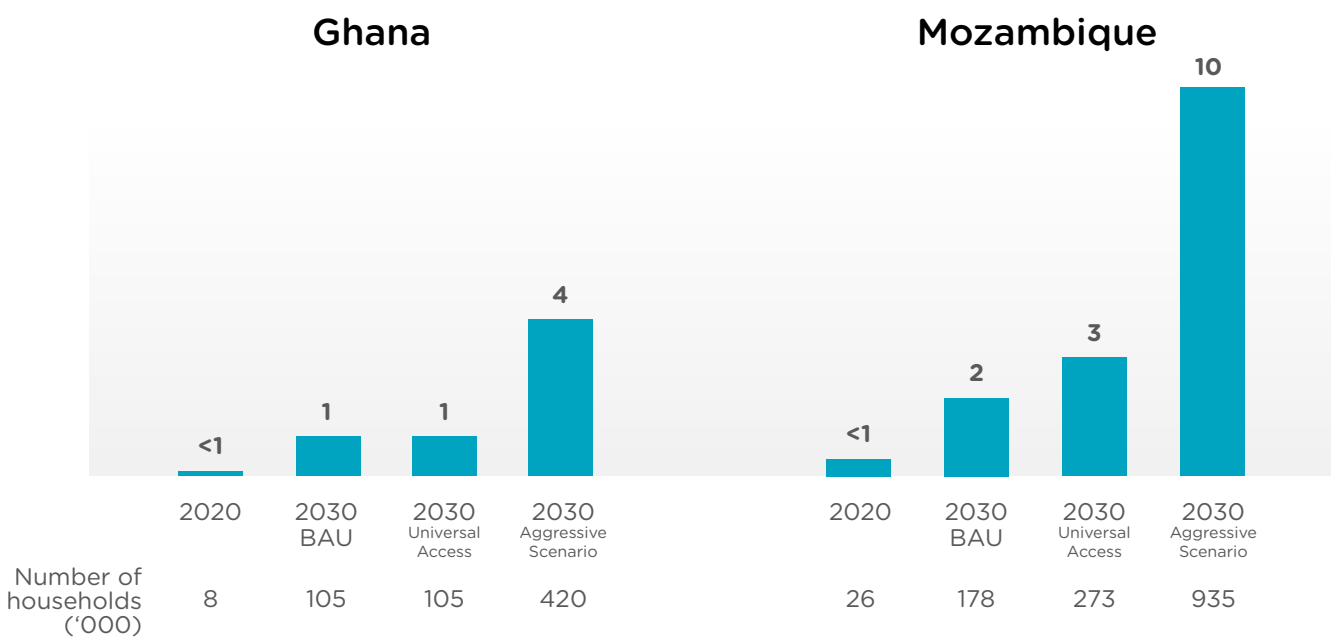
Achieving universal access to electricity: mini-grid contributions

Mini-grids will make a relatively small contribution to universal Tier 1 electricity access in the BAU scenario. They will provide electricity to up to 3 percent of the population in Mozambique and only about 1 percent in Ghana by 2030. High connection costs (relative to SHSs[12]) combined with a lack of policy and regulatory clarity around licensing, land acquisition, concessions, tariffs, and subsidy schemes, limit private participation in mini-grids.[13]

GHANA

Mini-grids in Ghana have been built and operated almost entirely by the government, with funding from donor sponsors, and currently serve only a small proportion of households (less than 1 percent). The government-led rural electrification strategy restricts private-sector mini-grid activity; developers are not allowed to charge cost-reflective tariffs, and private companies are barred from applying for licences to sell electricity. Its renewable energy plan has identified 300 mini-grid sites that are in various stages of development based on financial support from development partners. As a result, the BAU scenario considers

FIGURE 4
Percent of households in Ghana and Mozambique electrified with mini-grid[10]



[12] In Mozambique, mini-grid capital expenditure per connection is USD 700 to USD 1,500, compared to less than USD 100 for SHSs.
[13] It is important to note that mini-grids can provide higher levels of electricity access to households relative to SHSs (i.e., beyond basic Tier 1 access), which explains higher connection costs. While SHSs remain the fastest pathway to basic Tier 1 electricity access, mini-grids could have a bigger role to play in electrification in the long term, but not without improvements in the regulatory landscape. In fact, SHSs can set the stage for mini-grids by increasing household willingness to pay for higher-order electricity applications (including applications for productive use) that are needed to make mini-grids commercially viable.

only these government-led 300 mini-grids and does not project an increase in its universal-access scenario. With no private-sector engagement projected, this report does not estimate any private-sector finance needs for mini-grids.

MOZAMBIQUE

Mini-grid development in Mozambique is mostly led by the government and funded by international donors. Successful completion of priority mini-grid projects planned by the government and Fundo de Energia (FUNAE), the government entity in charge of rural electrification, could provide access to 2 percent of households. The absence of a clear regulatory framework and tariff limitations (benchmarked to the rate charged by the national utility) has discouraged private-sector interest in the country. Thus, in a BAU scenario, only the donor-sponsored mini-grid projects stand to be completed by 2030. For similar reasons, the universal-access scenario estimated in this report sees a minor role for mini-grids. In a BAU scenario, this report estimates the cost of private-sector led mini-grid expansion at about USD 221 million, accounting for 3 percent of overall access. However, if regulatory reforms currently tabled are adopted by FUNAE, the sector could grow to cover up to 10 percent of households by 2030 and require about USD 1.8 billion[14] in private financing.

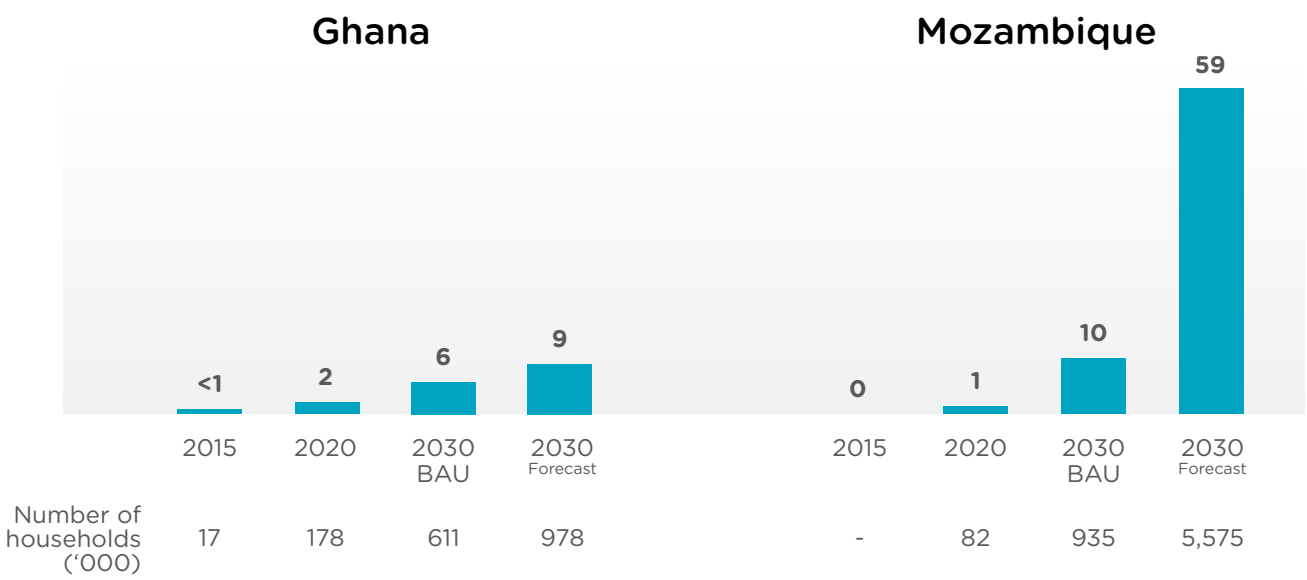
Achieving universal access to electricity: standalone solar contributions

Standalone solar solutions will deliver access to all transition households not served by the grid or mini-grids. Achieving this will require a substantial increase in public and private financing above current levels, especially in Mozambique.

GHANA

Under a BAU scenario, about 6 percent of Ghana's households receive Tier 1 access through standalone solar, a figure that rises to about 9 percent in the universal-access scenario (Figure 5). These households are primarily located in rural areas and are not covered under the government's grid electrification plan or by its mini-grid projects. With several mature companies and high pay-as-

FIGURE 5
Percent of households in Ghana and Mozambique electrified with solar home systems



[14] This estimate is based on third party reports including ESMAP's least-cost analysis and stakeholder interviews in Mozambique. (World Bank 2019). Mozambique geospatial option analysis towards universal electrification.

you-go (PAYG) penetration, the private sector in Ghana has the capacity to service a significant share of non-electrified households by 2030. About USD 22 million is needed in total finance, with about USD 10 million reserved for companies and the remainder, USD 12 million, required to address the consumer affordability gap.

MOZAMBIQUE

Under BAU, access to electricity is expected to increase to 50 percent by 2030, with standalone solar systems accounting for about 10 percent of households. In the universal-access scenarios, standalone solar is expected to play a primary role, with nearly 59 percent of households receiving first-time Tier 1 access through SHSs (Figure 5). 70 percent of the population lives in low-density, rural areas that are complex and costly to serve through the grid and mini-grids and favouring SHS distribution. To reach almost two-thirds of Mozambique's population, the domestic SHS sector will require USD 854 million in total finance, of which USD 630 million (74 percent) would be needed to address the large consumer affordability gap. 46 percent of Mozambique's population currently lives below the poverty line and 80 percent of households are not able to purchase SHSs on a PAYG basis over 24 months.

Eight cross-cutting challenges that impede universal access

While Ghana, Mozambique and Vietnam are all unique in their context and solution set to achieve universal energy access, there are important cross-cutting challenges.

Consumer affordability. This is the costliest and most important challenge. Many consumers are unable to afford the one-time cost of solutions such as an SHS, much less pay for the cooking technologies and ongoing fuel costs necessary to reach universal energy access. This challenge is exacerbated by seasonal variability of incomes, the limited reach of consumer finance options such as PAYG, and lower awareness and willingness to pay for clean energy solutions (especially clean cooking) due to the availability of cheaper traditional alternatives.

Customers who are unable to afford energy services are often the hardest to reach. In most markets, companies naturally focus on serving the lowest hanging fruit in terms of potential customers. These tend to be those who live in urban and peri-urban areas. Meanwhile, those who lack reliable energy access often reside in regions where distribution is more costly due to limited existing infrastructure. According to stakeholder interviews, without incentives, private companies tend to focus on more profitable customers, often selling higher-tiered systems to households that already enjoy some level of energy access, and not organically pushing into areas with households needing first-time electricity access.

Gender disparities related to energy access that are common to many developing countries also affect the three focus countries, albeit to different degrees. Interviews in all three countries indicated that, on average, women have a lower ability to pay and less agency than men in household purchasing decisions, including those concerning energy services. Women's participation in modern energy supply chains (including for SHSs, mini-grids, and clean cooking) is almost universally lacking. They are largely missing in the energy sector workforce (as technical and sales agents, for example) and women-owned energy enterprises are rare. Overall, gender disparities are highest in Mozambique and are more pronounced in the clean cooking sector.

Energy companies remain mostly small and lack access to the suite of financial solutions and capital (debt, equity and grants) required to reach all potential consumers across countries and technology segments. Across technologies, only a few energy solution providers are mature and large enough to obtain commercial finance from local financial institutions or international funding from investors. As a result, the private sector will continue to rely, at least in part, on grants and concessional finance. Addressing these issues requires a combination of industry capacity building and funding companies' supply chain activities.

The absence of clear, enabling regulatory frameworks has hampered energy access, particularly for mini-grids. In both Ghana and Mozambique, this has resulted in a lack of private mini-grid development. Meanwhile, in countries where tariff subsidies allow private companies to recoup their investments, the number of mini-grids has expanded (AMDA 2020). Additionally, in Mozambique, the lack of fiscal incentives, including import duty exemptions and value-added tax (VAT) on SHSs makes them up to 45 percent more expensive than in Ghana. The lack of clarity around long-term government priorities, willingness to support the sector, and technology preferences also contributes to an uncertain business environment, which disincentivizes the private sector from entering the market.

A lack of government commitment and leadership on clean cooking is negatively impacting energy access. Stakeholder interviews suggest that government commitment to clean cooking in the three focus countries is limited; no universal access strategies have been outlined, no clear commitments have been made, and leadership on the issue has been missing. These interviews also suggest that government support for regulatory standards, clear energy access goals, and access to carbon finance would enable greater further private-sector growth.

A lack of coordination between electricity, clean cooking, and climate efforts is slowing energy access. National and development partner strategies often view electricity, clean cooking and climate in silos, despite common challenges and solutions. Energy access through decentralized renewable energy technologies can significantly contribute to national emission reduction targets, yet few countries have clear strategies that incorporate these into electricity and climate plans. In this regard, the advantages of Integrated Energy Planning (IEP)[15] should be emphasized further to simultaneously address these challenges in a cost-effective manner by creating multiple benefits in these areas.

The Covid-19 pandemic has negatively impacted energy access in all three focus countries, but the sector is expected to bounce back. Overall, the impact has been uneven, influenced in part by variations in local policy responses. In Ghana and Mozambique, Covid-19 has not caused a significant slowdown in energy access. In large part this is because the government in Ghana and development partners in Mozambique provided subsidies to support customers' continued access to grid and off-grid energy. Overall, stakeholders are optimistic that the sector will return to pre-pandemic growth levels as early as 2022, particularly in energy access where SHS sales increased in 2020.

Country-specific financing recommendations

In each country, the private sector's finance requirements and the affordability gap will need to be addressed with solutions appropriate to the local context.

GHANA

The finance required to cover the consumer affordability gap for universal electricity access is USD 12 million (mainly for SHSs) and the private-sector finance need is USD 10 million. This could feasibly be managed through a single energy access programme, which could be structured in several ways. For example, a competitive bidding process could identify companies that are willing to cover the remaining population at the lowest cost and are able to apply an upfront grant toward establishing the supply chain to cover these areas. Another option could be an RBF payment that companies are able to realize for each verified sale.

For Tier 4 universal cooking access, the execution of the national LPG strategy would increase access to "clean" fuels. Developing a strategy incorporating other pathways for access, as well as developing a national scheme for carbon finance would also increase Tier 4 access. For Tier 2 /Tier 3 universal

[15] Universal integrated energy planning is a 'power tool' that helps direct resources effectively and efficiently to where they are needed the most. Integrated energy planning is required to ensure that current and future energy service needs can be met in the most cost effective, efficient, and socially beneficial manner while also considering environmental impacts and policy development to shape the future energy landscape of the country.

cooking access, the development of a national clean cooking strategy — with clear guidelines and measures for private sector development — could go a long way toward addressing constraints related to lack of government planning and minimal access to enterprise funding. Development partners could explore demand-side and supply-side subsidies to increase uptake of ICS stoves as well as consumer consumer finance to address severe affordability constraints.[16]

MOZAMBIQUE

Efforts should focus on reducing the estimated USD 927 million affordability gap for SHSs and ICS. The Government of Mozambique should coordinate with development partners to determine a set of solutions and instruments to address this challenge. Lifting import duties on SHS products and introducing a VAT exemption would make an immediate and significant contribution to reducing the affordability gap; at least part of the fiscal loss could be balanced by increased economic activity and associated revenues downstream for the resultant enterprise activities. Programmes that address affordability gaps by providing direct subsidies to consumers are being implemented in other countries including the CIZO programme in Togo (GSMA 2021) and could offer lessons for Mozambique. In addition, development partners could explore scaling up existing RBF programmes to incentivize private-sector expansion in harder-to-reach areas – for example, by adapting an approach piloted in the Kenyan KOSAP programme, which provides grants to offset high distribution costs in remote areas.

VIETNAM

The private sector for ICS remains small and lacks access to finance. Supply-side support, including grants, RBF mechanisms that encourage firms to expand into harder-to-reach areas[17] and working capital facilities are necessary. To address consumer affordability challenges (which are less severe than in Ghana and Mozambique), development partners should consider supporting the rollout of more PAYG models for clean fuels and investigate developing consumer finance options for ICS users. There is also a need to expand access to carbon credits by supporting small manufacturers through technical assistance. The ICS affordability issue in Vietnam could be addressed with a single USD 40 million facility, which could be dispensed in the form of targeted demand-side subsidies for the 5 percent of the population unable to afford ICSs and RBF to companies, as noted above.

COMMON RECOMMENDATIONS

Across countries and technology solutions, achieving universal electricity and clean cooking access will require interventions through the finance value chain that are customized to local needs. Enterprise finance solutions will need to effectively combine the funding capacity, time horizons, risk tolerance, and capabilities of different types of funders or investors and map these clearly to private-sector needs and capacity. In all three countries, there remains a significant requirement for debt and equity to support the growth of firms and the associated expansion of energy access, alongside appropriately targeted grants as outlined above. Various combinations of grants, concessional capital, and risk-mitigation instruments, such as guarantees, will be needed for energy access investments that commercial investors consider risky. Carbon finance could play an important role in addressing Tier 4 clean cooking finance needs, as part of a portfolio of finance solutions, especially for transition with ethanol.[18] The feasibility of carbon finance mechanisms, which are nascent globally, is critically dependent on carbon prices that have thus far been variable and difficult to predict. These mechanisms also require complex and stringent monitoring and reporting to ensure proceeds are effectively deployed. Technical assistance to government and companies will be critical to the expansion of carbon finance.

[16] Ghana has leveraged demand-side subsidies in the past to increase access to the grid and to subsidize electricity tariffs; such mechanisms could be explored to address the SHS and clean cooking affordability challenges.
[17] Ethnic minorities who often speak different languages and live in isolated, hard-to-reach communities require additional investments including in translation, awareness campaigns, etc.

FIGURE 6
Key finance instruments and policy recommendations by country

	Country	Main recommendations
1	**Ghana**	**Electricity** • **Explore RBF programmes** to incentivize the private sector to reach lowest income households in harder-to-reach areas while addressing affordability. **Clean cooking** • **Execute on LPG strategy and incorporate into national clean cooking strategy** a pathway for "clean" fuels beyond LPG, support ICS sector with clear guidelines. • **Provide demand-side subsidies** (e.g., voucher programmes) to improve customer affordability – potentially with carbon finance proceeds. • **Support PAYG model expansion** for clean fuels and consumer finance options to improve customer affordability, including through R&D
2	**Mozambique**	• **Explore demand-side subsidies** programmes to address the USD 930 million affordability gap in electricity and clean cooking. • **Expand supply-side finance**, including catalytic grants to encourage market entrance and RBF to incentivize expansion in last-mile areas. • **Remove import duty and VAT** for SHS products to improve affordability.
3	**Vietnam**	• **Build on prior results-based mechanisms** to encourage the private sector to expand in harder-to-reach areas and to serve ethnic minorities. • **Explore targeted demand-side subsidies** programme for households unable to afford ICS. • **Expand PAYG access and consumer finance options to improve customer affordability.**
4	**Cross-cutting**	• **Expand local debt and concessional finance** to the private sector – invest directly and in partnership with **local financial institution**s. • **Expand access to carbon credits through government carbon schemes** that capture carbon proceeds and apply them to expand "clean" fuels. • **Develop coordinated electricity access, cooking access and climate change strategies.**[19] • **Explore financial instruments and policies** specifically targeting women that recognize the additional (and often unique) **legal and cultural barriers women face** in accessing finance; provide training and capacity-building support to incorporate gender lens in programme planning and design.

[18] Clean fuel costs amount to USD 32-40 billion in the three focus countries (USD 49–57 net of USD 17 billion in savings on charcoal fuel spending). This corresponds to USD 3.5–4.5 billion annually until 2030. Assuming a carbon credit price of USD 30 this represents 120 to 150 million carbon credits a year. Assuming each household can generate five credits per year, this requires transitioning 25 to 30 million households to clean fuels and providing them with a fuel subsidy. This corresponds to the 75 to 95 percent of households that will need support to transition to Tier 4 in the three focus countries by 2030.

[19] This coordination should be present across all actors (government, development partners and investors) and all dimensions including planning, financing, and private sector engagement.

Stakeholder-Specific Recommendations

FIGURE 7
Key recommendations for energy access stakeholders

Stakeholder	Recommendations	Country
Governments	**Address barriers that limit private sector participation:** For mini-grids, universal tariff, licenses; for SHS cost of doing business, duties and tariffs.	GH, MZ
	Define a national clean cooking strategy to address adoption and awareness with clear guidelines and measures. Coordinate across ministries and governing bodies to ensure that energy access is fully integrated within the wider development priorities.	MZ
	Define clear policy or regulatory environments where these are lacking, particularly with respect to mini-grids and LPG.	GH, MZ
	Consider demand-side and/or supply-side subsidy support and risk mitigation to address affordability and financing challenges, in coordination with development partners.	
Development partners	Collaborate with governments and other development partners in HICs to **allocate enough funds to ensure universal access**.	GH
	Pilot financing mechanisms including demand-side subsidies, carbon finance, impact bonds, etc. in specific contexts where existing tools may be insufficient.	GH, MZ, VT
	Support private-sector development through **additional finance**, including **RBF** to incentivize distribution in last-mile areas, and mechanisms to **support access to carbon finance**.	
	Expand **technical assistance efforts** to include private companies, particularly distributors and local financing institutions.	
	Support awareness campaigns to increase demand and adoption of clean cooking technologies.	
	Increase the number of 'scaling mini-grid' initiatives, where development partners support the implementation of the full set of required legal, regulatory and institutional improvements to enable the mini-grid sector to take off.	GH, MZ
	Support a national clean cooking strategy development process that leverages carbon finance as a tool for financing access to clean cooking.	GH, MZ, VT
Investors	Explore **risk-sharing mechanisms** with the local financial sector to provide affordable local currency funding.	GH, MZ, VT
	Assess how financial products could evolve to meet the needs of smaller, local companies.	
	Support smaller local companies with a combination of **seed funding and concessional debt.**	
	Explore aggregation modalities that can combine multiple smaller companies or projects with similar characteristics into a single, larger financing mechanism.	

Civil society organizations (CSOs)	**Advocate for the needs** of communities with governments, development partners, and investors; monitor energy access progress.	GH, MZ, VT
	Engage with communities to increase awareness, education, and information on clean cooking and electricity benefits to allow people to make informed choices.	
	Advise governments and stakeholders on gender-responsive energy sector planning and financing.	
All	**Explore financial instruments and policies** specifically targeting women that recognise the specific **barriers they face** in accessing finance for energy services.	GH, MZ, VT

CHAPTER 1

INTRODUCTION

Objectives

***Taking the Pulse 2021* charts how an energy sector transformation can take shape in three focus countries — Ghana, Mozambique and Vietnam — by estimating the volume and nature of finance needed by customers and enterprises to achieve Sustainable Development Goal 7 (SDG7)[20] — affordable, reliable, sustainable and modern energy for all by 2030.** This report updates and extends the biennial Taking the Pulse report, first published in 2017 by Sustainable Energy for All (SEforALL) as part of its Energizing Finance research series.[21] It seeks to (i) estimate the total volume and type of finance needed by decentralized renewable energy (clean cooking and electricity) enterprises, (ii) estimate unmet finance needs (the affordability gap) for end-use customers, (iii) provide high-level recommendations on the use of funding to unlock private sector capacity and deliver energy access solutions at scale, and (iv) suggest enabling policies and regulations that governments can implement.

New Features

Energizing Finance: Taking the Pulse 2021 builds on the comprehensive and robust methodology of previous editions in several ways.

- **The report provides cost estimates for universal Tier 4[22] access to cooking.** In addition to reviewing the cost of providing access to improved cookstoves (ICS), this edition calculates the cost of providing universal access to liquefied petroleum gas (LPG) and ethanol, two of the Tier 4 clean cooking solutions. It also looks at the cost of Tier 4 access to electric-induction cookstoves, assuming that only those households that are connected to the grid will be able to use such appliances.

- **The report also looks at multiple-access scenarios to identify a range of finance needs for each country.** These include growth scenarios for mini-grids and solar home systems (SHSs) as well as LPG, electric, and ethanol scenarios for clean cooking. This enables a nuanced exploration of finance needs, including for a range of Tier 1 electricity technologies and Tier 4 cooking fuels.

- **Importantly, *Energizing Finance: Taking the Pulse 2021* now incorporates a gender lens.** The report looks at women's participation in the energy sector as customers, employees and entrepreneurs. It also considers specific and unique obstacles that female energy consumers and entrepreneurs face. Finally, it identifies models and strategies that have successfully increased women's participation in the energy-access sector and outlines several recommendations, especially for further research.

- **Finally, this report includes a greater focus on highlighting the opportunity and catalytic capacity of blended finance solutions,[23] as part of the full continuum of finance solutions, to enable the finance that is required in each focus country.** It then suggests several instruments and solutions that could increase energy access finance.

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[20] SDG 7.1 calls for universal access to affordable, reliable and modern energy services. This target has two indicators: Indicator 7.1.1: Proportion of population with access to electricity. Indicator 7.1.2: Proportion of population with primary reliance on clean fuels and technology. "Clean fuel" in this context is defined by the emission rate targets and specific fuel recommendations (i.e., against unprocessed coal and kerosene) included in the normative guidance WHO guidelines for indoor air quality.)

[21] Other reports published by SEforALL as part of the Energizing Finance series include Understanding the Landscape, which focuses on finance commitments for energy access in 20 countries with large energy access deficits, and Missing the Mark, which examines gaps and lags in disbursement of development finance for energy access.

[22] As defined by the World Bank's Multi-Tier Framework (MTF). Tier 4 access is a composite metric that incorporates higher levels of air quality, efficiency, convenience, and health and safety of the cookstove and greater affordability and availability of clean and high-quality fuel.

[23] The term 'blended finance" can have different definitions; according to the OECD, blended finance is "the strategic use of development finance for the mobilization of additional finance towards sustainable development in developing countries."

Structure of the Report

Energizing Finance: Taking the Pulse 2021 dedicates a chapter to each focus country. The three focus countries — Ghana, Mozambique and Vietnam — are part of a wider set of 20 high-impact countries (HICs) drawn from the *Tracking SDG7 2021* report. Together, these 20 nations have the highest absolute gaps in access to electricity and/or clean fuels and technologies for cooking and are home to more than 80 percent of the world's population without energy access. The countries were chosen on account of several factors: they represent three different levels of electricity and clean cooking access and market maturity; they offer an opportunity for a deeper exploration of clean cooking pathways (an area of emphasis for this edition of Taking the Pulse); they were not covered in the 2017 and 2019 editions of this report; and they provide a window into the state of energy access in both Sub-Saharan Africa and Asia. In addition, there was a desire to align the same focus countries in *Energizing Finance: Taking the Pulse 2021* and *Energizing Finance: Understanding the Landscape 2021* to enable a comprehensive examination of the energy finance landscape in each.

Each chapter summarizes key findings, outlines the energy sector context, details the current state of energy access, describes potential 2030 access scenarios, specifies enterprise and consumer finance needs for achieving universal energy access, and highlights key challenges and opportunities the country confronts. Appendices contain the detailed quantitative methodology that underpins this report. They outline the structure, key inputs, and assumptions upon which the report is based and summarize qualitative interviews.

Each country chapter is split into two sections focused on electricity and clean cooking. Each section is structured as follows:

- Key messages
- Sector context including government strategy, key companies and gender perspective
- Current and future state of access
- Cost of universal access to electricity and cooking by technology and private sector finance needs
- Key challenges for the sector
- Recommendations and suggested key instrument(s) to address the prioritised challenges

Methodology Overview

Electricity tiers

Energizing Finance: Taking the Pulse 2021 is anchored in the World Bank's widely recognized Multi-Tier Framework (MTF) to enable the mapping of different levels of energy access across countries to SDG7 indicators of universal access to electricity and clean cooking. For electricity, the report measures the remaining gap to achieving universal Tier 1 access. This corresponds to a minimum 12 kWh of electrical energy per person per day and lighting performance of 1,000 lumen hours per person per day, which provides enough power to illuminate three to four lights, charge a phone and operate a radio. This can be provided through solar hybrid mini-grids and SHSs – but importantly, not through solar lanterns. This report notes that electricity consumption thresholds would need to increase beyond Tier 1 to make way for energy access for productive use and the industrialization of rural economies. Additionally, this report does not focus on achieving Tier 3 access by 2030 given that higher tiers of access will most likely not be achieved within that time frame.

Electricity access

The report examines two main scenarios – business-as- usual (BAU) and universal access.

- **BAU:** The report's methodology does not follow a least-cost approach, which typically includes geo-spatial analysis and future technology cost assumptions. Rather, the access mix between grid, mini-grid, and SHSs is calculated by determining a 'realistic' expansion scenario, called the BAU. Grid expansion until 2030 is assessed from third-party analysis and stakeholder interviews. The same is done for mini-grid expansion,

[24] High-impact countries (HICs) are those that together account for more than 80 percent of people globally without energy access. For electricity, the HICs are Angola, Bangladesh, Burkina Faso, Chad, Congo (DR), Ethiopia, India, Kenya, Korea (DPR), Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, South Sudan, Sudan, Tanzania, and Uganda. For clean cooking, the HICs are Afghanistan, Bangladesh, China, Congo (DR), Ethiopia, Ghana, India, Indonesia, Kenya, Korea (DPR), Madagascar, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Philippines, Tanzania, Uganda and Vietnam.

considering the current policy, regulatory direction, and business environment of each country. The SHS BAU trajectory until 2030 is also determined based on stakeholder input, and inference of potential growth based on the trajectory in more mature markets.

- **Universal access:** Once the BAU scenario (and related number of households without access in 2030 in that scenario) is established based on the 'realistic' assumptions above, the methodology looks at households without access by 2030. There is no further grid expansion beyond the BAU scenario. It examines whether more households could achieve access through mini-grid expansion, were the private sector provided with additional finance and given the local context and stakeholders' expectations. All other households without access in the BAU scenario are deemed to achieve it through SHSs.

Electricity finance needs

The universal-access scenario provides the basis for estimates of the enterprise finance and the affordability gap. Under this scenario, BAU electrification finance is considered to have already been secured. This includes investments for grid expansion, existing mini-grid plans, and existing SHS growth finance. The additional finance only refers to the population that is without access in 2030 in the BAU scenario.

- **Finance gap (mini-grids and SHSs):** A cost of access per household is calculated for SHSs and mini-grids in each focus country based on in-country and regional benchmarks of the cost of each technology solution. The report then splits the finance need by instrument (equity, debt, grant) based on private business' own assessment of their future needs (based in turn on their size – start-up, mid-sized, or scaled), which were collected through interviews and private-sector surveys.

- **Affordability Gap (SHS):** The affordability gap is defined as the finance required to provide access to an SHS for households unable to afford one based on their current income. It is calculated using the World Bank poverty calculator tool, which identifies the percentage of households unable to afford a Tier 1 SHS based on the monthly payments required to buy one and the monthly expenditure on electricity needs in the focus countries. While it is acknowledged that there are other types of affordability challenges, including for accessing grid electricity, these are not the focus of the current report.

Clean cooking tiers

For clean cooking, this report estimates the deficit to both universal Tier 2/Tier 3 cookstoves and Tier 4 fuels and cookstoves. The report discusses a particularly efficient ICS option that can provide access up to Tier 2/Tier 3, as opposed to ICS in general, which only provide Tier 1/2 access. Tier 2/Tier 3 cookstoves, although less carbon intensive than traditional biomass alternatives, are not zero-carbon and have negative health implications for users. This report therefore also looks at Tier 4 clean cooking access. Tier 4 access is a composite metric that incorporates higher levels of air quality, efficiency, convenience, and health and safety of the cookstove and greater affordability and availability of clean and high-quality fuel. Tier 4 access is typically only achieved by widespread use of "clean" fuels like electricity, LPG, ethanol, gas pellets, and biogas, most of which are not used at scale in most developing countries. It should be noted that access to a "clean" fuel is a necessary, but insufficient condition of Tier 4 access.

Tier 2/Tier 3 solutions are often a critical intermediate step to a longer-term (beyond 2030) and costly transition to universal access to zero-carbon Tier 4 and Tier 5 solutions. Tier 2/Tier 3 solutions continue to remain critical, especially in the lead up to 2030 (WHO 2018).

Clean cooking access

Using a detailed study of the existing MTF reports, stakeholder interviews in focus countries, and a review of demographic indicators, the model matches each of the focus countries with an archetype country for which a recent MTF survey exists. The model then combines a fuel-to-Tier mapping from the MTF with a picture of each focus country's fuel mix in 2030. The 2030 fuel mix is estimated by using the latest available historical

data, examining historical trends, and projecting the mix forward, considering urbanization trends and any available studies that project likely fuel mixes in 2030. The calculated ratios multiplied by the primary fuel mix for 2030 for the respective countries leads to the distribution of households across Tier 0–5 of clean cooking under a BAU scenario in 2030.

Clean cooking finance needs

Tier 4: Transition households comprise all households unable to achieve Tier 4 levels of access in the BAU scenario. The model calculates the overall transition cost of enabling universal Tier 4 access including stove costs, fuel costs for five to ten years (depending on the household's current Tier), infrastructure costs, and costs associated with informing the needed household behavioural changes. To find a reasonable estimate for each cost the report relies on global benchmarks as well as country-specific data on three "clean" fuels: LPG, electricity and ethanol. Note that upstream and midstream investments are not incorporated into the cost calculation.

Tier 2/Tier 3: The report replicates the approach and general assumptions used to estimate private finance needs and the affordability gap for access to Tier 1 electricity. The households that are unable to purchase a Tier 2/Tier 3 ICS constitute the affordability gap population. The model then calculates the finance requirement per household to enable a transition to Tier 2/Tier 3 ICS.

Estimates are informed by deep, country-specific data collection that considers both qualitative sources (interviews with 40 stakeholders and webinars with over 25 stakeholders across the three focus countries and the broader energy access sector) and quantitative sources (surveys of private-sector companies in the electricity and clean cooking sector in each of the focus countries).

Photo by Dominic Chavez/World Bank

CHAPTER

2

TAKING THE PULSE OF ENERGY ACCESS IN GHANA

PART 1

TAKING THE PULSE OF ELECTRIFICATION IN GHANA

KEY MESSAGES
The Cost of Universal Electricity Access in Ghana

Grid electrification in Ghana has progressed rapidly over the past 20 years. Grid coverage is high with 81 percent of the population able to access electricity through the main grid in 2020, and 3 percent of the population having access via solar home systems (SHSs) or mini-grids (*Tracking SDG7: The Energy Progress Report 2021*). Under a business-as-a usual (BAU) scenario, access to electricity is expected to increase to 97 percent by 2030, (6 percent through SHS) with only the remotest of populations remaining without access.

Standalone SHSs will account for the last mile in universal electrification given the lack of a guiding framework for private mini-grid development. In the universal access scenario, SHSs are expected to provide access to a total of 9 percent of the population by 2030.

The mini-grid sector remains constrained by unsupportive policies. Mini-grid expansion is driven solely by the government, though some private companies currently operate in the sector. Without significant regulatory changes and investments, mini-grids will account for only 1 percent of electricity access by 2030.

Ghana will require USD 22 million in finance to achieve universal electricity access by 2030. 55 percent of this (USD 12 million) will be needed in end-user grants and subsidies to address the affordability gap; the remaining 45 percent (USD 10 million) will be needed for the private finance needs of SHS enterprises. 40 percent of the private finance need is in the form of grants to support operations in last-mile areas where distribution is costly.

Beyond funding, it will be critical to resolve broader ease-of-doing-business challenges to help set the stage for private-sector growth. This includes changes to the regulatory mini-grid framework and technical assistance for newer, less mature SHS companies.

Sector Context

With over 31 million people, Ghana is the second-most populous country in West Africa, after Nigeria. Ghana is a middle-income country and its economy is fuelled by exports of cocoa, gold and oil. Between 1991 and 2016, the poverty rate declined from 53 percent to 23 percent (World Bank; IMF 2019).

GOVERNMENT ELECTRIFICATION STRATEGY

Adopted in 1989, the National Electrification Scheme (NES) set out a plan to reach "universal access" by 2020 (since adjusted to 2025) through an ambitious grid expansion policy – although the government's definition of universal differs from this report's definition, as discussed below. Aside from the construction of new power generation facilities, a major objective of the NES was to expand transmission and distribution networks and to reinforce existing networks to improve grid reliability. At the time of development, national electrification was around 20 percent, with only 46 of the 110 district capitals connected to the grid.

The NES comprised two major programmes: the District Capitals Electrification Programme (DCEP) and the Self-Help Electrification Programme (SHEP). In the former, the government directly supported the efforts of the national transmission operator, Ghana Grid Company (GRIDCO), and the two distribution operators, the Electricity Company of Ghana (ECG) in the south and the Northern Electricity Distribution Company (NEDCO) in the north, to connect all district capitals. The SHEP focused on subsidizing the cost of extending the grid to communities with a population above 500. Under this scheme, communities agreed to pay 20 percent of the capital cost of bringing grid power to their homes, while the government covered the remaining 80 percent through grants and concessional loans. The programme was accessible only to 4,200 communities within 20 kilometres of an existing 33/11 KVA transmission line. The NES implementation plan consists of 69 grid-based development programmes, to be implemented over six five-year phases, towards which there has been rapid progress. Under the DCEP, all district capitals have now been electrified. The SHEP has continued to grow and is now in its sixth phase of implementation. Of the 4,200 eligible communities across the country, approximately 3,500 have participated in the programme.

In 2019, the government developed the Rural Energy Master Plan (REMP), focusing on providing off-grid solutions for about 10 percent of remote, rural households currently without grid access. The REMP aims to provide renewable, decentralized electrification to an estimated 3 million people in 1,000 off-grid communities by 2030, through a combination of 300 mini-grids and 20 MW of SHSs[26] (Ghana MoE 2019). Meeting these targets would imply enabling electricity access for an estimated 900,000 households, roughly approximating the 10 percent of households located in areas where small, remote communities situated far from the existing grid network predominate. These include the Upper Eastern and Upper Western regions and the island and lakeside communities in the Volta region.

The REMP favours mini-grids and SHSs in different regions of the country, depending on which technology represents the lowest-cost option within the local context. It focuses on the rollout of mini-grids in the lakeside communities of the Volta region given their relative size and density, as well as their distance from roads and the lack of grid expansion plans. SHSs, on the other hand, are better suited to serve the Upper Regions and small, remote communities in the southwest.

Ghana also subsidizes grid-based electricity consumption through the Lifeline Tariff Scheme; participating households consuming less than 50 kWh of electricity per month pay an equivalent of USD 0.06 per kWh.

[26] The plan also calls for 200 MW distributed solar systems to be connected to the grid and for 1 million solar lanterns by 2030. These are not included in this report's calculation since they do not contribute to energy access as defined here.

MAIN DEVELOPMENT PARTNER PROGRAMMES

Ghana receives significant donor support to enable rapid grid expansion under the NES. The World Bank, USAID, Millennium Challenge Corporation, and others have been strong supporters of electrification in Ghana, providing significant funding over the past 30 years to support investment in grid expansion.

MINI-GRIDS

Mini-grids currently serve a small share of households (less than 1 percent) and have been built and operated almost entirely by the government, with funding from donor sponsors. The World Bank's Ghana Energy Development and Access Project (GEDAP) financed and operationalized five solar pilot mini-grids for isolated communities on islands in the Volta Lake and the Volta River, generating a total of 150 KW to serve 10,000 beneficiaries. These five sites are owned by the Volta River Authority (VRA) and were recently transferred to be managed by the ECG and NEDCO. Going forward, the World Bank has recommended that the Ministry of Energy (MoE) explores partnerships and operating models in conjunction with private-sector mini-grid developers, especially considering ongoing operational and financial challenges faced by the two domestic utilities. The development of three further sites, supported by the Swiss Government, is currently underway, with tendering assigned (Power Africa 2019). Figure 8 highlights other development partners that are supporting off-grid expansion in Ghana.

FIGURE 8
Key programmes financing off-grid expansion in Ghana

Donor	Key Programmes
World Bank (including GEDAP)	• Mini-grid development (5 grids around Lake Volta) • SHS distribution (15,000 units) • Grid development support
AfDB	• Technical assistance for Renewable Energy Program Mini-grid development (55) • Mini-grid development (55) • Stand-alone solar systems for (33,000 households)
GIZ	• Market entry support for private distributors of solar pumps • Decentralized energy for irrigation, productive uses, and social infrastructure • Technical assistance through (100 technicians training)
SECO	• Mini-grid development (3 sites)
DFID/FCDO	• Testing Lighting Global-certified quality assurance laboratories • Grants to off-grid companies through the Africa Enterprise Challenge Fund • Technical assistance: Policy frameworks and ESMAP best practices dissemination (in partnerships with World Bank)
USAID	• Mini grid development (50 sites) • SHS rollout and last mile deliver support ($150,000 grant to PEG)

Private-sector participation in the mini-grid sector is extremely limited, and no future growth is planned. Ghana has no operating framework for private mini-grid operators, and private companies are not able to apply for a license to sell electricity. A single private sector mini-grid provider operates in Ghana: Blackstar Energy, a subsidiary of Energicity Group, serving 6,000 customers with 17 mini-grids in the Ashanti and Brong-Ahafo region. Despite not being to apply for a license, the company has been running 17 solar mini-grids. There are no current plans for private-sector expansion in the mini-grid sector in Ghana.

SOLAR HOME SYSTEMS

Ghana has a growing competitive market for SHSs, reaching approximately 2 percent of households with sales of Tier 1 and above systems. The SHS market in Ghana started in the early 2010s with the entry of several international companies, including PEG and Zola Electric, which focus primarily on higher-end and more profitable products (e.g., 25W systems with TVs, which range from USD 400 to USD 700) sold almost exclusively on a pay-as-you-go (PAYG) basis,[27] and the launch of several local distributors. To date, companies have made 300,000 cumulative sales (including pico solar products). The market grew quickly in 2015–2016. Customers who experienced unreliable grid-connected electricity supply — long delays and blackouts — accounted for an estimated 40 percent of sales. As penetration increased, sales slowed in 2017–2018. Today, the market includes 10 SHS companies operating with a range of payment and distribution models. Over half of all sales, including those made by PEG and Zola Electric, are on a PAYG basis, whereby the customer pays in small installments towards ownership of the SHS.

Several local SHS distributors and retailers including Wilkins, Sukasol, SunHut and Burro are active, with small but growing market footprints. Most local distributors are smaller scale and target specific geographic regions. They focus on smaller SHSs and pico products (lanterns) that customers can afford to purchase upfront in cash. Most local businesses lack the finance and operational systems to operate on a PAYG basis, a key limitation to bridging the affordability gap and scaling their operations.

Non-GOGLA products represent an estimated 30 percent of the market. Like most other SHS markets, Ghana has seen an influx of cheap, generally low-quality products. However, existing SHS companies do not view this as a major concern. As the SHS market in Ghana matures, brand recognition is growing, and customers are becoming increasingly aware of the downsides of low-quality products. Market participants note that unbranded market sales can also contribute to Tier 1 electricity access, and that some unbranded products are of good quality. However, unaffiliated providers typically do not offer PAYG finance, maintenance, or warranties, which limits their growth potential.

Across the board, however, SHS enterprises face last-mile distribution challenges, and therefore have limited appetite to enter remote and rural areas. Most SHS enterprises operate on a commission-based sales agent model; they typically face challenges with sales agent capacity and retention in rural areas due to low familiarity with products and technology. Enterprises also face challenges around underdeveloped transportation infrastructure, as lack of quality roads hinders distribution and after-sale customer service. Poor mobile network coverage remains an issue in remote regions, particularly in the Upper Eastern and Western areas, where a significant share of the population still lacks reliable mobile network access. These barriers are likely to prevent SHS enterprises from entering new areas without significant incentives to mitigate risks.

[27] The report notes however that the strategy of SHS providers in Ghana has been to focus on higher-end products, which are more profitable than Tier 1 access products. These companies also do not focus on selling these products in last-mile markets. As a result, incentives such as conditional grants or RBF may be required to ensure that scaled private companies focus on Tier 1 system sales.

FIGURE 9
Key Ghana SHS companies

	Ownership	Geo focus	Business model	Retail cost (GH₵)	Funding
PEG	International	All regions	Distribution only; PAYG and cash	Up to $700	$50 M debt / equity, from impact investors (e.g., Acumen, CDC, EAV)
ZOLA	International	Ashanti	Manufacturing and distribution; PAYG, cash	N/A	$55 M debt / equity from impact investors (GE Ventures, Helios Investment Partners)
NorthLite Solar Ltd.	National	N/A	Distribution; Cash and MFI partnership	N/A	Local
WILKINS ENGINEERING	National	Central, Eastern, Greater Accra	Distribution; Cash	N/A	Local
sükasol	National	Greater Accra, Northern	Distribution; Cash	₵~200 (lantern)	Local
SUNFUT Enterprise VILLAGEBOOM A Social Enterprise	National	Central, Eastern, Northern	Distribution; Cash	N/A	Local
BURRO DO MORE	National	Eastern and Volta	Distribution, Cash and PAYG pilot	N/A	Local
GTEC	National	Ashanti and Volta	Distribution through NGOs, cash	N/A	Local
Other micro-distributors	National	All regions	Cash sales	N/A	Local
Total					

GENDER DYNAMICS IN GHANA

Although no comprehensive statistics exist on gender in the energy sector in Ghana, stakeholder interviews revealed a number of observations. Greater focus on capturing and aggregating gender data in Ghana is therefore recommended.

A general gender gap in education persists in Ghana. Gender parity has been reached in primary education and junior high school, but not beyond. Female participation is just 5 percent in some fields traditionally considered 'male-dominated', including electronics. As a result, few women are employed in these fields (AfdB 2019).

The majority of women's economic participation is through self-employment and the informal sector, with limited participation in salaried energy-sector employment. Just 14 percent of women hold salaried jobs, compared to 27 percent of men,37 and few programmes exist to encourage women to participate in the workforce. The Gender Africa Index 2019 ranked Ghana 20th

out of 51 countries. One consequence of the relatively low women's participation in the formal workforce is likely to be more time at home and therefore much greater exposure to indoor air pollution arising from relatively low clean cooking uptake.

Women in particular benefit from energy access for productive uses and income generation. A study in Ghana found that the number of women entrepreneurs increased by 29 percent and women's incomes increased by up to 11 times once electricity became accessible (Power Africa 2019). (See Case Study 1 in Appendix on alternative approaches to the productive use of electricity.)

Access to finance for women is limited. Stakeholder interviews suggest that access to finance depends primarily on inheritance and landholding, from which women are traditionally excluded. Women tend therefore to lack adequate finance and assets to access working capital. In addition, they have less education and insufficient skills in entrepreneurship and business management to grow their businesses.

Current State of Electricity Access

Tier 1 and above electricity access in Ghana currently stands at approximately 84 percent, primarily through grid access.

The government's grid expansion policy is the main driver of the increase in access to electricity historically. Access is markedly higher in urban areas (94 percent) than in rural areas (50 percent).

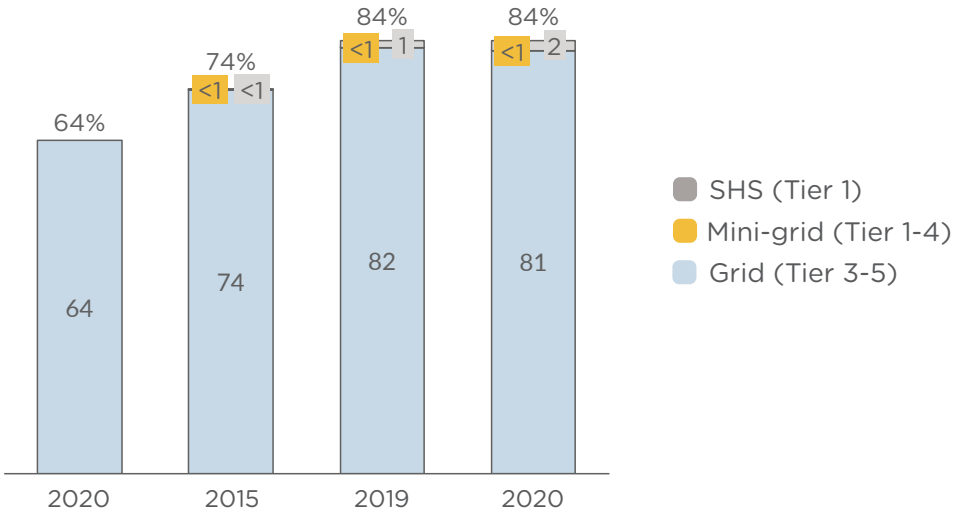
FIGURE 10
BAU and universal access scenarios for electricity in Ghana[28]

		Ghana		
		2020	2030 BAU	2030 Universal Access
Population (in millions)	Population	31	38	
	Households	9	11	
Access to electricity (% of households)	Grid access	81	90	90
	Mini-grid access	<1	1	1
	Standalone solar access	2	6	9
	Total	**83%**	**97%**	**100%**

[28] World Bank World Development Indicators for population and household estimates. Author's calculation for access estimates.

FIGURE 11

Electricity access in Ghana 2010–2020 (% of households)[29]



The primary challenge for Ghana's progress towards universal electrification is the difficult-to-reach last-mile distribution of SHSs.

- **Unelectrified populations tend to also be the hardest to reach.** Still-unelectrified communities tend to be in remote and rural parts of the country for which there is no plan to expand grid coverage. SHS operations in these same regions are often limited by difficult or lack of road access, poor mobile coverage, few warehousing options, etc.[30] Private-sector companies naturally focus on serving the lowest hanging fruit in terms of potential customers – those who live in urban and peri-urban areas.
- **Consumer affordability is also low in the hardest-to-reach areas.** Household incomes in remote areas tend to be lower, resulting in lower ability to pay for electricity service. Availability of consumer finance options such as PAYG are limited due to low mobile money penetration.
- **Private sector finance is insufficient.** Local enterprises are for the most part pre-commercial and must also contend with all the challenges commonly faced by small and medium-sized enterprises (SMEs), including access to finance, both equity and debt – particularly to finance growth. As companies in a still-maturing energy industry, they are not well understood by local financing institutions and this results in the perception of high risk.

Covid-19 has not caused a significant slow-down in energy access, as the government limited the negative impact of the pandemic through subsidies for grid-connected households. During the pandemic, the Ghanaian economy suffered a significant economic slowdown, as annual GDP growth dropped from 6.8 percent pre-Covid to just 1 percent in 2020. The International Monetary Fund (IMF) expects a rebound to 4 percent growth in 2021, which is still below pre-pandemic levels (IMF 2021). While poverty levels increased and living standards deteriorated, social distancing measures did not last as long as those seen elsewhere in the region, as the partial lockdown was lifted on 23 April 2020. As a result, on-grid energy demand remained stable. The government fully covered the bills of low-income consumers for grid electricity (consuming 0 to 50 kWh per month)

[29] Tracking SDG7 2020 data extrapolated based on local stakeholders' perspective. Grid access (Tier 3–Tier 5), mini- grids (Tier 3– Tier 4), SHSs (Tier 1–Tier 2)

[30] Stakeholder interviews and secondary research also highlight additional issues including few local distribution partners, and limited capacity of partners. SHS enterprises face challenges recruiting and retaining sales agents due to lower product and tech familiarity, and difficulties reaching customers with after-sale care.

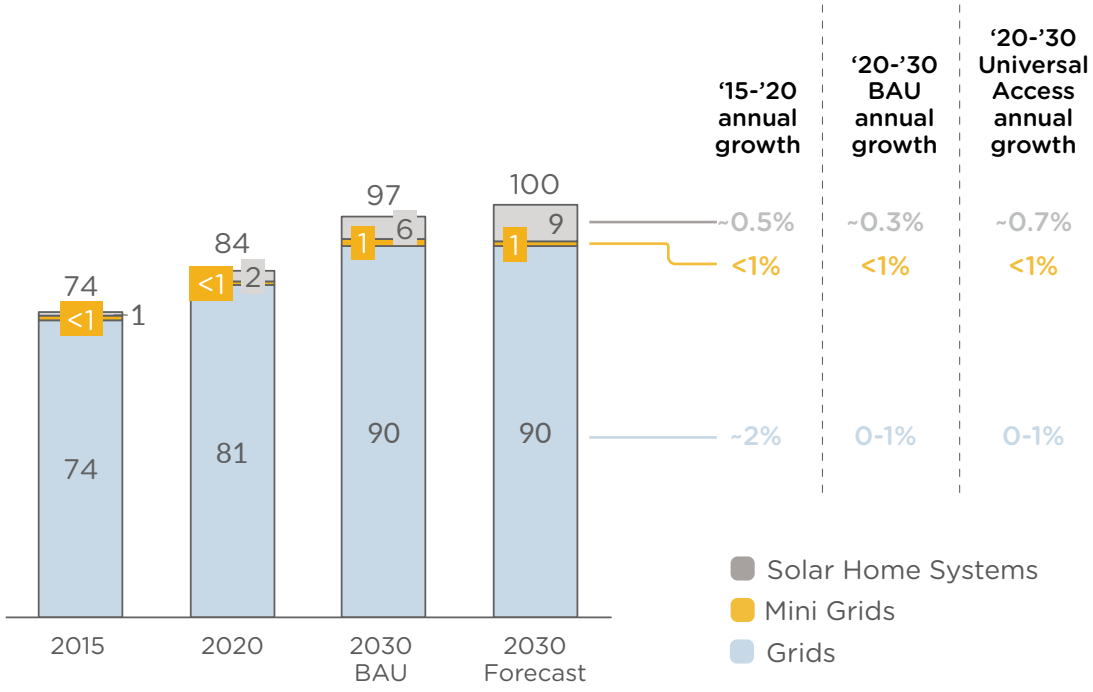
for April, May and June 2020. Other consumers were granted a 50 percent reduction in the cost of grid electricity for the same period.

The off-grid private sector has continued to grow during the pandemic. Off-grid solar companies were exempt from travel restrictions, mitigating the impact of the lockdown. Additionally, demand for electricity has increased as households spend more time at home. Several private support programmes have been launched that SHS companies are able to participate in, such as the Covid-19 Recovery and Resilience Programme run by The National Board for Small Scale Industries (NBSSI) and Mastercard Foundation. This programme has provided financial assistance in the form of grants and concessional loans to SMEs, including off-grid solar companies (GOGLA 2020). GOGLA data suggest that the Ghana SHS sector saw a 171 percent year-over-year increase in SHS sales (for a total of 84,000 units) in the first half of 2020. This growth is most likely attributable to increased customer demand for energy and electronic devices (such as a greater need for lighting for educational purposes) spurred by lifestyle changes due to Covid-19.[31]

BAU and Universal Energy Access by 2030

In the BAU scenario, Ghana is expected to reach 97 percent electrification by 2030. Given current grid expansion and investment plans, Ghana is likely to be on track to meet its target of 90 percent access to on-grid energy by 2030, as set out in the NES. Another 7 percent of the population can be reached through off-grid solutions, including mini-grids (1 percent) and SHS (6 percent). In the universal access scenario, Ghana will reach 100 percent electrification through the expansion of SHSs, which will account for 9 percent of access.

FIGURE 12
Ghana electricity access 2015-2030e – BAU and Universal Access



[31] The GOGLA report also mentions a new programme due to come online towards the second half of 2021 as sales increases, but stakeholders interviewed were not aware of it.

GRID EXPANSION

As a reminder, estimating the cost of grid expansion beyond the BAU scenario is not in the scope of this report.

Ghana is likely to reach its energy access target of 90 percent of households connected to the grid by 2030. Ghana has demonstrated a historical track record of implementing grid projects at a fast pace, increasing access by an average of 2 percent per year. The NES is generally considered to be well coordinated and implemented. Given that 81 percent of households were already connected to the grid in 2020, a further growth of 9 percent in the coming five years would represent a slowdown compared to historical access growth and is deemed feasible.

OFF-GRID EXPANSION

MINI-GRIDS

Government mini-grid development plans will provide electricity access to an additional 1 percent of households, but some delays have already occurred. Of the 300 mini-grid projects identified by the government, the REMP targeted 86 of them to be operational by 2020. So far, only five mini-grids supported by the World Bank's GEDAP are operational, with three further sites under development, sponsored by the Swiss government. Other mini-grids are currently in development, including an AfDB-financed programme conducting high-level feasibility planning for 50 sites as part of the Scaling up Renewable Energy Program (SREP). USAID is also supporting the feasibility study of a further 50 sites. The government is currently scoping the potential for 100 further sites to connect remote areas and islands, with the potential to reach 0.35 percent penetration. However, funding for the remaining 187 mini-grids has not been confirmed.

FIGURE 13
Status of operational and planned mini-grids in Ghana

Sponsor	Description	Currently operational # (% households[1])	# grids planned (% households)	2030 mini-grid feasibility (# and % of 2030 households)			
				Locations identified	Feasibility study undertaken	Tender awarded	2030 potential mini-grid #
Government (REMP)	300 mini-grids operational by 2030 serving 24K households	5 (N/A)	300 (~1%)	108 (0.35%)	108 (0.35%)	3 (<0.1%)	113-300 (0.4-1%)
Private sector (Black Star)	17 grids currently operating, serving ~6K customers	17 (<0.1%)	N/A	Private sector operations halted and no new mini-grid development plans given lack of regulatory framework			
Total		17 (<0.1%)	300 (~1%)				117-317 (~1%)

Government grid rollout plan behind schedule (86 by end of 2020, 200 by 2025)

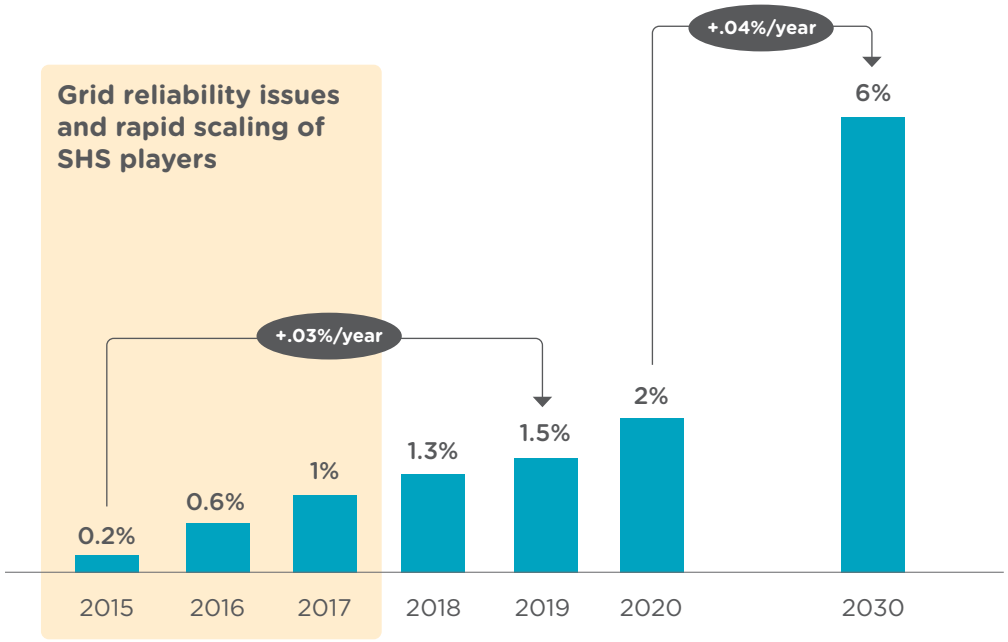
Beyond government-led initiatives, there are unlikely to be any further private-sector mini-grid developments due to regulatory and economic challenges around uniform tariffs. Given that the government has taken no action to address the regulatory challenges for mini-grid operators, there is currently no market basis for the private sector to enter the Ghana mini-grid market. The BAU scenario therefore assumes that the 300 mini-grid projects identified with development partners will be completed by 2030, but that no additional projects are undertaken. This report also estimates the cost of access in a more aggressive scenario. In that scenario, where regulatory changes would enable the private sector to invest in Ghana, stakeholder consultations estimate that mini-grids could provide access to 4 percent of Ghana's households by 2030. In this scenario, the finance needs for universal access increase to USD 475 million given the higher cost of connection per household of mini-grids compared with SHS. This scenario would require regulatory changes to crowd in the private sector beyond the current sole private sector company. No discussions around a new framework for private-sector participation are underway in Ghana and therefore there is little likelihood of the "aggressive" scenario materializing.

SOLAR HOME SYSTEMS

Based on historical growth trend and market potential, SHS penetration will reach 6 percent by 2030, bringing overall access to electricity to 97 percent by 2030 in the BAU scenario. Private SHS companies have identified areas with limited SHS penetration through geo-mapping and are actively targeting them. As the market matures, they expect customer awareness and brand recognition to increase, in turn increasing customer product demand. Finally, increasing mobile money penetration will support the growth of PAYG, allowing SHS companies to continue to expand into lower-income areas. Projected market penetration of SHS implies annual growth of SHS sales of 15 percent, which is high but not uncommon in markets where PAYG helps drive penetration.

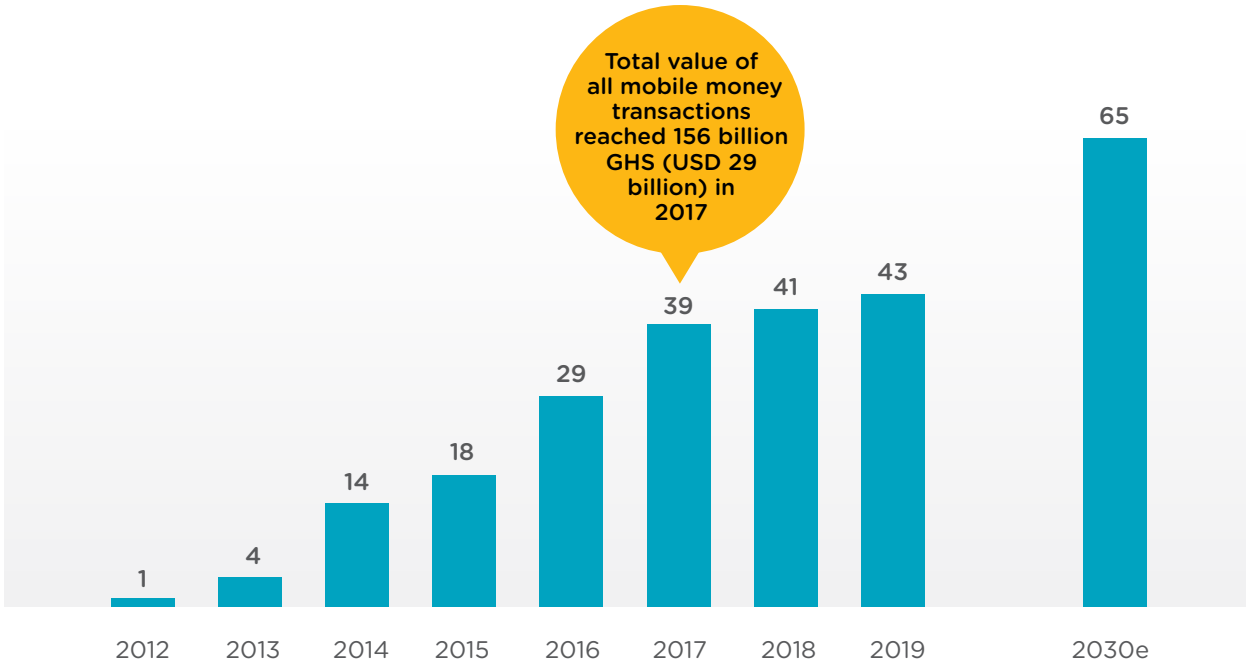
FIGURE 14

Historical and projected BAU share of households with access to Tier 1 SHS not connected to the grid in Ghana (% of households)



PAYG represents a key opportunity in Ghana, as mobile phone penetration is growing rapidly. If this continues at the current pace, mobile money usage will reach 65 percent penetration by 2030.

FIGURE 15
Share of population in Ghana using mobile money (percent of total) - BAU



Financing Universal Electricity Access in Ghana

ENTERPRISE FINANCE NEEDS

There is no finance need for private sector mini-grid development, given that the government will take the lead, with donor support.

To reach universal energy access, SHS enterprises will require an estimated USD 10 million.[32] Based on the estimated inventory costs, including initial distribution set-up and infrastructure costs, the total finance needed per new household connection is USD 33. This represents the required average level of finance per new connection given that SHS enterprises do not generate sufficient cash to finance a higher rate of deployment. Additional details on the finance needs calculation can be found in the Methodology.

Figure 16 illustrates the private sector's perspective (based on a survey of a subset of that sector) on how its finance need should break down by instrument. Overall, a continuum of types of capital is needed to meet small, local company needs and last- mile delivery. Mid-sized and larger companies such as PEG and Zola have demonstrated an ability to raise debt funding, which over time can make up to 50–60 percent of finance. The model assumes that by 2030, larger and more mature SHS companies will account for 80 percent of sales, requiring debt finance, particularly in local currency, alongside grants and equity. This is broadly in line with the current market structure with PEG and Zola accounting for most sales in Ghana.

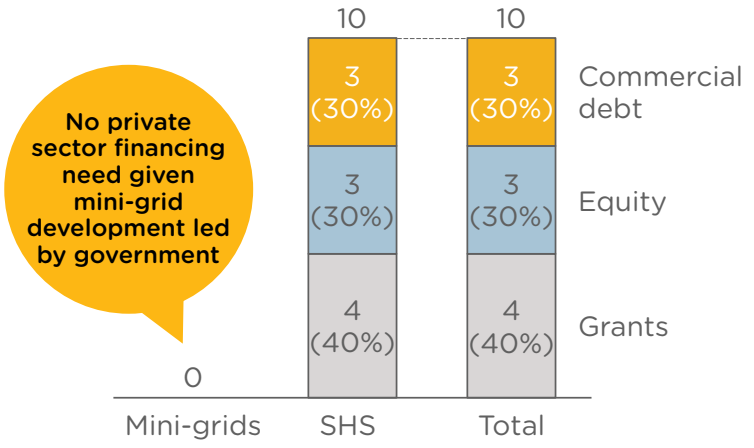
[32] This amount differs from the cost of standalone solar expansion estimated by REMP of USD 55 million. The USD 10 million corresponds to an incremental finance need for private companies beyond what they are expected to obtain in a BAU scenario.

To properly address the market, funders will need to assess the fit-for-purpose nature of their funds against market needs. Results-based financing (RBF) instruments are an appropriate tool for larger companies with the ability to undertake deliveries before receiving payments. Given the early stage of development of many local SHS companies, stakeholder interviews suggest that grant funds are needed to support smaller enterprises entering harder-to-reach areas. Smaller enterprises typically lack tresources, and therefore require upfront grants to reach last-mile customers.

AFFORDABILITY GAP

Transition households (those that will not achieve access by 2030 in the BAU scenario) make up 3 percent of total households in Ghana. Of that 3 percent, about one third are currently unable to afford SHSs on a PAYG basis. USD 12 million is needed in demand support to provide universal access to those households. This calculation assumes that SHS products are purchased by households using their existing expenditure on electricity (8 percent of total consumption expenditure; IRENA 2016; World Bank), considering an average cost of USD 100 per SHS. Leveraging PAYG models, households pay the total cost of a system over the course of one year in monthly payments of USD 8.33 per month.[33]

FIGURE 16
Universal electricity access finance needs in Ghana

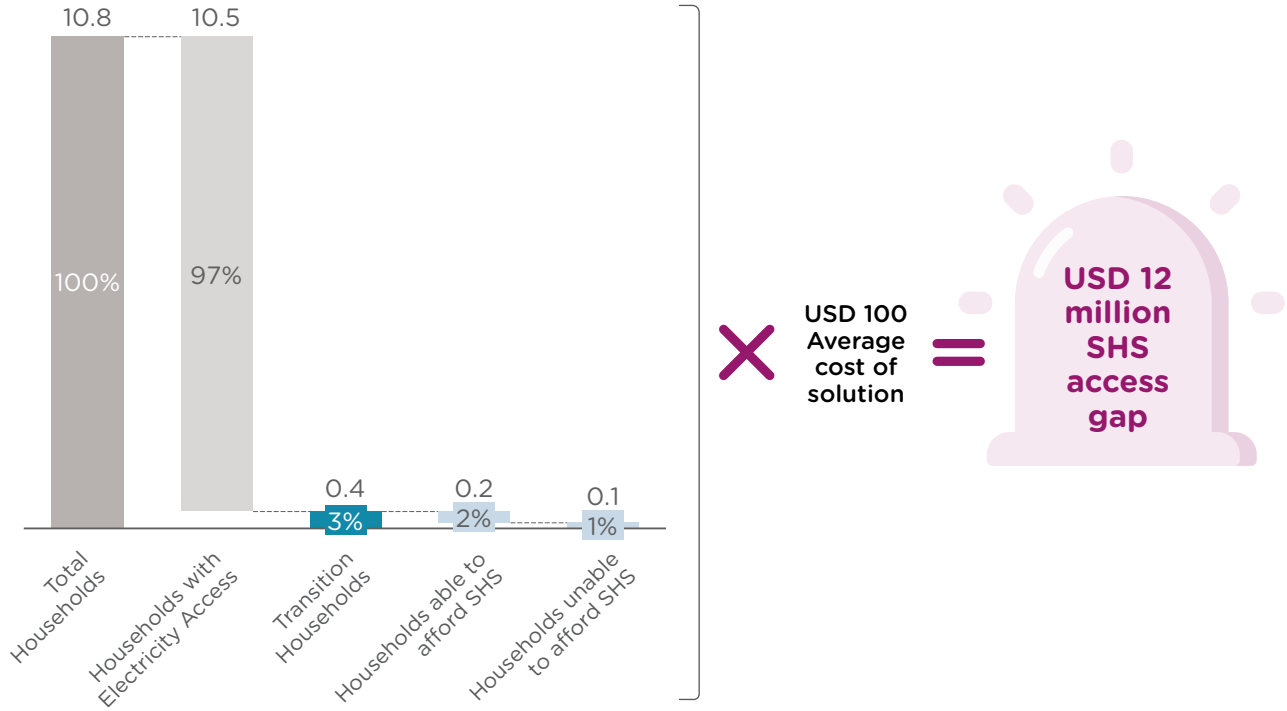


	Mini-grids	SHS	Total
No. of transition households connected (M)	N/A	0.37M	0.37M
Access gap bridged (% total)	N/A	100%	100%
Finance needs / household ($)	N/A (gov't, donor financed)	~$33	~$33

[33] Tenor varies from 12 to 36 months in Ghana. For Tier 1 systems 12 months is used as the standard tenor.

FIGURE 17

Ghana SHS affordability gap calculation (2030 households USD million)[34]



Demand-side subsidies are needed to make these systems affordable for transition households. While subsidies in the form of lower electricity tariffs have been provided in Ghana to households with access to grid-based electricity, these types of subsidies do not work for customers without such access. By contrast, in Vietnam the government provides cash directly to lowest-income households to pay towards their cost of electricity consumption. This is possible in Vietnam because the government can leverage the existing administrative infrastructure of wider social assistance programmes (Scott 2020). In Ghana, development partners and the government could explore a similar mechanism to deliver demand-side subsidies to households. The key question lies in how to deliver the subsidies efficiently.[35]

AVAILABILITY OF FINANCE

Across all capital sources and, like in most other markets, there is limited funding available in Ghana for off-grid energy enterprises.

Local financial institutions are mostly unwilling to lend to energy enterprises due to perceived high risks, low returns and unfamiliarity with the sector. The same issues drive a limited appetite from investors to provide equity to these enterprises, particularly smaller, local companies. There is very limited availability of commercial debt given perceived complexity and risk of transactions, with limited return on investment. Stakeholder interviews suggest that local enterprises are predominantly pre-commercial and face the same challenges as SMEs, including access to finance; this is complicated by the fact that they are companies in a maturing industry less understood by financing institutions.

[34] Market participant interviews conducted by authors. This compares with USD 125 in Mozambique where SHS products do not benefit from VAT or tariff exemptions.

[35] Case study 7 in the Appendix looks at how Vietnam successfully delivered targeted electricity consumption subsidies.

The limited track record of individual enterprises within the sector is also a key barrier, with financial institutions typically unwilling to lend to enterprises less than three years in business. Commercial lenders also lack technical expertise in the off-grid energy sector, which discourages them from investing given their lack of familiarity with relevant business models and financing structures. This situation in not unique to Ghana and donor-funded programmes are designed to address this. SNV in Ghana is active in supporting banks with technical expertise to appraise new enterprises and develop tailored financing offerings though stakeholder interviews suggest the impact of these programmes has yet to materialize.[36]

Development finance institutions (DFIs) have started to explore mechanisms to mobilize more local lending for the energy sector in Ghana, incentivizing local financial institutions through risk sharing, but these initiatives are still nascent. Where banks do lend to off-grid enterprises, the terms are often short and costly. As one stakeholder put it: "the return for these financial institutions is just too low for commercial banks". The difficulty of lending against SHS as an asset has been cited as a challenge, since it is costly to repossess this type of collateral compared with the value of the product itself, and from a mission and impact on brand perspective, some companies may be reluctant to do so. Development partners have developed several initiatives that seek to scale and simplify local lending. CDC's off-grid solar debt facility provided local currency finance for PEG in Ghana.[37] AFD has implemented a local energy lending facility through the local CalBank. Development partners have also explored risk-sharing mechanisms with commercial banks (e.g., declining first-loss guarantees), but none have been launched to date. (See Case Study 2 in the Appendix on emerging solutions to provide off-balance sheet finance, including through securitization.)

International SHS companies in Ghana receive international debt and equity finance from patient capital sources, but there are few finance options available for smaller local companies. Zola and PEG have attracted a total of more than USD 100 million in finance. Purely commercial lenders and local investors or banks have not participated in their funding rounds; to date impact-motivated capital such as impact investors and DFIs have provided most of the funding. PEG recently closed several debt and equity financing rounds, attracting capital from the CDC Group, the European Electrification Financing Initiative (ElectriFi), and several impact-focused investors such as Energy Access Ventures and the Blue Haven Initiative. Zola Electric similarly has attracted up to USD 50 million in investment from GE Ventures and Helios Investment Partners. However, these types of investments are not accessible to local companies, given their limited international exposure and smaller-scale operations.

Grant funding is limited, given the perceived success of energy access expansion. In the last few decades, development partners focused on energy access in Ghana have mostly supported government electrification efforts. Given the rapid advancement of these programmes, and the strength of the SHS private sector market, few donor-funded programmes are focused on reaching the last mile. However, donor funding is still critical to incentivize the private sector to focus on lowest income and remote communities. For local companies to be part of the solution, donor funding and technical assistance to build viable and sustainable businesses will also be required.

[35] SNV simultaneously works with enterprises to help improve their creditworthiness through better financial management practices.
[36] Direct lending without the involvement of local financing institutions.

FIGURE 18

Overview of finance availability in the Ghana electricity market

	Description	Availability	Market perspective
Commercial debt	Very limited commercial lending to SHS and mini-grid players to date Donors have explored risk-sharing mechanisms with commercial banks (e.g., declining first-loss guarantees), with no closing to date	 Limited availability of commercial given perceived complexity and risk vs. return on investment for financial institutions	With the notable exception of Standard Bank which also acts as a security and documentation agent, the returns on these investments are just too low for commercial banks
Equity	Significant international investors and patient capital has been invested in Ghana SHS players • PEG (Acumen, CDC, EAV) • Zola (GE Ventures, Helios Investment Partners)	 Limited availability for local players with smaller scale Limited availability of funding in local currency, partially driven by high cost and complexity of financing structure (lack of assets to secure, typically structured against receivables)	We were hoping for a snowball effect 5 years ago – and for more commercial finance for the sector. That is taking a lot longer than expected. No one has really found a structure that everyone can get behind
Grants	Donor funding primarily focused on support government electrification plans, including mini-grid development Few donor-funded programs to reach last segments of the market and to incentivize private sector to focus on lowest income regions	 Limited availability of grants or RBF mechanisms	Ghana is seen as such a successful market for electricity access, it is seen as less of priority country so less funds dedicated to it, and there's no RBF mechanisms at the moment

Key Finance Opportunities and Solutions

A blended finance approach will be critical to address the primary challenges of last- mile electricity service and consumer affordability. Key recommendations are summarized in Figure 19.

A combination of debt and equity will be required to **support last-mile delivery of SHSs**. These types of finance should support the growth of firms and the associated extension of energy access, alongside appropriately targeted grants to incentivize private-sector participation in harder-to-reach areas, through for example RBF mechanisms. Development partners could replicate successful examples of RBFs such as the CIZO SHS programme in Togo that leverages a demand-side voucher programme (see Case Study 3 in Appendix). Key success factors would require among other things the availability of an independent verification entity with the ability to rigorously monitor outcomes, and the capacity of companies to fund upfront activities (since payments are made after results are achieved).

Scaling up support for the SHS private sector with an additional USD 10 million investment, preferably in the form of concessional debt in local currency (USD 3 million), equity (USD 3 million) as well as grants (USD 4 million) to support both early-stage and larger, more mature private companies' expansion to last-mile areas. The impact of private-sector support would be enhanced if paired with technical support for earlier-stage local companies.

To address consumer affordability challenges, development partners could explore a USD 12 million demand-side subsidy programme to ensure no one is left behind. Given that there is a relatively mature SHS private sector in Ghana, demand-side subsidies may distort competition, as they tend to favour select firms. As a result, development partners could explore mechanisms that channel demand-side subsidies that enable consumer choice among all private companies.

Additional work is required to improve women's participation in the energy sector in Ghana including additional data gathering. Not enough data exist at a gender-disaggregated level. Incubating more women-led energy enterprises and mobilizing more capital for women-led businesses can further improve women's participation. Existing initiatives include the 2X challenge, launched by the G7 DFIs, which aims to mobilize USD 3 billion for companies that focus on women as consumers, employees, leaders, or owners. Other options include mandatory investment levels in women-owned businesses in the energy sector or incubators specifically targeting women.

Introducing work-inclusive policies, flexible working hours and encouraging the take-up of paternity leave will increase the attractiveness of jobs in the energy sector for women. Stakeholders can also create programmes to actively promote women's participation.

A gender-specific, people-centred design approach can help create the right products for women. Incorporating women in the design process and understanding their specific needs is more likely to lead to better product design and higher uptake.

Finally, development partners should work with the Government of Ghana to secure funding for the mini-grids identified as part of the REMP. Figure 19 summarizes potential approaches and an initial assessment of their applicability to the Ghanaian context.

FIGURE 19

Recommended instruments to address Ghana's electricity challenges

Audience	Challenge	Recommendation
Development Partners	Difficult last mile distribution	Result-based mechanisms to incentivize private sector distribution in harder to reach areas.
	Low customer affordability	Demand-side subsidies (e.g., voucher programs) to improve customer affordability. Research and development funding for more efficient ICS stoves sold at a similar cost based on future carbon financing to increase consumer willingness to pay.
	Insufficient funds	Local lending support to the private sector through guarantees, first loss schemes, etc. Carbon credits expansion for private sector finance. Explore pooling carbon credits from small manufacturers, providing upfront finance against future carbon credits.
	Market uncertainty	Mini-grids program funding for mini-grids identified as part of Ghana's REMP.
Investors	Low customer affordability	PAYGO models for clean fuels, consumer finance options for ICS expansion.
	Insufficient funds	Local debt and concessional finance expansion to support the expansion of Paygo.
Government	Market uncertainty	Mini-grid regulatory changes to enable private sector participation and financing of mini-grids in Ghana.
All	Gender imbalance	Additional data gathering to size the issue. Women led energy enterprise expansion. Mobilize more capital for women-led businesses and create programs that promote women participation in the private energy sector. Inclusive work policies to support women employees. Gender specific, human-centered design to help design the right products for women.

PART 2

TAKING THE PULSE OF CLEAN COOKING IN GHANA

KEY MESSAGES
The Cost of Universal Clean Cooking Access in Ghana

Ghana has seen steady growth in access to clean cooking. This report estimates that 14 percent of the population had access to Tier 4 clean cooking and 32 percent of the population had access to Tier 2/Tier 3 clean cooking in 2020. Under a BAU scenario, access to clean cooking will continue to increase by 2030 but will fall far short of universal access targets, both in terms of Tier 2 / Tier 3 (40 percent estimated access by 2030) and Tier 4 (18 percent access by 2030).

Universal Tier 4 access has a USD 10–13 billion cost. This is largely due to the cost of fuel (USD 7.6 billion), driven by the number of households that are not able to afford Tier 4 solutions.

Universal Tier 2/Tier 3 access to improved cookstoves (ICS) requires a much smaller amount of USD 299 million. This is driven by the household affordability gap of USD 146 million and private-sector finance needs of USD 153 million. ICS manufacturers in Ghana are only commercially viable when they receive carbon credits or grants (SNV 2020). Many ICS companies are small companies with limited scale, no access to lower-cost international finance, and limited local commercial funding. As a result, grants will remain a core source of funding for many companies until 2030 to support the expansion of private companies.

It is critical for the government to develop a comprehensive strategy for clean cooking in which the private sector plays a key role. This includes incorporating into the existing national clean cooking strategy a pathway for "clean" fuels beyond liquefied petroleum gas (LPG) and supporting ICS sector growth with clear guidelines and measures for private-sector engagement and expansion.

Sector Context

Clean cooking falls within the remit of the MoE in Ghana, which oversees all aspects of energy-sector policy. The MoE began interventions to support clean cooking in the 1980s, but the sector really started to expand under the MoE's Ahibenso coalpot programme in the 1990s. Led by the National Energy Board, in collaboration with the World Bank, the programme supported local artisans to design, produce and disseminate efficient charcoal pots knows as gyapas, which still dominate the ICS market today. Since then, the MoE has issued various policies promoting more sustainable consumption of traditional solid fuels (charcoal and firewood) to combat growing deforestation, such as the 2010 National Energy Policy, the 2010 Energy Sector Strategy and Development Plan, the Ghana Shared Growth and Development Agenda II, the SEforALL Action Agenda 2015 and the Strategic National Energy Plan 2006–2020. Through the REMP, the national government set a target of distributing 1.3 million ICS by the end of 2020.

The MoE has also supported the growth of LPG as an alternative cooking fuel. The Government of Ghana has been a strong proponent of LPG since the 1980s and formalized the National LPG Policy in 2017. In the early 2010s the government issued an untargeted subsidy making LPG just 30 percent more expensive than charcoal for end users. In 2013, LPG uptake reached 36 percent in urban areas. However, the subsidy was abandoned the same year, due to the inability to differentiate LPG use for vehicle fuel from cooking fuel, which was the intended benefit. The government also promoted the advancement of LPG in rural areas through the Rural LPG Programme, including through subsidized LPG stoves and cylinders. Since then, LPG growth has slowed, and the lack of fuel subsidy has made LPG less affordable to households. National LPG access targets were pushed back multiple times, from 2015, to 2020, and recently to 2030, marking the slow progress of the sector. Finally, a National LPG Policy approved in 2017 sought to consolidate activities in the LPG value chain and reform the LPG sector according to international best practices with the view to reducing health, safety and security risks and encouraging investment. According to stakeholders, there remains significant unmet LPG demand, even with higher prices. A lack of investment in and maintenance of safe cylinders negatively impacts demand. This is what the planned LPG sector reforms were intended to solve.

The Energy Commission and Ghana Standards Authority have regulatory authority over the clean cooking sector, but the regulatory framework is limited. LPG falls under the authority of the Energy Commission and the National Petroleum Authority. Their roles include setting local standard on products and labelling and operating a small number of modern testing centres. However, there has been limited progress on the development of a national policy framework on clean cooking to date, or on the enforcement of national quality standards, making it difficult for consumers to differentiate truly efficient stoves from lower quality ones.

The Ghana Alliance for Clean Cookstoves & Fuels (GHACCO) is an association that seeks to bring together private producers, distributors, marketers, civil society organizations (CSOs), practitioners and development partners to promote cooperation and catalyze the growth of the clean cooking sector. The network has an overriding target to foster the adoption of clean cookstoves and fuels by 4 million households in Ghana and by distributing 5 million cookstoves (which would have resulted in 56 percent of households owning a stove) by 2020, a target that was not reached.[38]

Until recently, Ghana had no independent testing facilities or universal ICS standards. GHACCO began testing members' stoves in the early 2010s but focused mostly on efficiency gains as opposed to emissions reduction or understanding the potential health benefits of ICS. Stoves found on the market today typically have between 25 and 40 percent fuel efficiency, but there is limited consistency across products. The lack of fixed enforced standards has led to limited improvements in stove design across the market.

[38] Market participant interviews conducted by authors.

The *Energizing Finance: Understanding the Landscape 2021* report identifies total finance commitments of USD 22 million for clean cooking in Ghana from 2013–2019. However, an estimated USD 153 million in private finance is still required to achieve Tier 2/Tier 3 universal access by 2030 (SEforALL 2021).

Current State of Clean Cooking Access

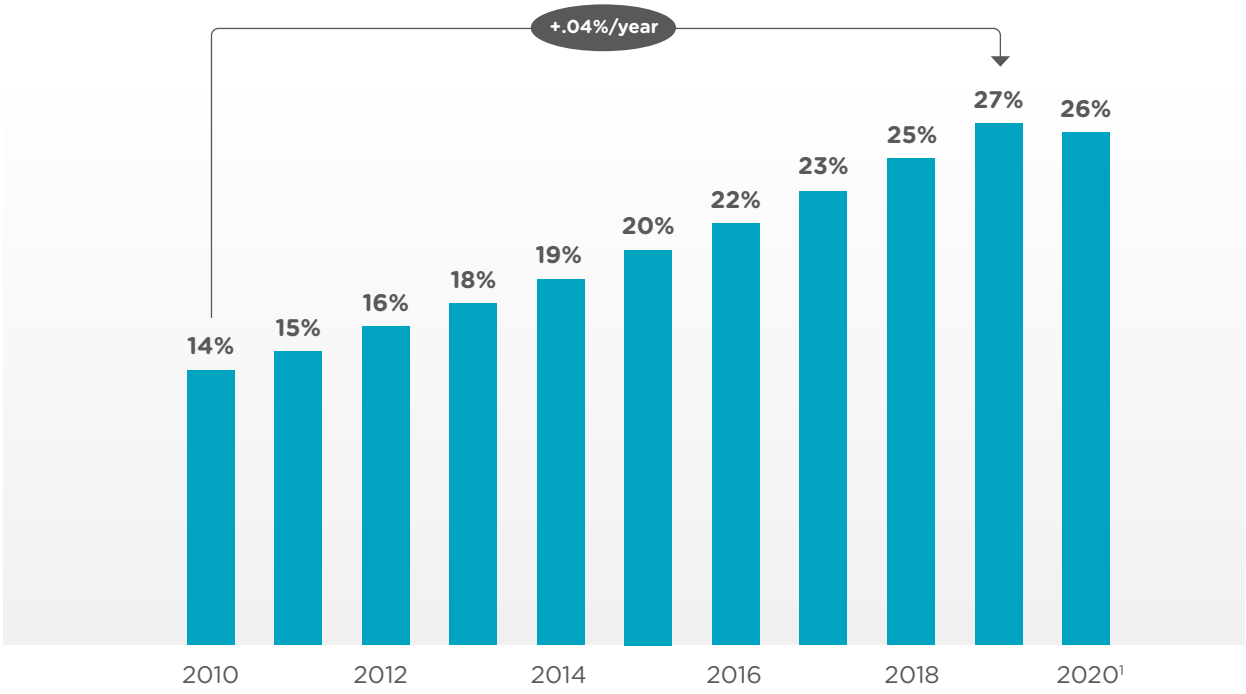
Ghana has experienced slow, steady growth in clean cooking, but overall access remains low. As of 2020, only 26 percent of the population in Ghana had access to clean cooking (Figure 21) World Bank Open Data), with moderate growth in access of around 1.4 percent per year. This was driven by government-supported LPG expansion, coupled with a growing market for ICS.

FIGURE 20
BAU and universal access scenarios for clean cooking in Ghana[39]

		Ghana		
		2020	**2030 BAU**	**2030 Universal Access**
Population (in millions)	Population	31	38	
	Households	9	11	
Access to clean cooking (% of households)	Tier 2 access	32%	40%	100%
	Tier 4 access	14%	18%	100%

[39] World Bank World Development Indicators for population and household estimates. Author's calculation for access estimates.

FIGURE 21
Historical access to clean cooking in Ghana (percent of population)[40]



Across the country, biomass remains the norm for 77 percent (Tracking SDG7, 2021) of households in 2020, resulting in significant negative health impacts, particularly for women and children. 77 percent of households, almost 22 million people, use biomass solid fuels as their primary fuel. Biomass users can be broadly classified into two groups. Urban or peri-urban charcoal users, primarily concentrated in southern regions, represent 32 percent of the population. Firewood users are concentrated in rural, northern regions, and represent 35 percent of the population. Across both groups, exposure to smoke from polluting, open fires or inefficient fuels causes 18,000 premature deaths each year. According to the World Health Organization (WHO), more than 2,200 children die in Ghana every year because of acute respiratory infections caused by the use of solid fuels (WHO 2017).

While the ICS market in Ghana is robust, an SNV study, confirmed by stakeholder interviews, has found that local ICS manufacturers are only commercially viable when they receive carbon credits or grants (SNV 2020). This is driven by limited consumer willingness to pay more than USD 5 for an ICS. Large companies can lower the cost of stoves using the proceeds from carbon credits. These companies however only represent 20 percent of the market. To support the expansion of smaller companies and improve consumer affordability, additional grant funding will be required.

Three primary challenges are slowing Ghana's progress towards universal transition to Tier 4 and Tier 2/Tier 3 cooking. These are: low customer affordability, lack of government strategy and insufficient funds.

- **Consumer affordability:** LPG and other clean fuels are often too expensive for households, particularly when they are required to purchase a full canister of gas at once. This is compounded by the low cost of substitutes: 35 percent of households still use wood, which can

[40] Author's analysis, World Bank Indicators, 2020 data are projected considering Covid impact benchmarked with decline in access in other allied sectors at a Sub-Saharan Africa level. Note that access to clean cooking as measured historically does not fully align with the MECS definitions of access introduced later in this section. 2020 data extrapolated based on local stakeholders' perspective.

be gathered or purchased relatively cheaply. Households are also reluctant to switch to ICS on the basis of awareness campaigns linked to health benefits or reduced emissions (though campaigns focused on stove efficiency and fuel savings tend to work better according to stakeholders).

- **Lack of government strategy for "clean" fuels beyond LPG or access to carbon finance:** The lack of a holistic government strategy that encompasses other "clean" fuels and/or support mechanisms to leverage carbon finance has limited access to clean cooking.

- **Insufficient funds** to fund the cost of universal access. Local enterprises are for the most part pre-commercial and face the same challenges as SMEs , including access to finance and carbon finance. **Covid-19 has led to a temporary decline in demand and supply issues.** On one hand, stakeholder interviews suggest that restrictions led to customers spending more time at home, leading to increased demand for cleaner cooking, particularly from middle-income households with less severe affordability constraints. On the other hand, the economic slowdown reduced affordability for lower-income households to purchase ICS, moving their priorities elsewhere. This offset the impact of more time spent at home, leading to a short-term decline in demand. Clean cooking enterprises reported significant disruptions in the value chain, including those caused by equipment providers facing staff shortages and national shutdowns, and disruptions in door-to-door distribution activities and customer maintenance.[41]

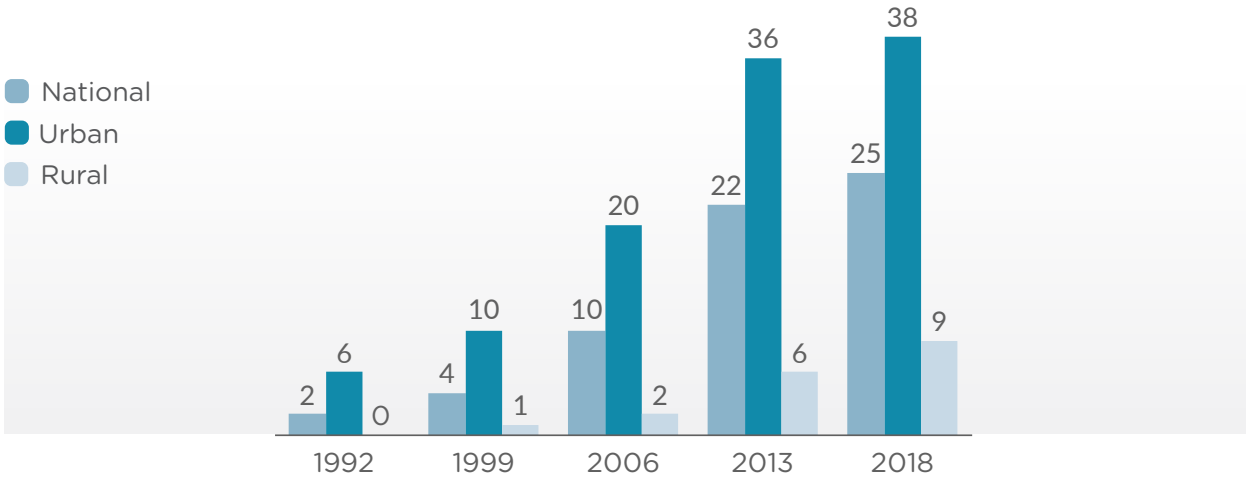
ACCESS TO LPG

Ghana saw significant increase in LPG uptake between 1990 and 2010, driven by government policies including the national LPG policy described above. **28 percent of the population currently uses LPG as a primary fuel, because of active government promotion of the LPG sector (Figure 24).** The government has supported a move towards cleaner fuels, and particularly LPG, through domestic production and imports. LPG is most widely used in urban areas that have better access to re-fuelling infrastructure than rural areas. It is delivered through a highly fragmented distribution model, whereby customers own their cylinders and interact with one of 42 LPG marketing companies who operate 641 gas refilling stations across the country (MECS 2021). According to stakeholders, there is a filling station in every district of Ghana.

As a result of using poorly-maintained cylinders the LPG sector in Ghana faces significant safety concerns. To increase LPG affordability, in 2010, the government introduced a scheme for unbranded, generic cylinders. Cylinders are owned directly by customers who are responsible for their maintenance. This led to branded-LPG marketers losing control over cylinder assets. It also reduced their incentives to ensure safety or maintenance, and created an influx of low-price, low-quality cylinders that do not meet global standards and safety regulations, including those surrounding the possibility of gas leaks.[42]

[41] Market participant interviews conducted by authors.
[42] Market participant interviews conducted by authors,

FIGURE 22
LPG uptake as a percent of households in Ghana[43]



Not all LPG users have Tier 4 energy access due to the continued use of biomass as an alternative fuel. Tier 4 access encompasses multiple criteria beyond using a clean fuel, including air quality, efficiency, convenience and safety, affordability, and fuel availability. For instance, a household using LPG as a primary fuel but still using a secondary charcoal stove may not meet the definition of Tier 4 access (see Methodology.) The true usage of LPG is difficult to determine as most households stack fuels and stoves, alternating different fuel sources at given times for different tasks. Stakeholder interviews indicate that high prices of LPG compared to the alternatives of charcoal and firewood mean that households often reserve LPG for specific quick tasks, while still relying on biomass for others. Some LPG households do not achieve Tier 4 cooking access due to issues around inconvenient filling, having to travel long distances to filling points, and the affordability of gas and appliances.

Affordability of fuel and equipment is a key issue for the sector to expand beyond its current customer base in urban and peri-urban areas, especially when combined with the mini-station distribution system, which requires consumers to queue up in very long lines to obtain refills. Existing customers are typically wealthier urban residents who can afford LPG and buy it in large canisters. Some customers struggle to cover the cost of a full 14.5 kg gas canister[44] and instead prefer to purchase smaller canisters of 3 to 6 kg. To improve affordability, some stakeholders are exploring consumer finance for stoves to gain consumers who can afford gas on a monthly basis but cannot afford the full cost of an LPG stove. An LPG stove costs a minimum of USD 20 for a stove directly above a canister; countertop stoves are significantly more expensive. Finally, to increase affordability for households who cannot afford a stove or gas, PAYG LPG models are being piloted by multiple companies including Envirofit and XpressGas (see Case Study 4 in Appendix).

LPG uptake has been particularly low in rural areas, primarily due to affordability issues. Only 9 percent rural of households used LPG as their primary fuel in 2018. In 2013, the government replaced the universal LPG fuel subsidy with a programme to provide free or discounted LPG stoves and cylinders to rural households, distributing 150,000 appliances. However, 18 months later, these stoves had an average refill rate of only 8 percent indicating low usage levels. This can be explained by several factors. Firstly, while stakeholders suggest that there are filling points in every district in Ghana, these filling points may still be far for households. LPG also remains very expensive compared to collected firewood.

[43] LPG users can fall below Tier 4 access definition due to issues around convenience and affordability.
[44] Stakeholder interviews suggest that a 6 kg cylinder would cost the equivalent of USD 6 for two to three weeks of fuel. A typical customer of LPG earns USD 100 or more per month. Monthly consumption of LPG could therefore amount to 6 to 12 percent of monthly income

The government has outlined comprehensive reforms to address these safety and distribution challenges, and with these reforms in place, some stakeholders estimate that LPG access in Ghana could increase to 55 percent (GPLPG 2018).[45] Aware of the safety issues around the customer-owned cylinder model, the government is exploring LPG sector reform with the Global LPG Partnership (GLPGP), moving to a 'branded cylinder recirculation model' (BCRM) and implementing greater safety standards. These reforms would require customers to trade in existing cylinders for upgraded and safety-checked standard cylinders. Reforms also seek to consolidate the high number of micro-filling stations and fragmented LPG markets to a more centralized system, for more standardization and efficiency.[46] The *Energizing Finance: Understanding the Landscape 2021* report includes a more detailed review of the proposed cylinder reforms.

Since the adoption of a National LPG Policy in 2017 to reform the LPG sector according to international best practices, the pace of reform has been slow. Investments were due to start in 2019 but are stalled to date due to the lack of available finance. Covid-19 also moved government priorities away from clean cooking. Finally, according to local stakeholders, the government has experienced some pushback on the reforms, particularly from oil marketing and LPG marketing companies, which face changes in their operating models because of the reform. Given these delays, the effect of the National LPG Policy has not been factored into this report's BAU scenario.

ACCESS TO TIER 2/TIER 3 COOKING SERVICES

The local market focuses on small, portable charcoal cookstoves that are most suitable for urban and peri-urban customers. Ghana has a growing ICS market, originally developed by the government and World Bank 'Ahibenso coalpot' programme in the 1990s. The programme selected and trained local entrepreneurs in the production of improved charcoal pot stoves, gyapas, which have been the focus of the market since the 1990s. Major local market companies include CookClean, Man & Man and Sudra. Man & Man spun out of this government programme and continues to produce this model for the market.[47]

ICS take-up is growing, partially driven by robust local production, but penetration remains limited particularly in rural areas. To date, 26 percent of households who use biomass fuel (1.6 million households) use improved charcoal cookstoves. Stakeholder interviews suggest that over 2 million gyapa cookstoves have been sold to date, improving efficiency by up to 30–40 percent and generating less smoke and emissions than traditional stoves. Sales are particularly high in urban and peri-urban areas, where fluctuating cost and availability of charcoal makes ICS an attractive solution to generate cost savings.

However, neither artisans nor industrial ICS manufacturers have focused on biomass stoves in Ghana, where firewood is the primary fuel in rural areas. There was limited research into local cooking habits or dietary preferences of rural communities during the stove design phase, leading to limited uptake in these areas. Stakeholders indicate that this is primarily driven by a more limited ability to pay for ICS in rural areas, and the lower savings on emissions compared to charcoal stoves.

International companies such as Envirofit and BURN recently entered Ghana, although their market share remains small, given that their stoves are six to ten times more expensive than a typical gyapa improved stove. Several global ICS producers have entered the Ghanaian market with a range of products, including improved charcoal and woodstoves. They were attracted to Ghana by the large, underserved market and favourable licensing policies. However, import duties and VAT remain a particular challenge, adding up to 30 percent on the price of imported cookstoves. International companies have concentrated their operations in the south, given that distribution to regions in the north is complex and costly.

[45] Note that 55 percent adoption of LPG stoves does not translate into 55 percent Tier 4 access, as Tier 4 access also requires meeting additional criteria including affordability and availability.
[46] Other stakeholders believe that the infrastructure investments required to achieve universal access to clean cooking have less to do with distribution and more with imports and storage, including building another jetty in the port of Tema to unload LPG as well as additional bulk storage infrastructure.
[47] Toyola Enterprises also spun out of the government programme. After selling close to 1 million stoves in Ghana, the company is no longer operating in the country, having relocated to Nigeria where the company believed the market was under-penetrated and could command higher prices.

FIGURE 23
Overview of ICS private sector in Ghana

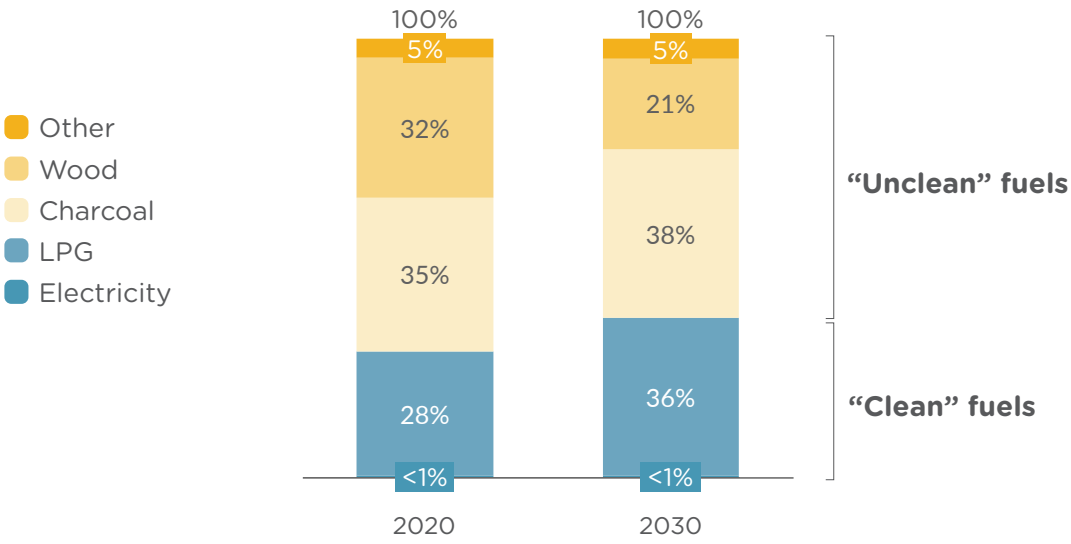
Company	Cumulative sales	Ownership	Fuel	Business model	Efficiency	Retail cost (USD)	Funding
Man & Man Enterprises	1M+	National	Charcoal	Manufacturing, distribution to local retailers	30-40%	USD 5-10	Initially USAID RI/EW, now grants (SEED award, UNFCC)
Sustainable Development & Relief Associates	1M+	National	Charcoal	Non-profit	40%	5-10	Grants (Enterprise Works and Relief International)
CookClean Ghana Ltd.	100K+	National	Charcoal, Wood	Manufacturing, distribution	50%	20	Grants (e.g., CCA grant fund), Carbon finance (GS)
ENVIROFIT SMARTER LIVING		International (US)	Charcoal	Manufacturing, distribution to local retailers	60%	50	Impact Fund (Clean Cooking Working Capital Fund) Carbon finance (CDM)
ADARSH PLANT PROTECT LIMITED	N.M.	International (India)	Charcoal, agri residue	Manufacturing, local sales agents	N/A	N/A	N/A
burn life · saving · stoves		International (UK)	Charcoal, wood	N/A	N/A	N/A	N/A
BioLite		International (US)	Charcoal, wood	N/A	N/A	N/A	N/A
Other micro-distributors	N/A	National	Charcoal, wood	Neighborhood sales	<30%	5	Local capital

BAU and Universal Clean Cooking Access by 2030

Ghana is expected to fall short of universal clean cooking access by 2030, as the transition away from wood and charcoal would take 50+ years at the current pace. By 2030, the primary fuel mix is expected to change slightly. This move is driven by continuing urbanization and economic growth creating new potential customers for "clean" fuels and ICS. However, without significant reform and investment, the pace of these changes remains too slow to make a significant change across all clean cooking levels.

[45] Note that 55 percent adoption of LPG stoves does not translate into 55 percent Tier 4 access, as Tier 4 access also requires meeting additional criteria including affordability and availability.
[46] Other stakeholders believe that the infrastructure investments required to achieve universal access to clean cooking have less to do with distribution and more with imports and storage, including building another jetty in the port of Tema to unload LPG as well as additional bulk storage infrastructure.
[47] Toyola Enterprises also spun out of the government programme. After selling close to 1 million stoves in Ghana, the company is no longer operating in the country, having relocated to Nigeria where the company believed the market was under-penetrated and could command higher prices.

FIGURE 24
Ghana 2020 and 2030 BAU primary fuel mix[48]



2030 ACCESS TO TIER 4 COOKING SERVICES

In the BAU scenario, no major reform is implemented, and the main driver of Tier 4 access increase is growing urbanization. This results in a limited increase to Tier 4 cooking from 14 percent in 2020, to 18 percent in 2030. Note that these numbers are lower than current LPG usage as a primary fuel, of 28 percent. This is driven by the fact that meeting the Tier 4 access threshold requires meeting other criteria, including good air quality, efficiency, convenience and safety, affordability, and quality fuel availability. Research for this report indicates that not all LPG users meet these criteria in Ghana. In the BAU scenario, the use of clean fuels, primarily LPG, is concentrated amongst urban households, who have access to LPG infrastructure and services. Over the coming years, urbanization will be the key driver of increased LPG use, as more households will be within easy reach of LPG services (e.g., re-bottling plants). The BAU scenario assumes no significant additional investments will be made towards clean fuels, and no progress will be made on the LPG sector transformation reform proposed by the Government of Ghana to improve the safety and distribution of LPG (more details below). Given the low current penetration levels, the growth of other clean fuels is assumed to be very small.

In addition to the BAU forecast, this report evaluates three scenarios for Tier 4 cooking access:

- A universal access to Tier 4 scenario through a full LPG transition for households without access
- A universal transition with ethanol in which all households without access transition to ethanol
- A universal transition with electricity in which all households with grid connections are equipped with induction stoves and achieve Tier 4 access. Households with access to electricity through mini-grids or SHSs are equipped with an electric pressure cooker since induction stoves require high voltage. As a result, this corresponds to a partial access scenario.

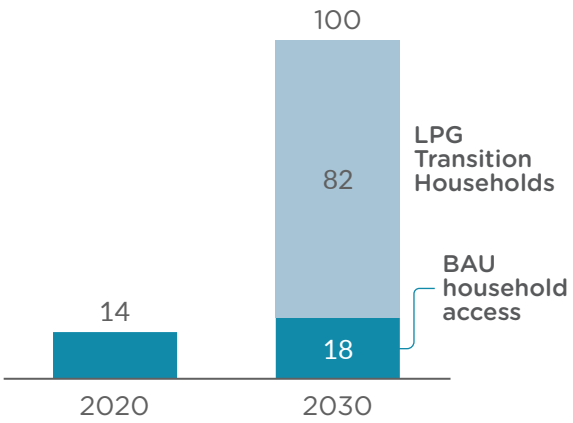
These scenarios are costed in the following section.

[48] Note this does not map 1:1 with the definition of access to clean cooking used in this report; please refer to the methodology section for a mapping of primary fuel use to MTF Tier access definitions. Other fuels include other biomass fuels such as agricultural residue.

FIGURE 25
Three scenarios reviewed for Ghana universal Tier 4 cooking access

Scenario 1
Universal LPG Transition

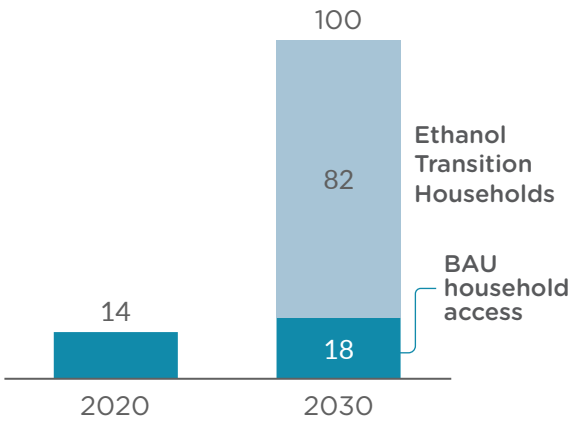
2020 & 2030 Tier 4+ cooking access
% households



- Universal LPG access scenario
- Sizes the financing cost of universal shift to LPG in Mozambique, both in rural and urban areas
- Calculates the cost of shifting all households to LPG stoves, required infrastructure investments, and implied cost of fuel subsidies for 5-10 years

Scenario 2
Universal Ethanol Transition

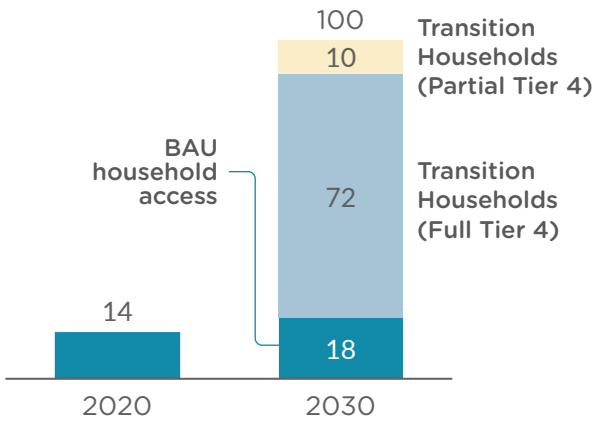
2020 & 2030 Tier 4+ cooking access
% households



- Universal ethanol access scenario
- Sizes the financing cost of universal shift to ethanol in Mozambique, both in rural and urban areas
- Calculates the cost of shifting all households to ethanol stoves, required infrastructure investments, and implied cost of fuel subsidies for 5-10 years

Scenario 3
Universal Electric Cooking Transition

2020 & 2030 Tier 4+ cooking access
% households



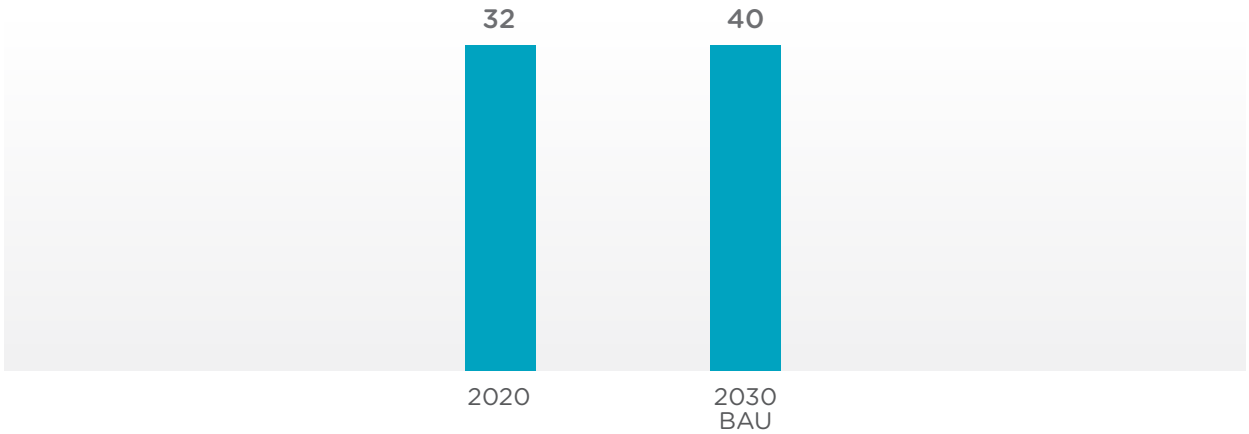
- Universal electric cooking access scenario
- Sizes the transition cost of moving grid households to induction stoves, mini-grid and SHS households to EPCs
- Calculates the cost of shifting households to induction stoves/ EPCs, implied cost of fuel support and additional burden on projected grid production

In the universal LPG transition scenario, investments are undertaken to expand LPG infrastructure and provide subsidies for stoves and fuel to all households that cannot afford them. The potential of new clean fuels (e.g., biogas, ethanol, gasification from pellets) is difficult to assess at this stage given that the market is not yet commercially established. However, several new fuels are being tested in Ghana, supported by donor programmes. Biogas has strong potential due to the availability of agricultural residue, with the potential to develop 80,000–270,000 household biogas plants, according to SNV. GIZ also assessed the theoretical potential of electricity generation from biogas as more than 800 MW. The opening of the first Ghanaian ethanol plan, generating gas from cassava, creates the potential to use this as well for cooking purposes. Pellet gasification is already in use by some factories and industrial sites, and the cost of fuel is currently competitive with biomass but requires new infrastructure for gasification stoves. Finally, the potential of electric cooking is also significant given wide-spread electrification, with small NGOs promoting the use of solar cooking (e.g., SolCook Ghana). However, this report does not provide a perspective on the potential clean fuel mix of Ghana by 2030, rather, it provides a high-level estimate of the cost associated with a universal transition using LPG, ethanol and electricity, respectively.

2030 ACCESS TO TIER 2/TIER 3 COOKING SERVICES

The share of households with access to Tier 2/ Tier 3 cooking in Ghana is expected to increase from 32 percent to 40 percent in 2030. This will primarily be driven by a continuation of historical trends, including continued urbanization in Ghana. The robust local private sector actively targets charcoal users, primarily in urban areas. As these populations increase, the share of ICS users will also increase. Finally, clean fuel users are expected to grow slightly, as shown in the Tier 4 clean cooking analysis and will also contribute to the increase in Tier 2/Tier 3 access based on trends in the stacking of cooking solutions.

FIGURE 26
Percent of households in Ghana with access to Tier 2/Tier 3 cooking (2020–2030e BAU)



Financing Universal Clean Cooking Access in Ghana

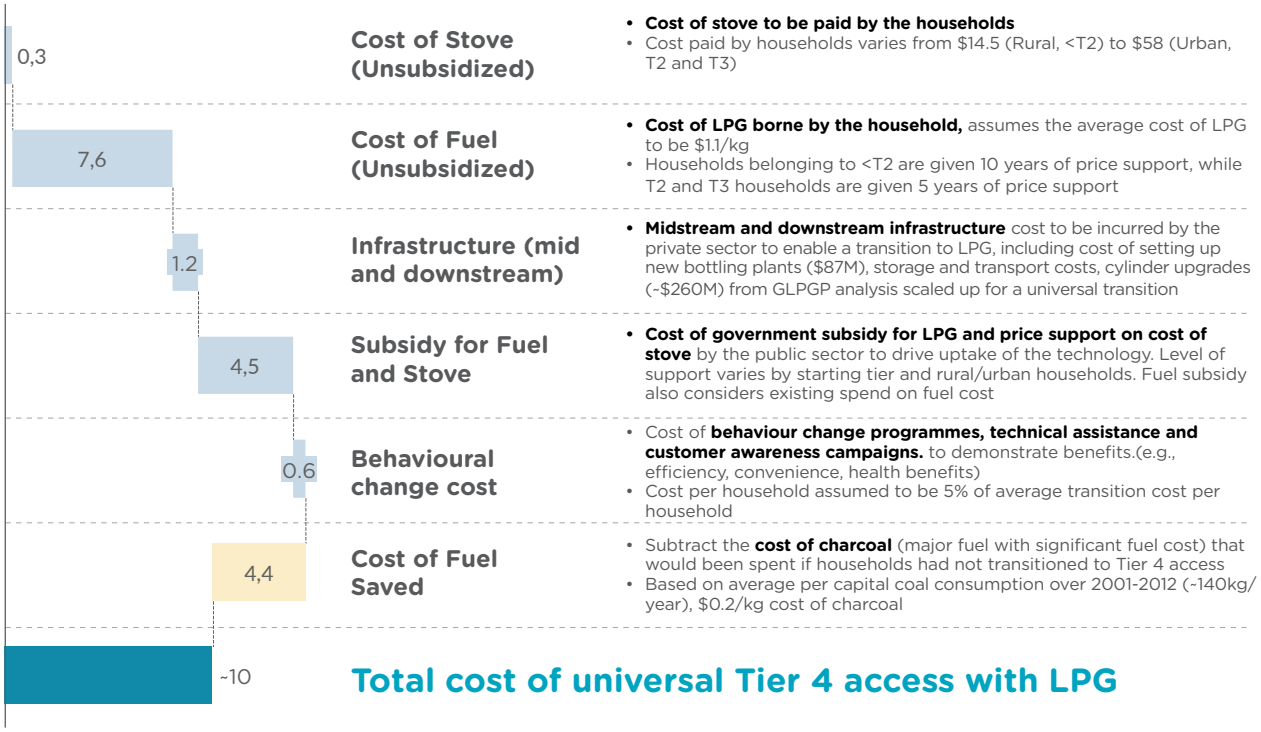
TRANSITION TO TIER 4 COOKING ACCESS

This report finds that the cost of achieving universal Tier 4 access through LPG **will cost USD 10 billion including fuel costs and subsidies.** This compares with an estimated cost of USD 11–13 billion for universal transition with ethanol, and an estimated USD 9 billion partial Tier 4 access with electricity; this is referred to as partial access given that households without access to the grid would not be able to achieve Tier 4 access, since mini-grids and SHSs do not deliver enough power for electric stoves that can provide Tier 4 access.

Similarly, the cost of universal access to Tier 4 through ethanol and electricity is also primarily driven by the cost of fuel. As with the LPG calculation, these scenarios estimate that households that currently have Tier 2/Tier 3 access require a five-year fuel subsidy before they can transition to Tier 4 independently. Households with Tier 1 access or below are estimated to require 10 years of subsidies.

In addition, electric cooking would also increase the projected 2030 generation in Ghana by 27 percent, requiring additional investments in on-grid generation that were not measured as part of this report.

FIGURE 27
Cost of universal Tier 4 clean cooking access with LPG in Ghana (USD billion)



The cost is primarily driven by the cost of fuel and required subsidies for households. The largest cost required for the transition is for LPG fuel.[49] Given affordability constraints, the government would likely have to provide a subsidy to cover a significant portion of the LPG fuel and stove cost. The level of support provided to various households could vary, based on households' starting Tier of cooking access and existing expenditure on fuel. Other major cost drives include midstream and downstream infrastructure needed to bring LPG to new, rural areas, including the development of new bottling plants, storage, cylinder upgrades, and behavioural-change campaigns. This figure does not include additional investment on production or importation of LPG, given existing production and a newly-opened terminal in 2021 for the import of LPG from Nigeria.

However, a GLPGP feasibility study found that with the policy reforms required and USD 350 million in infrastructure investments, LPG stove ownership could increase to 55 percent, but this does not consider consumer subsidies to address the fuel affordability gap. Leveraging existing LPG infrastructure, a significantly smaller investment focused on cylinder replacement and bottling plants, could help extend LPG to 55 percent of households. These households are within reach of the current network, and do not have affordability constraints. Beyond this level of growth, reaching more rural areas would require significantly more investment in infrastructure and economic incentives, as laid out above. GLPGP therefore estimate 55 percent to be a limit for the organic growth of the LPG sector, without significant economic interventions. Remaining customers could achieve Tier 2/Tier 3 access through ICS solutions.

TIER 2/TIER 3 COOKING ACCESS

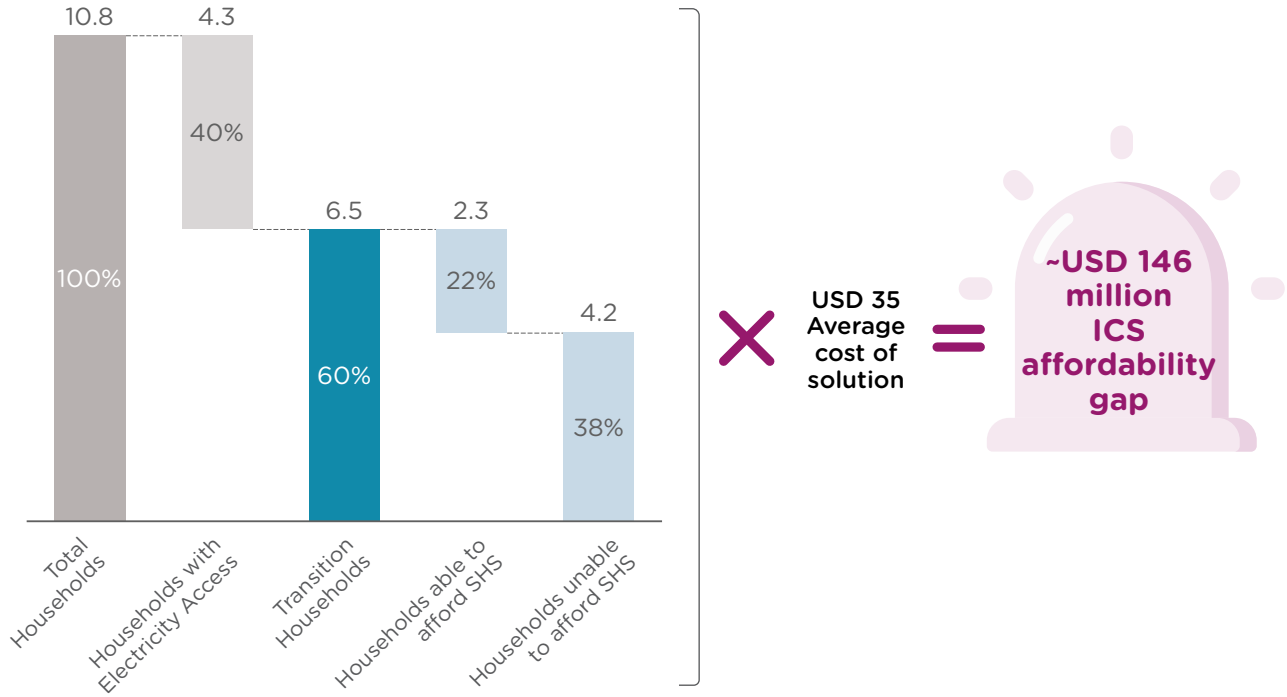
While universal access to Tier 4 cooking should be the standard, accessing Tier 2/Tier 3 where Tier 4 is not feasible represents an alternative transition path. This report estimates the cost of Tier 2/Tier 3 access as a 'second best' option.

ICS are a viable solution to extend clean cooking to households who are unlikely to be reached by LPG or other modern fuels. Transition households account for 60 percent of the total population in Ghana but 38 percent are unable to afford them. ICS must be purchased upfront in cash, due to a lack of available finance solutions for customers. PAYG models are not offered, given the lack of mechanisms to ensure customer repayments. It is therefore assumed that households would purchase an ICS through 6 percent of their consumption expenditure over three months. Purchasing decisions are mostly based on an understanding of their potential cost savings on fuel, while studies found that customers are less motivated by health benefits or emissions reduction (SNV 2020).

The affordability challenge represents a USD 146 million access gap to reach all households using biomass with an ICS.[50] An improved charcoal stove costs on average USD 35 in Ghana, and advanced stoves from international companies cost between USD 25 and USD 50. Gyapa stoves cost between USD 5 and USD 20, but typically do not provide Tier 2/Tier 3 access as they do not meet the efficiency, air quality and safety criteria related to Tier 2/Tier 3. In comparison, traditional iron-bar woodstoves cost between USD 1.5 and USD 3.

[49] Assumes the average cost of LPG to be USD 1.1/kg, households belonging to <Tier 2 are given 10 years of price support, while Tier 2 and Tier 3 households are given five years of price support.
[50] Note that the model calculates the financing cost of only one stove per household given that further replacements can be financed through on-going fuel savings.

FIGURE 28
Ghana ICS affordability gap calculation (2030 households USD million)



Assuming consumer finance is made available for ICS, this could lower the affordability gap to 34 percent of households, resulting in a USD 84 million affordability gap. If consumers were given the option to purchase stoves through a lower upfront payment, leveraging multilateral financial institution (MFI) finance or an enterprise PAYG model,[51] up to 66 percent of households would be able to afford ICS. This would significantly expand the ICS market, despite the fact the total cost of the stove would increase slightly due to financing costs.[52] However, no ICS providers have developed consumer finance mechanisms at scale, due to challenges accessing local debt for improved cooking solutions. This represents an area for further research and development (R&D) partner support.

ENTERPRISE FINANCE

This section focuses on universal Tier2/Tier 3 access; enterprise finance needs are only calculated for this scenario.

Access to finance for the clean cooking sector in Ghana has been challenging across instruments, as summarized in Figure 29. The ICS sector was originally financed through USAID and the World Bank, as part of the Relief International/Enterprise Works programme. After this programme ended, ICS companies in Ghana benefitted from a few targeted grant programmes, including the Spark Fund and Catalytic Grant Fund, or direct donations from donor countries, such as the Government of South Korea.

Access to funding remains a challenge today. Stakeholder interviews indicate that local institutions are mostly unwilling to lend to enterprises focused on low-cost clean cooking solutions. Where debt is available, interest rates for loans from private banks and MFIs in Ghana are around 30 percent, making debt prohibitively expensive for most SMEs. One stakeholder highlighted how their first loan was just USD 5,000 and required as collateral the CEO's house. After almost 10 years, commercial funding has increased

[51] Assumes cost of stove is repaid over six monthly installments, with each installment being about USD 6.5.
[52] Assumes 20 percent interest over six months which increases the cost of the stove by USD 3.

for that organization to close to USD 1 million, an exception for the clean cooking sector. Beyond that there is limited appetite for local banks to lend.

A small pool of international lenders is available for more mature companies in later stages of growth. Envirofit received working capital from the Clean Cooking Alliance's Clean Cooking Working Capital Fund, and some companies in the clean fuel sector are currently negotiating funding with international providers. This funding is typically not in local currency, creating a risk for enterprises, and is inaccessible to smaller local companies.

Larger companies have leveraged carbon finance to compensate for the decline in direct grant funding. Over the last decade, Ghana has had two accredited and two registered Gold Standard stove projects and one registered Clean Development Mechanism project, although not all remain active today.[53] Stakeholder interviews suggest that carbon credits can provide a steady income flow for ICS enterprises, as they can generate one to two tons of carbon per stove sold, depending on the efficiency of the stove.

However, carbon finance is an onerous process, requiring the verification of each stove to an individual customer, and therefore needs significant scale to operate. Additionally, increasing concerns on the integrity of offsets may present more complex and detailed monitoring requirements to access carbon finance. It is challenging for smaller ICS providers to qualify for carbon finance, based on existing carbon market certification requirements. As a result, this remains an untapped source of finance for smaller, local manufacturers in Ghana beyond CookClean, Man & Man and Sudra.

FIGURE 29
Overview of finance availability in the Ghana clean cooking market

	Description	Availability	Market perspective
Commercial debt	Local funding not readily available or at very high cost • Limited debt from global lenders e.g., Clean Cooking Working Capital Fund	 • Limited access to local financing • Collateral requirements a challenge	The sector itself is not interesting for banks Now at $1M we are stuck and that's why we looked for external funding
Equity	Larger ICS enterprises have 'graduated' to raised capital sums from international (concessional) investors • Envirofit received working capital from the Clean Cooking Working Capital Fund (Fund), and Toyola Energy from (E+Co). • This funding is not in local capital creating currency risk for enterprises, and is inaccessible to local companies	 • Investor appetite remains limited; LPG and ICS enterprises viewed as high risk vs. expected return • No support from VC or commercial equity investors	It's a challenge we have been on a fundraising journey for a long time Investors are more interested in quick returns

[53] The Relief International programme ended, and Toyola Energy is no longer active in Ghana. Envirofit, CookClean and Co2Balance all continue to operate and make use of carbon finance.

Grants	Small ICS enterprises are primarily financed through grants • ICS were originally financed through USAID as part of the RI/EW and the World Bank GESAP program • ICS is funded through a few targeted grant programs (e.g., Spark Fund, Catalytic Grant Fund) or through larger energy-access focused programs (e.g., GIZ EnDev)	 • Clean cooking often subsumed within 'energy access' grant programs, with limited funds ear-marked for clean cooking specifically	There are few grants available for the sector now
Carbon finance	Carbon finance is an attractive option for clean cooking, but certified emission reductions are necessary • It is challenging for ICS provider to qualify for carbon trading, based one existing carbon market certifications demonstrating significantly reduced emissions • Ghana has two accredited and two registered Gold Standards (GS) stove projects and one registered CDM project	 • Few enterprises are able to capture this type of financing, due to complexity of verification, difficulty in finding carbon investors • However, verification in Ghana easier vs. other countries	Carbon financing accreditation and monitoring & evaluation of CO2 emission reduction can be challenging, especially for smaller local players

Scaling ICS requires USD 153 million to support the private sector in delivering universal access to Tier 2 and Tier 3 ICS, roughly split equally between grants, equity and commercial debt, according to private companies. In comparison, the *Energizing Finance: Understanding the Landscape 2021* report identifies total finance commitments of USD 22 million for clean cooking in Ghana from 2013–2019 (SEforALL 2021).

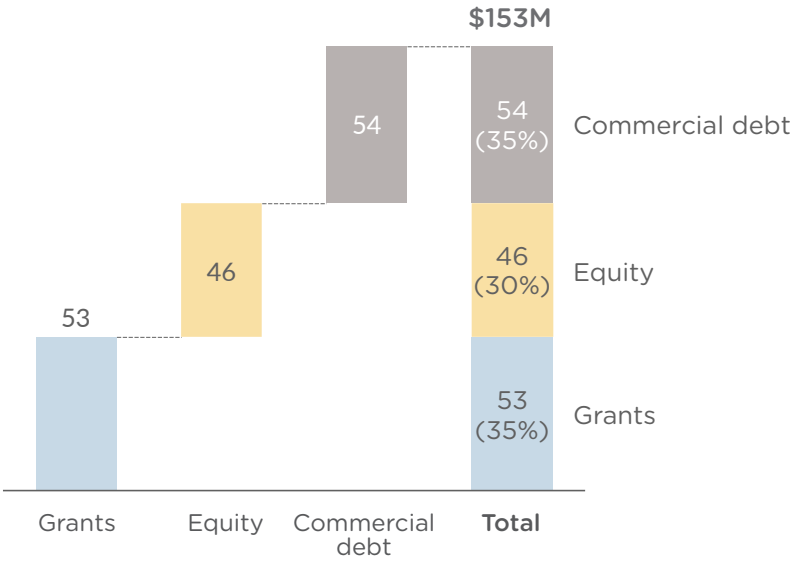
To date, the ICS market is primarily made up of robust medium-sized local producers. Medium producers can leverage carbon finance. By 2030, more mature companies such as CleanCook, Man & Man and Sudra are expected to scale and provide 60 to 70 percent of ICS stoves, driven by their ability to attract carbon finance and sell higher quantities of stoves at lower prices than their competitors. These companies rely less on grant finance but are not currently able to secure commercial finance. It is expected that by 2030, local financial institutions will be lending to the clean cooking sector more actively. Start-ups will continue to account for 20 percent of sales, relying mostly on grant funding.

Access to grant funding, which may be substantial, is expected to be limited to a strict number of uses. Grants are most likely to be obtained to catalyze public goods and play down the cost and risks of infrastructure investments – though other grant uses could include deploying systems, building

sales networks or buying vehicles. These public goods include quality testing and certification, establishing carbon finance verification, and consumer-awareness campaigns. RBF could be provided to attract private companies to regions where they would not otherwise go quickly enough.

Stakeholder interviews suggest that public-funded grants for LPG expansion have historically been harder to get than for other SDG7 solutions, because of LPG's present status as a fossil fuel. This is despite the fact that many developing country governments have prioritized LPG and have sought donor help to develop their LPG sectors to meet SDG7 cooking targets.

FIGURE 30
Ghana Tier 2/Tier 3 clean cooking enterprise finance needs (USD million)



As the ICS sector continues to scale, it is expected to rely increasingly on debt finance and equity. Currently, local debt is not readily available or was only made available at very high cost, with large international companies raising debt from impact-oriented lenders. Stakeholder interviews have not revealed any local currency lending from impact-oriented funds in the clean cooking sector, although some transactions have occurred in the SHS sector. Local companies primarily leverage carbon finance as a tool to subsidize stoves and increase sales. However, as ICS manufacturers scale, they are expected to generate higher margins, and rely on profit to finance expansion. As margins improve, commercial finance is also expected to increase. Overall, debt and equity will account for 65 percent of finance needs by 2030.

Carbon finance is an attractive option for clean cooking, but only more mature companies can capture carbon finance. Development partners should explore both mechanisms that would facilitate carbon finance for smaller enterprises, and upfront finance mechanisms. Development partners could explore mechanisms that would facilitate carbon finance for smaller enterprises; for instance, creating pooling facilities across several manufacturers to have the scale required to sell carbon credits on international markets. Additionally, another challenge for local enterprises is that the overall process to obtain carbon finance can take several years. Exploring upfront financing mechanisms that would provide local enterprises with carbon funds before verification, for instance by lending against future carbon credits, could have a positive impact on carbon finance in Ghana.

Key Finance Opportunities and Solutions

Appropriate financing tools are needed to address the primary challenge of limited private-sector funding as well as the lack of government strategy and, for LPG, the suboptimal regulatory environment. New tools could be designed and piloted – specifically around the affordability gap and last-mile delivery challenges, as summarized in Figure 31.

To prioritize the overall development of the sector, the government can incorporate into its national clean cooking strategy a pathway for "clean" fuels beyond LPG and support ICS sector growth with clear guidelines and measures for private-sector development. An holistic strategy can leverage carbon finance and other support measures to increase the adoption of clean cooking technologies. Executing the existing strategies it already has on LPG expansion and LPG reform could also increase access further.

To address consumer affordability challenges, development partners should support the rollout of more PAYG models for LPG and develop consumer finance options for ICS users. PAYG LPG reduces the upfront cost paid by a consumer, making LPG purchases far more affordable on a monthly basis.[54] This model requires working capital to finance LPG companies who front the full cylinder cost. ICS providers, on the other hand, are unable to provide PAYG schemes but can partner with local consumer finance institutions to offer systems on credit. Development partners should focus on new risk-sharing mechanisms to help unlock more finance for these purposes.

Development partners could also explore further ICS support in the form of subsidies and additional R&D. Since many households do not perceive the fuel and time savings to be significant enough to invest in an ICS stove, any ICS programme should incorporate a subsidy incentive to increase take-up of ICS stoves. This could be provided under the form of vouchers, or results-based support to ICS manufacturers. Additionally, stakeholders should explore researching more expensive stoves that would generate additional savings but be sold at a similar cost to household based on emission avoidance and future carbon finance proceeds. R&D funding support from donors could help create additional PAYG LPG technologies and models that are economically sustainable at much lower per-kg premiums.

To address last-mile delivery challenges, RBF mechanisms could be explored. Development partners could explore replicating the SNV clean cookstove RBF mechanisms implemented in Mozambique and Vietnam, with specific geographic targeting the areas with the highest need. Key success factors would require among other things the availability of a network of independent verification agents.

To address insufficient funds, development partners could explore new grant, debt and equity funding with concessional terms and access to lower cost funding, exclusively for clean cooking. Many donor programmes (e.g., Energising Development (EnDev)) include clean cooking under the broader umbrella of energy access, limiting the funds available for clean cooking in particular. Carving out specific funds of programmes for clean cooking could be effective in further promoting the sector.

To address insufficient funds, development partners could also encourage lending to the ICS sector (e.g., through investment risk mitigation like first-loss schemes) that would also help the private sector expand in spaces where costs of doing business are higher (e.g., due to transportation).

Finally, development partners can explore mechanisms to pull carbon credits from small manufacturers together to generate carbon finance for smaller, early-stage companies. Verification and pooling of credits are time consuming and expensive for smaller companies, and typically do not reach a large enough scale to be sold on international markets. Supporting smaller companies by pooling carbon credits on their behalf could increase financing sources. Additionally, development partners could explore lending against future carbon finance proceeds, to provide funds to private companies more quickly.

[54] Total cost is likely higher given cost of operations and smart meter.

FIGURE 31

Recommended instruments to address Ghana's cooking challenges

Audience	Challenge	Recommendation
Government	**Clean cooking strategy**	Incorporate into national clean cooking strategy pathway for "clean" fuels beyond LPG and support ICS sector growth with clear guidelines. Execute on existing strategies such as LPG reform.
Development Partners and Government	**Low customer affordability**	Demand-side subsidies of up to USD 146 million.
	Difficult last- mile distribution	Results-based mechanisms to help target areas with the highest need and incentivize private sector distribution in harder to reach areas.
	Insufficient funds	Additional support to the private sector through grants, debt and equity of USD 153 million. Carbon credits expansion for private sector financing. Carbon credits pooling from small manufacturers. R&D funding for more efficient ICS stoves sold at a similar cost based on future carbon financing to increase consumer willingness to pay.
Investors	**Customer affordability**	PAYG models for clean fuels, consumer finance options for ICS expansion.
	Insufficient funds	Additional support to the private sector through grants debt and equity.
All	**Gender imbalance**	Expansion of financing for women-led businesses. Inclusive work policies, programmes and people-centred design that promote women participation in the energy sector.

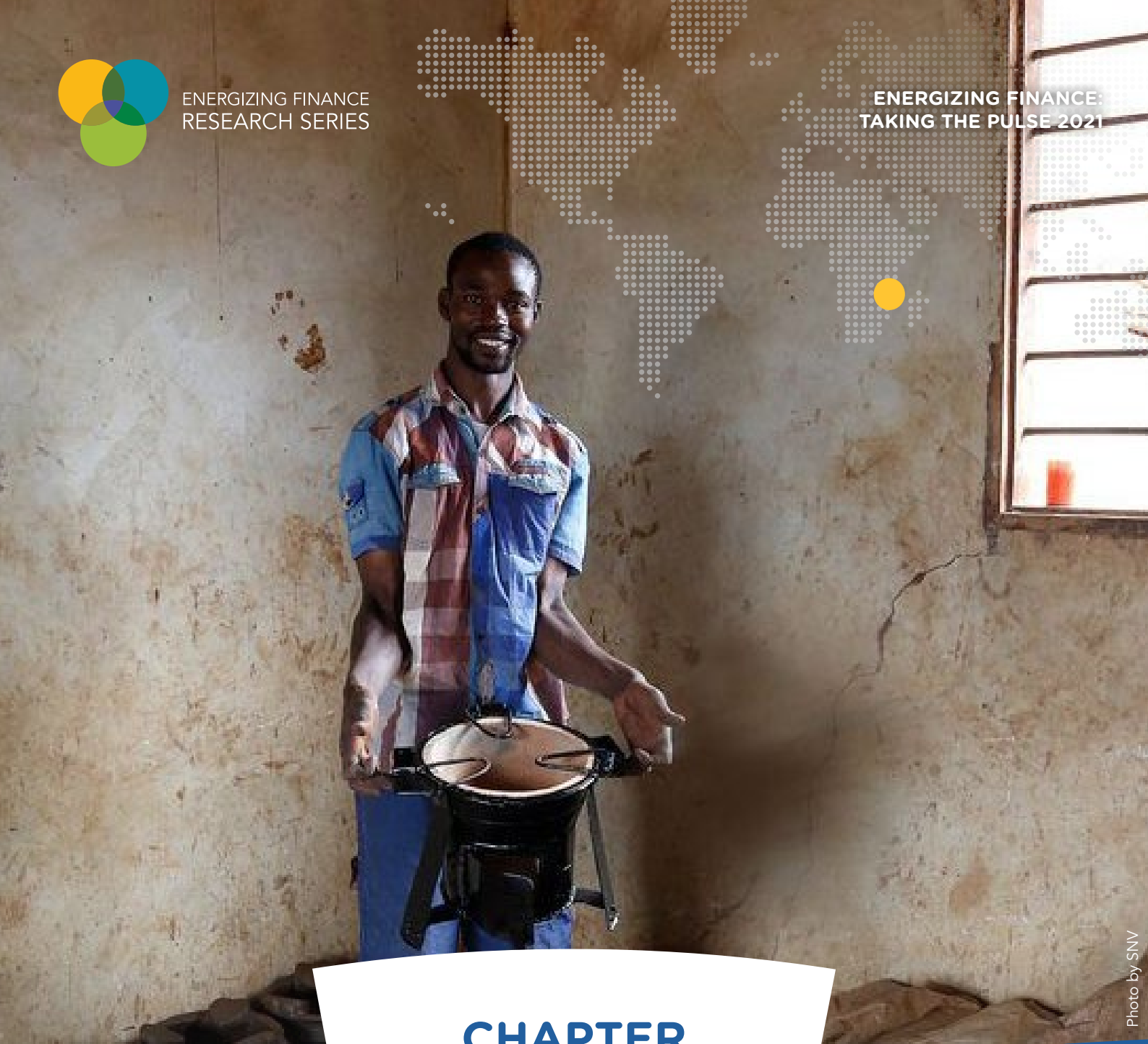


Photo by SNV

CHAPTER

3

TAKING THE PULSE OF ENERGY ACCESS IN MOZAMBIQUE

PART 1

TAKING THE PULSE OF ELECTRIFICATION IN MOZAMBIQUE

KEY MESSAGES
The Cost of Universal Electricity Access in Mozambique

Grid electrification in Mozambique has made progress over the past 10 years but remains low. Grid coverage is low with only 28 percent of the population able to access electricity through the grid in 2020, and 1 percent of the population having access via solar home systems (SHSs) or mini-grids. Under business as usual (BAU), access to electricity is expected to increase to 50 percent by 2030, (10 percent through SHS and 2 percent through mini-grids).

Off-grid solar solutions, including mini-grids and SHSs, which are currently nascent in Mozambique, will need to play a substantial role in expanding electricity access, especially to rural and low-income populations. Under this report's universal access scenario, they are expected to provide access to 62 percent of the population by 2030.

The mini-grid sector remains constrained by unsupportive policies — especially universal tariff obligations — and lacks private-sector participation. Without significant regulatory changes and investment, mini-grids will only account for a marginal share of electricity access (2–3 percent) by 2030. However, in September 2021, the Government of Mozambique approved a decree on regulating off-grid energy access that is expected to facilitate mini-grid development by energy providers (SNV 2021).

Mozambique will require approximately USD 1.1 billion in finance to achieve universal electricity access by 2030. 59 percent of this, or USD 630 million, will be needed in end-user grants and subsidies to address a substantial and persistent affordability gap. Currently, 46 percent of the Mozambican population lives under the poverty line, which is not expected to change substantially in the next few years. The remaining 41 percent of the total, or USD 445 million, will be needed to meet demand from mini-grid and SHS operators. 61 percent of the USD 445 million will be required in the form of grants, driven by a lack of larger, more mature mini-grid and SHS companies operating in Mozambique, and high operating costs.

Beyond funding, it will be critical to resolve several broader issues to make doing business easier and set the stage for private sector growth. Chief among these are tariff and tax exemptions for solar products, components and applications.

Sector Context

GOVERNMENT ELECTRIFICATION STRATEGY

The Government of Mozambique has outlined a universal electrification strategy, which is spearheaded by the Ministry of Mineral Resources and Energy (MIREME). MIREME is responsible for national energy planning and policy formulation and for all energy sector operations and development activities and is represented in the provinces through the Provincial Directorates of Mineral Resources and Energy (DIPREME).[55] MIREME has committed to the SDG7 target of achieving universal access to electricity by 2030 and has pursued this objective through various policies. In 2018, the government launched the National Energy for All Programme, which focuses on grid expansion and densification, and promotes off-grid solutions to reach remote areas and populations. The programme targets reaching 70 percent of the population though the central grid and 30 percent through off-grid connections.

Electricidade de Moçambique (EDM), a vertically integrated national utility, and Fundo de Energia (FUNAE), which oversees rural electrification, are the two principal energy sector institutions in Mozambique. EDM, which is government owned, is responsible for Mozambique's electricity generation, transmission, and distribution infrastructure and for the sale of electricity to customers.

EDM buys most of its electricity (about 400 MW) from Hidroelectrica de Cahora Bassa (HCB), owner and operator of the Cahora Bassa hydro power plant on the Zambezi River (2,075 MW). *Energizing Finance: Understanding the Landscape 2021* finds that extreme weather events pose a grave risk to the electricity distribution system in Mozambique, especially because Cahora Bassa contributes more than 50 percent of the country's power supply and does so via a single high voltage power transmission line, adding to the country's power sector vulnerability (SEforALL 2021).

The Government of Mozambique owns 82 percent of HCB, which operates as an Independent Power Producer (IPP). The bulk of the electricity generated at HCB is exported to South Africa, with a small amount to Zimbabwe (Salite et al. 2021). While EDM has made important progress in extending access, it remains constrained both financially (persistent and large operating losses driven by low tariffs that are not cost reflective) and by wider political and socio-economic instability (including conflict and endemic poverty). FUNAE leads mini-grid development and supports growth of the private SHS market. Since its establishment, FUNAE has developed and executed numerous (1,000+) projects focused on off-grid and renewable energy solutions to electrify communities and public institutions. This includes electrifying small towns, schools and health centres. FUNAE also operates a solar PV manufacturing plant in Boane (Maputo province), which is used to supply households and institutional users in rural areas with solar systems (ECA 2019). FUNAE receives most of its funding from international donors and works closely with several development partners including FCDO, SNV, GIZ, World Bank, JICA and USAID.

MAIN DEVELOPMENT PARTNERS

Most development finance committed to Mozambique's electricity sector to date has supported grid expansion. Decentralized renewable energy solutions have received increased donor interest and money recently but remain a small piece of the pie. About USD 160 million has been committed by development partners, with some of these funds yet to be disbursed. In comparison, the *Energizing Finance: Understanding the Landscape 2021* report identifies total finance commitments of USD 118 million in Mozambique for mini-grids and off-grid solar from 2013–2019. However, an estimated USD 445 million in private finance needs are still required to achieve universal access by 2030 as explained in the following sections (SEforALL 2021).

[55] Market participant interviews conducted by authors.

GIZ, through the Energising Development (EnDev), programme, is the largest donor programme operating in Mozambique's electricity sector, having contributed a total of USD 40 million. Other prominent funders include BMZ through Green People's Energy for Africa: Mozambique programme (GPE) (USD 35 million), the FCDO BRILHO programme (USD 33 million), and FUNAE through Enabel (USD 25 million; AMER 2021). In recent years, a large portion of donor funding for the electricity sector has been earmarked for results-based-financing (RBF) facilities, which provide financial incentives for private enterprises to provide new connections.

FIGURE 32
Key programmes financing electricity access in Mozambique (USD million)

Development partner	Funding	Focus	Key Programmes
endev	40[56]	• Grid Electrification • Off-grid • ICS • Technical Assistance	• Finance for energy generation, grid densification and distribution, and for energy efficiency • Subsidy programmes to counter the impact of Covid-19 on demand • Renewable energy and energy efficiency credit line through local financial institution BCI • Technical assistance and training for SHS companies • Education campaigns and dialogue between government representatives, business and civil society
GREEN PEOPLE'S ENERGY FOR AFRICA	35	• Grid Electrification • Off-grid	• RBF financing: FASER RBF fund to enable commercial and agricultural enterprises to purchase equipment • Technical assistance
BRILHO Funded by FCDO – UK Aid Implemented by SNV	33	• Off-grid • ICS • Technical assistance	• Catalytic grants: non-reimbursable funds to de-risk business initiatives • RBF: incentives to deliver energy services to challenging markets and for productive use • Demand activation: raising awareness on benefits of modern renewable energy solutions • Market uncertainty: Research to generate strategic information in the energy sector • Support for off-grid energy policy reform and the creation of an enabling environment • Technical assistance
Enabel	25	• Grid Electrification • Technical Assistance	• Technical assistance: FUNAE capacity building on planning and project management • Finance: Support for construction of hydro powered mini-grids

[56] Funding allocated over 10 years; current budget is lower.

THE WORLD BANK	10	• Grid Electrification • Off-grid	• Finance: Grid electrification • Mini-grid: Geospatial options analysis and financing of mini-grids • RBF: Off grid expansion including SHSs, water pumps
Sida	6.5	• Grid Electrification • Off-grid	• Finance: Incentives for private firms for off-grid energy solutions • Finance: Matching grants to RE solution providers, including mini-grid, SHS and clean cooking solutions
ecf	4	• Off-grid • Technical Assistance	• Catalytic grants: supporting private-sector development, especially for companies seen as risky • Technical assistance: legal, regulatory and institutional frameworks
Total	**150-160**		

Current State of Electricity Access

Electricity access in Mozambique has progressed at a slow pace in the last two decades. It stood at only 30 percent of the population in 2019, lower than most countries globally. Access rates remained at 73 percent in urban areas in 2019 but just 5 percent in rural areas (*Tracking SDG7: The Energy Progress Report 2021*). Electricity access has been growing incrementally since 2000, increasing on average 1.5 percentage points per year. Grid expansion led by EDM has now reached all urban administrative centres in the country. However, grid access remains mostly concentrated in urban and peri-urban areas, and 69 percent of the population continues to live off-grid. Due to Mozambique's large size (800,000 km2) and very low average population density (38 people per km2), electrification is concentrated in urban centres and along main roads and transport corridors. Even in these areas, the grid faces critical challenges such as aging transmission infrastructure, unstable generation, poor demand growth, and poor service quality. Rural populations (about 70 percent of the country's population) are severely underserved with only about 5 percent enjoying electricity access in 2019.

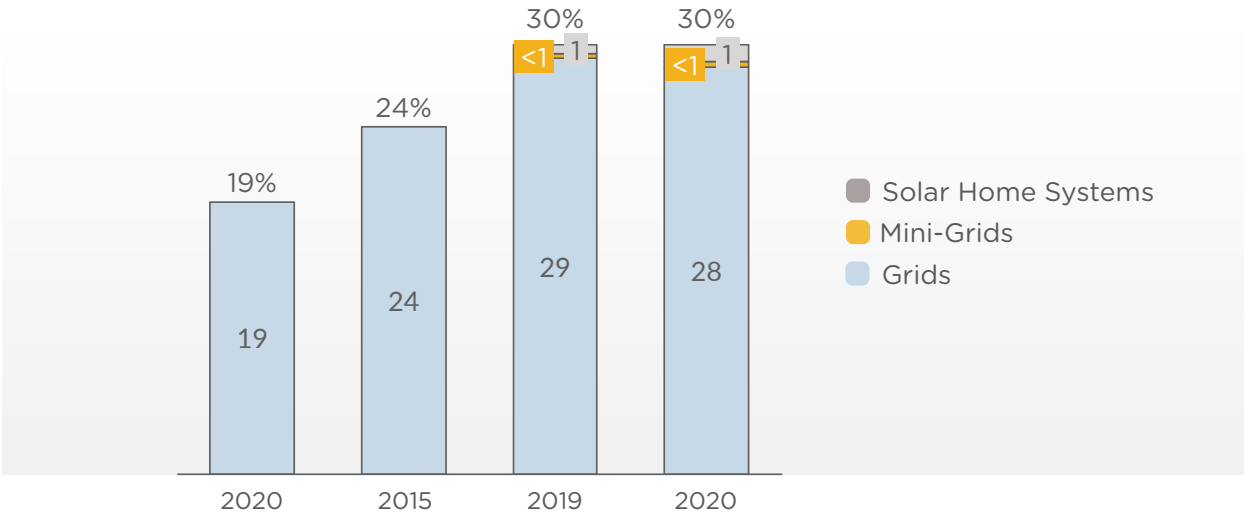
FIGURE 33
BAU and universal access scenarios for electricity in Mozambique

		Mozambique		
		2020	**2030 BAU**	**2030 Universal Access**
Population (in millions)	Population	31	41	
	Households	7	9	
Access to electricity (% of households)	Grid access	28	38	38
	Mini-grid access	<1	2	3
	Standalone solar access	1	10	59
	Total	**30%**	**50%**	**100%**

There has been limited government-led mini-grid development. Less than 1 percent of electricity access is currently supplied through mini-grids. FUNAE has installed approximately 130 sites in rural areas to date (GET-Invest). Mini-grids are then typically transferred to EDM for operation and maintenance. Stakeholder interviews suggest that existing mini-grids may be in sub-optimal condition: some may not work at all, while others are unable to operate at night as their batteries no longer function.

SHS access is growing with a few international companies entering the market, but it remains nascent. To date, SHS enterprises have made 130,000 cumulative sales, providing approximately 2 percent of total electricity access (GOGLA 2020). Some estimates indicate that up to 27 percent of Mozambique's population has access to some solar products, but these are primarily pico-solar and solar lanterns, which do not qualify as Tier 1 access. However, the market is showing signs of growth, with a small number of international companies entering the sector, either directly (e.g., Fenix ENGIE) or through local distributors (e.g., Greenlight Planet).

FIGURE 34
Mozambique electricity access 2000-2018[57]



Primary challenges hampering Mozambique's progress towards universal electricity access include consumer affordability, market uncertainty, insufficient private sector financing, and last-mile distribution hurdles.

- **Limited grid expansion:** Grid access is expected to reach just 38 percent of the population by 2030, driven by the high cost and difficulty of providing access to populations in low-density, rural areas.
- **VAT and import duties on SHSs:** Tax duty and VAT account for 45 percent of the cost of SHSs in Mozambique. As a result, SHS products are more expensive than in other countries that have granted exemptions to SHSs.
- **Low consumer affordability:** Mozambique is a very low-income country, with 46 percent of the population and 70 percent of the rural population living below the poverty line. 40 percent of households are unable to afford a SHS, even with a 12-month pay-as-you-go (PAYG) repayment plan. This greatly constrains the addressable market for SHS solutions.
- **Market uncertainty and political and economic stability:** Mozambique presents challenging operating conditions, with

[57] Tracking SDG7 data extrapolated based on local stakeholders' perspective.

high setup and ongoing operating costs for companies and limited information on customer demand. This is exacerbated by political instability and currency volatility, which have created a negative impact on funding availability. Recent insurgencies could compound this by increasing political risk. Volatility in the local currency has also contributed to market uncertainty in the private sector. Between February 2021 and April 2021, the USD-MZN exchange rate dropped 23 percent (XE 2021). Currency fluctuations have led to increases in the cost of capital and made access to local funding critical to support the private sector. Mozambique is ranked 138 out of 190 countries globally (World Bank 2020) in terms of ease of doing business.

- **Difficult last-mile distribution:** Low population density and underdeveloped transport infrastructure make last-mile delivery of energy a significant challenge.

- **Insufficient funds:** There are significant funding gaps for extending electricity access. Government plans for grid expansion and mini-grid development lack the financing to proceed, and the private sector struggles to secure sufficient start-up and working capital to scale.

- **Gender imbalance:** Increasingly, development partners and energy institutions in Mozambique are engaging in gender capacity building. Overall, there is growing recognition of how gender balance and social norms influence institutional decision-making and at project implementation level in communities. Stakeholder interviews confirm that gender norms in Mozambique are very pronounced. Although no comprehensive statistics exist, the following observations were shared:
  * Women in rural areas are responsible for fuel for lighting but they do not have decision-making power when it comes to purchasing stoves or cooking fuels. There is also a lower awareness by women of off-grid energy solutions and limited agency to purchase them.
  * There are limited gender disaggregated data and limited female participation in the energy sector workforce, including energy access supply chains.
  * During exercises conducted in focus discussions by gender specialists across multiple projects, women were shy and felt like they were not allowed to speak. Stakeholders believe that women are used to not having a voice in the decision-making process.[58]
  * A gender pay gap in Mozambique exists; on average, men earn 17 percent more than women.
  * Some programmes aim to encourage women's participation in the energy sector. EDM, for example, has launched an internal gender initiative with the goal of achieving a workforce that is at least 40 percent female by 2030.[59] In partnership with USAID through the Engendering Utilities programme, it is providing tailored coaching to employees on gender equity and business best practices. EDM has also implemented other initiatives such as "Bring your Daughter to Work" day and gender roadshows, where schools can participate in interactive learning sessions aimed at exposing girls to careers in energy.

- **Covid-19 affected the electricity sector, but government and donor support has helped to mitigate its effects and SHS sales increased compared with 2019.** Mozambique's economy was negatively affected by the Covid-19 pandemic, with an economic contraction of 0.8 percent in 2020 (World Bank 2021). During this time, an estimated 850,000 households slipped below the poverty line (World Bank 2021). Growth is expected to rebound in the medium-term according to the IMF's World Economic

[58] Market participant interviews conducted by authors.
[59] Market participant interviews conducted by authors.

Outlook database, driven by Mozambique's export-oriented industries, but a return to pre-Covid growth is not expected until 2022 or 2023. However, the effect of this economic downturn on electricity access was mitigated by government and donor support. The government increased priority social expenditures and expanded its coverage to more households, including direct financial support to the most vulnerable, and provided some fiscal support to small and medium-sized enterprises (SMEs). EDM also cut its tariffs for grid-connected power in response to Covid-19, with a 10 percent reduction to the general tariff and a 50 percent reduction to the social tariff (ESI Africa, 2020). EnDev developed two parallel subsidy programmes to support the off-grid sector: Covid-Pay provided payments to PAYG companies to maintain consumer electricity access during the pandemic, while Covid Plus provided finance to reduce the cost of systems for new customers. Through Covid-Pay, EnDev's EUR 10 financial support per customer per month for a maximum period of six months supported almost 125,000 customers in maintaining their access to energy (EnDev 2021). Both mechanisms will remain active until at least the end of 2021. Thanks to these programmes and other market forces, SHS sales tracked by GOGLA increased by 50 percent in 2020 compared with 2019. Additionally, KFW allocated a EUR 6 million non-refundable emergency grant to assist SMEs with severe cash flow problems arising because of Covid-19. Five Mozambican commercial banks (Millennium BIM, BCI, Société Générale, MyBucks and Microbanco Confiança), partnered with KFW to implement the emergency grant scheme (All Africa, 2021).[60]

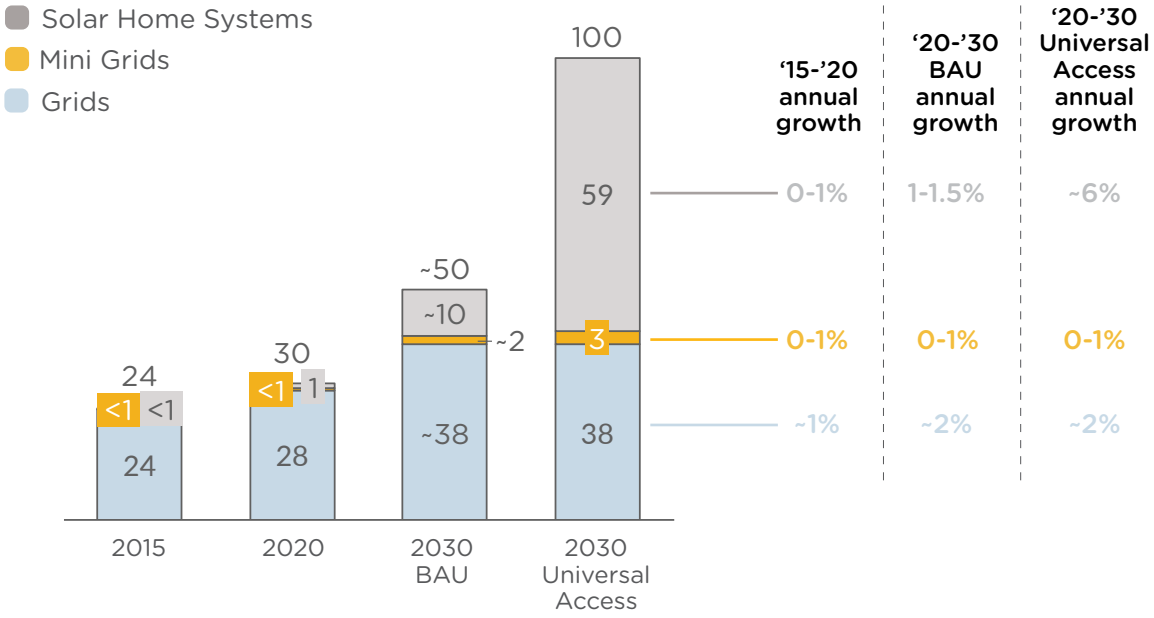
BAU and Universal Electricity Access by 2030

Mozambique is expected to fall significantly short of universal electricity access by 2030, with only an estimated 50 percent of the population projected to have access then. Based on the current trajectory of grid expansion, mini-grid development, and SHS market growth, it is unlikely that Mozambique will achieve its target of reaching 70 percent of the population though the central grid and 30 percent through off-grid connections by 2030. Overall electricity access will grow from 28 to 38 percent through further central grid expansion and rapid growth of the SHS sector, with mini-grids making up a smaller proportion of total electricity access. This estimate is broadly in line with other projections for Mozambique. For instance, the Africa Clean Energy Technical Assistance Facility projects that 50 percent of the population will have access to grid-connected electricity by 2030 (ACETAF 2021).

Figure 35 shows energy access historically and in the BAU and universal access scenarios. The universal access scenario achieves 100 percent electrification primarily through the expansion of SHS, accounting for 59 percent of electricity access compared to only 10 percent in the BAU scenario.

[60] The BRILHO Programme has managed to attract a large diversity of new local and international businesses into this market, improving its competitiveness; the business initiatives supported by BRILHO have already benefited over 165,000 Mozambicans (with independently verified results) with new access to electrification since the beginning of the pandemic, representing a market expansion of 83 percent compared to the market size previous to the pandemic. BRILHO aims to benefit 1,500,000 people with access to off-grid energy solutions until 2024.

FIGURE 35
Mozambique projected electricity access 2015–2030 (percent of population)



GRID EXPANSION

As a reminder, estimating the cost of grid expansion beyond the BAU scenario is not within the scope of this report.

Estimates suggest that the grid can conceivably expand to cover about 38 percent of households by 2030 (UNDP 2019), well short of the government target of 70 percent. The government plan would require a significant acceleration of current grid expansion, increasing from 120,000 new connections per year historically, to 590,000 per year in the coming decade – which is unlikely as concrete expansion plans and timelines to achieve this objective remain unclear. Mozambique's geography makes new grid connections particularly costly and challenging. This trend is reflected in the current inequality of access across regions and among urban and rural customers. Across the country, rural electrification stands at 15 percent of the population. Cabo Delgado, Naissa, Tete and Zambezia are particularly underserved regions, with energy access at or below 15 percent. In addition, two insurgencies have displaced half a million of Mozambique's 30 million population and made electrification in some areas all but impossible.

OFF-GRID EXPANSION

MINI-GRIDS

Successful completion of priority mini-grid projects planned by the government and FUNAE could provide access to 2 percent of households by 2030. In 2014, FUNAE identified 1,500 potential mini-grid sites. 500 of these were prioritized, of which 189 could be served by solar mini-grids. However, with limited available resources to develop these sites, only 60 development partner-sponsored mini-grids are under development to provide access to an estimated 178,000 households, or roughly 2 percent of estimated households in 2030 (AMER 2021). These projects are summarized in Figure 36 and include Enabel's tender for five solar-diesel hybrid mini-grids in Nampula and Zambezia (75 to 230 kWp); BRILHO support for up to 30 mini-grids; and 13 mini-grid projects identified as part of the Pro-Energia World Bank programme. While some funding has been committed towards these projects, it is unclear whether enough has been allocated for full design and construction.

FIGURE 36
Overview of finance for Mozambique mini-grids (USD million)

Donor	Programme	Commitment ($M)	Commitment (%)	# grids	MW	Potential households connected	Funding for construction
FCDO	Brilho	$33M	35	TBD	TBD	[up to 150,000]	Yes
BMZ/KFW	GPE	29	31	10-16	3	7,000	Yes
Enabel	RERD2	10	11	5	~1M	3,500	Yes
World Bank	ProEnergia	10	11	11	N/A	N/A	N/A
SIDA Sweden	BGFA	8	8	N/A	N/A	15,000	N/A
	React SSA	1.6	2	6	N/A	2,000	N/A
AICS	Ilumina	1.7	2	N/A	N/A	860	N/A
Total		$93M	100%	56-62	5+	178K	

Beyond the existing plans, it remains very difficult to predict mini-grid sector growth in Mozambique. The Government Energy Atlas, sponsored by AfDB, found that Mozambique has the potential to connect 22 percent of the population to electricity through mini-grids (AfdB 2017). This analysis assumes that mini-grids could cover all population centres found more than 15 km from the central grid, with a density higher than 50 households per km2. However, the analysis was not carried out on a least-cost basis and does not consider the funding levels (and opportunity cost in terms of SHS development) that would be needed to support this growth. A World Bank/ESMAP spatial analysis finds that mini-grids could be the least-cost electrification option in Mozambique for only 10 percent of households (World Bank 2019). This was also the consensus that emerged from stakeholder interviews. Given the lack of certainty associated with these higher mini-grid estimates and the methodological challenges, they have not been considered in the BAU scenario, which only focuses on the projects described in Figure 36.

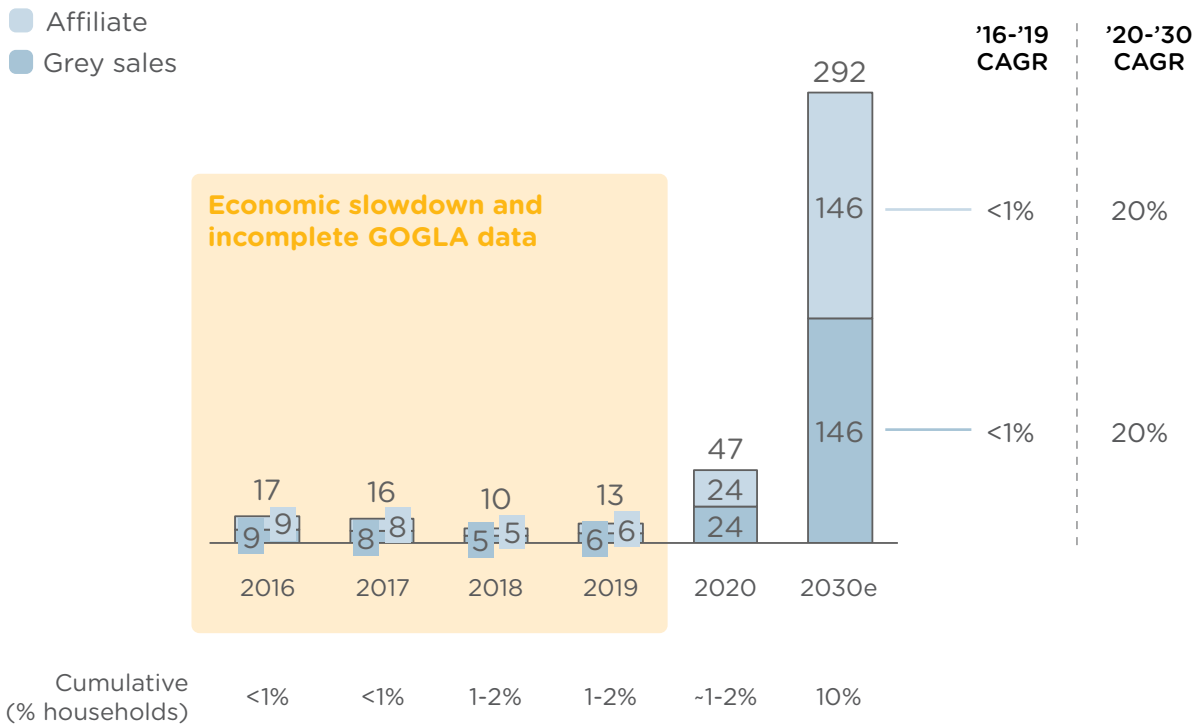
The BAU scenario assumes that all mini-grid projects identified with development partners are completed by 2030, but that no additional projects are undertaken. The more aggressive scenario suggests that even at its highest, mini-grids will account for no more than 10 percent of electricity access, as the ESMAP report identifies. This scenario would require regulatory changes to crowd in the private sector. Ongoing discussions with the support of BRILHO around a new framework for private-sector participation, including clarifications on concessions and tariffs, could crowd in the private sector once approved, although the timeline is unclear. In September 2021, the Government of Mozambique approved a decree on regulating off-grid energy access that is expected to facilitate mini-grid development by energy providers (SNV 2021).

Other business models that have successfully supported the expansion of mini-grids with private sector support could be explored to increase mini-grid deployment in Mozambique, including mini-grids to power cell towers in areas not covered by the central grid (see Case Study 5 in Appendix). This is particularly relevant in Mozambique where limited grid coverage creates power challenges for cell towers and expanding coverage could increase the opportunity to expand PAYG solar.

SOLAR HOME SYSTEMS

Tier 1 SHS penetration remains low to date at 2 to 3 percent but could increase significantly to up to 10 percent in 2030 under BAU. SHS sales have historically been low in Mozambique compared to other, booming East African markets. Because of low mobile penetration, PAYG has accounted for a small share of overall sales and cash sales are the norm. As a result, private companies are primarily focused on the most densely populated, highest income areas. Until recently, there has been limited participation of international companies, due to a difficult local operating context and political instability. Non-GOGLA affiliated sales are estimated to account for 50 percent of SHS sales. However, 2019 and 2020 saw significant growth in the sector, driven by increased access to donor finance for energy access in Mozambique, and the entry of new firms.

FIGURE 37
GOGLA affiliate SHS sales in Mozambique (in thousands and percent of households)



Growth can be attributed in part to the entry of a mature, international firm, Fenix (owned by ENGIE), and SolarWorks. These two companies account for an estimated 95 percent of SHS sales, with presence in six provinces.[61] Both companies have access to international, lower-cost funding to expand PAYG sales, which significantly improves the affordability of SHSs for customers. Their presence in the market, supported by local grant programmes, has significantly boosted the sector.

FIGURE 38
Overview of Mozambique SHS market[62]

	Cumulative sales (mkt. share)	Ownership	Geo focus	Strategy	Business model	Brand	Funding
fenix intl	40,000 (47%)	International (Uganda)	6 provinces-40 locations	Systems with TVs,	PAYG	Fenix	International (Engie, Orange, and Schneider; Shell Foundation, USAID, UK DID, etc.);Brilho
solarworks! your energy, your future	40,000 (47%)	International (Dutch/ S. Africa)	Deepest penetration-rural and urban both	Individually-owned shops & 3rd party sellers	PAYG/ Direct	SW	International ($2M from SunFunder in local currency, $4M from Electrifi); Brilho
EPSILON ENERGIA SOLAR	3,000 (3%)	International & local	Operations down since hurricane Idai	Door to door, individually-owned shops & 3rd party sellers	PAYG/ Direct	Greenlight	International (UK DID) and local equity; Brilho
DIGITECH Sistemas e Tecnologias	<3,000 (3%)	Local		Systems with TVs Locally assembled units	PAYG/ Direct	Sun King, Mobisol	Local equity; Brilho
Ignite		International (Rwanda)		Door to door sales	PAYG	Greenlight, Sun King	Grants (Brilho, DBSA) and local equity
ΔΥΝΑΜΙΣΣ		Local		SolarWorks! Agent in Southern Mozambique	PAYG/ Direct	Omnivoltaic	Local Equity; Brilho
Other micro-distributors		Local		Compete on price	Direct sales	Grey, lower quality products	Local equity
Total	**86,000 (100%)**						

[61] Market participant interviews conducted by authors.
[62] Note that numbers do not match the previous figure; this is driven by different sources (officially reported GOGLA sales vs. market participant interviews) and the fact that GOGLA sales have not been tracked across all years since 2016.

The PAYG business model shows significant promise in Mozambique but scale-up is constrained by low mobile money uptake to date. Ability to provide PAYG finance is critical in a market with low customer affordability. Fenix for instance sells entry-level systems on two- or three-year loan terms, making payments affordable for low-income customers.[63] However, PAYG expansion is limited by low mobile penetration to date. Growth in line with past expansion could result in 75 percent mobile money penetration by 2030, although further expansion is likely to be slower and costlier than in urban areas where most existing users are located. This also creates opportunities for SHS companies to partner with Mozambican mobile operators, which might be interested in leveraging PAYG energy as a use-case to expand the use of mobile money among mobile customers.

Another limitation of SHS scale-up to date has been a lack of tax and import exemptions commonly found in other countries, but there are on-going conversations about possible reforms. Tax duty and VAT make imports of SHSs or components more expensive. Private SHS stakeholders in Mozambique believe that a reduction or removal of import duties and VAT, which together correspond to 45 percent of the cost of SHSs in Mozambique, would multiply the number of households able to afford SHSs by a factor of two to three (Hodgkinson; Smeshko 2020 Challenges in the Solar Home Industry in Mozambique). This scenario has not been incorporated in the BAU forecast but would likely significantly decrease the affordability gap and private finance needs measured in the universal access scenario, as confirmed in the stakeholder webinars held as input into this report. Private stakeholders believe Mozambique could become a highly attractive SHS market for other international companies following such reforms.[64]

Finally, SHS enterprises face challenges related to difficult in-country logistics and operating environment. Distribution in Mozambique is expensive due to an underdeveloped road network, of which just 20 percent is paved (Global Logistics 2018). This limits the ability of enterprises to build distribution capabilities around the country beyond better-connected urban and peri-urban areas.

Despite the challenges described above, the SHS sector will need to provide access to 59 percent of households by 2030 to ensure universal electricity access. This figure is driven by the fact that access through grid electrification in a BAU scenario is not expected to exceed 38 percent, and mini-grids, as noted above, will play a limited role at most. In addition, 70 percent of the population lives in low-density, rural areas that are complex and costly to serve through the grid and mini-grids therefore favouring SHS distribution.

Financing Universal Electricity Access in Mozambique

USD 1.1 billion is required to achieve universal electricity access in Mozambique by 2030. In this scenario, finance from debt, equity and grants accounts for USD 444 million with the remaining USD 630 million attributed to the affordability gap. Of the USD 445 million, USD 224 million is required for SHSs and USD 221 million for mini-grid expansion.

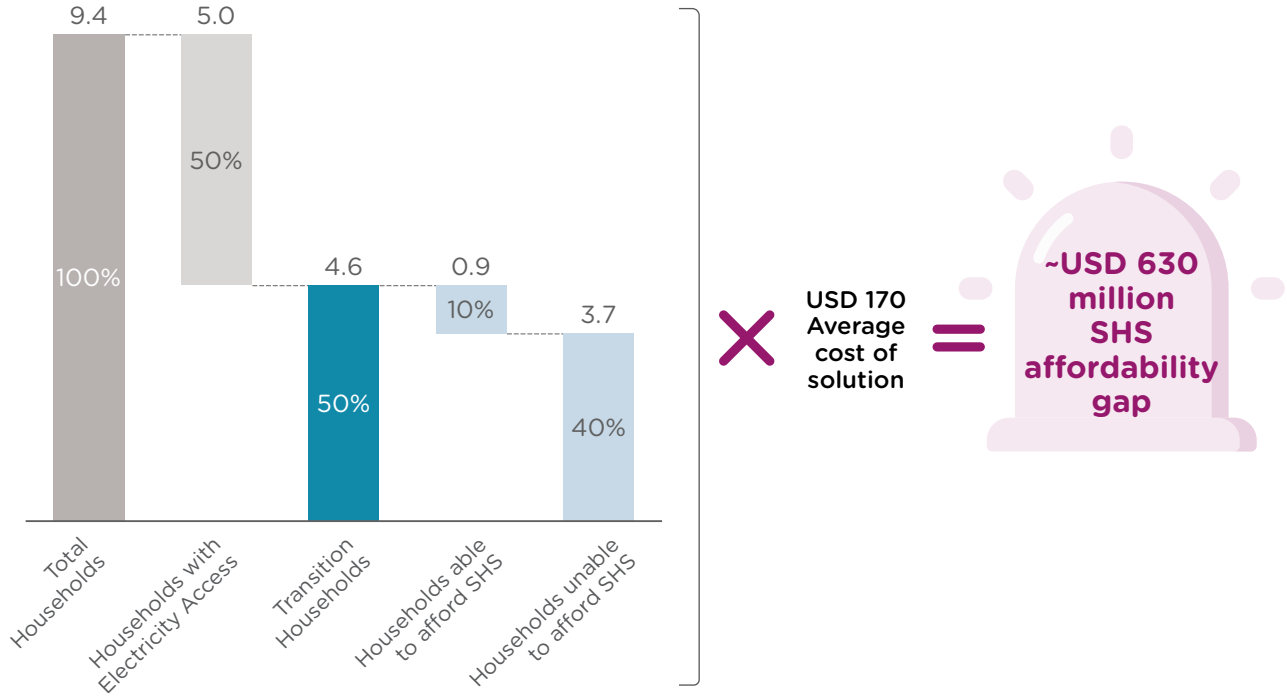
AFFORDABILITY GAP

The affordability gap in Mozambique is USD 630 million, driven by the country's large rural and low-income population. It is estimated that approximately 46 percent of the population lives below the poverty line (2014 estimate; World Bank), and 80 percent of transition households would be unable to afford a USD 170 SHS on a PAYG basis based on their available income. Affordability calculations assume that SHS products are purchased by households over 24 months in monthly payments, based on reallocation of their existing expenditure on electricity[65] for a total average cost of USD 170 or USD 7.08 per month.[66]

[63] Market participant interviews conducted by authors.
[64] Market participant interviews conducted by authors.
[65] 8 percent of total consumption expenditure.
[66] Methodology for Mozambique slightly differs given higher poverty rates.

FIGURE 39

Mozambique SHS affordability gap calculations (2030 households USD million)



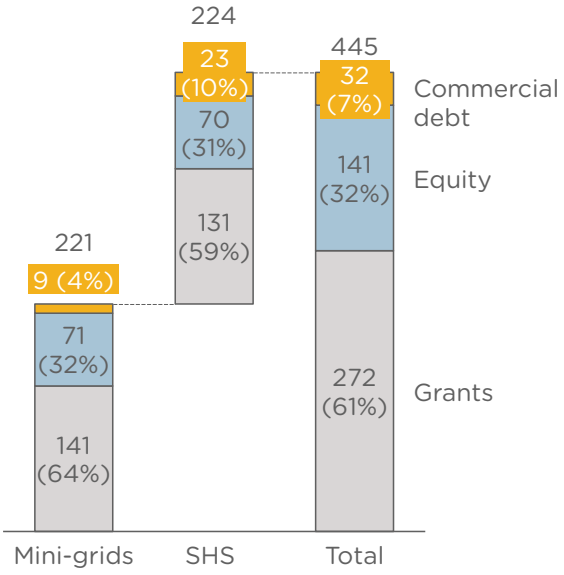
ENTERPRISE FINANCE NEEDS

The mini-grid and SHS private sector finance needs are estimated to be USD 445 million, with USD 221 million required for mini-grid expansion. While SHSs will provide access to 59 percent of households, they only account for 50 percent of the private-sector finance need. The mini-grid cost per connection is 40 to 45 times higher than that of SHSs, with an average cost per connection of USD 1,850/household, which is high compared to the regional average of USD 733 (AMDA 2020). It should be noted, however, that mini-grids provide households with increasing levels of electricity access over time compared to SHSs. Therefore, a phased approach could be used as a strategy to increase the pace of universal access, focusing on providing access to Tier 1 through the faster deployment of SHS in the short term, while planning for mini-grid expansion in the longer term. The universal access scenario incorporates the private sector's finance need in contrast to the BAU scenario, where funding for mini-grids is provided only through government as there is no private- sector presence (mini-grid access is 2 percent in the BAU scenario and 3 percent in the universal access scenario). This report also estimates a more aggressive mini-grid scenario. Assuming regulatory changes crowd in the private sector, mini-grids could deliver electricity access to 10 percent of the population according to local stakeholders. The cost of universal access in this scenario is higher at USD 1.9 billion given the higher cost of connection per household of mini-grids compared with SHSs.

According to stakeholder interviews, both mini-grids and SHS private companies will continue to require significant grant support to 2030. Grant finance accounts for 61 percent of the finance need, driven by the lack of mature, larger mini-grid or SHS companies in Mozambique and high operating costs. Based on the current pace of mini-grid development, few developers will be able to scale in the next 10 years and 80 percent of projects will continue to be led by small to mid-sized developers, which will require 50–60 percent grant finance (decreasing from 75 percent today). In the SHS market, it is assumed that more mature companies will account for 50 percent of sales by 2030, but these companies will still require grant funding, including to enable PAYG expansion.

Access to grant funding, which may be substantial, is expected to be limited to a strict number of uses. Grants are most likely to be obtained to catalyze public goods and pay down the cost and risks of infrastructure investments – though other grant uses could include deploying systems, building sales networks or buying vehicles. These public goods include quality testing and certification, establishing carbon finance verification and above the line consumer-awareness campaigns. RBF could be provided to incentivize private sector market entry in last-mile and logistically challenging locations.

FIGURE 40
Mozambique universal electricity access finance needs



	Mini-grids	SHS	Total
No. of transition households connected (M)	0.09M	4.6M	4.7M
Access gap bridged (% total)	2%	98%	100%
Finance need/ household ($)	~$1,850	~$44	~$80 (average)

Debt and equity account for 39 percent of the total finance need in the BAU scenario. Debt finance of USD 32 million and equity finance of USD 141 million are required.

AVAILABILITY OF FINANCE

Access to local debt finance is critical but has been very limited to date, and some international impact funders are developing new debt facilities. Access to local funding is critical given the volatility of Mozambique's local currency, but there is limited local commercial funding to date. The energy market is considered high risk and low return. A few initiatives from commercial institutions lending at concessional terms have emerged with donor support. For instance, in 2018 KfW partnered with BCI Eco Ambiental, a local financial institution, to launch a EUR 3 environmental credit line for both individual clients and entrepreneurs for off-grid energy production,[67] More recently, GEF and the UN Industrial Development Organization (UNIDO) worked with BCI to develop a credit line for clean

[67] These operations are in MZN and the term can be up to five years, with a limit, for individuals, up to MZN 5 million, and for companies up to MZN 20 million, at a 15 percent fixed rate.

energy and environmentally friendly technologies. The BCI credit line was launched in April 2021 and offers up to three-year loans with a one-year grace period at an interest rate of 7.5 percent, a much lower rate than typical loans in Mozambique; it will also be denominated in local currency. Maximum loan amounts remain limited at the equivalent of USD 55,000. Larger international debt funds exist, such as the IFC's mini-grid scaling debt fund, but currently there is no plan for this facility to be made available in Mozambique given the lack of a mini-grid regulatory framework for the private sector.

FIGURE 40
Overview of finance availability in the Mozambique electricity market

	Description	Availability	Market perspective
Commercial debt	• Access to local funding is critical given volatility of local currency, but limited commercial funding to date • Initiatives for commercial lending with donor support • Eco Ambiental credit line (KFW) • BCI credit line 7.5% for C&I productive uses	• Limited access to financing for energy companies	Having access to local funding below 10% interest would provide a lot of leverage, but it's not the case at the moment
Equity	• Cost of capital is high given significant currency volatility; very difficult to take capital denominated in foreign exchange • Insurgencies creating political risk and reducing attractiveness for potential equity providers	• Raising local equity is possible but still relatively rare	At Epsilon we were able to raise local equity, but that is still rare
Grants	• RBF facilities include Brihlo (£33M), Endev ($4.5M), World Bank ($3M) • Grant programs include AECF($6.5 M), Enable ($13.8M), Embassy of Sweden ($11M)	• Multiple programs support off-grid electrification	The private sector is fragile: local companies are still very reliant on donor initiatives; if Brilho halts for 4 months, then the private sector cannot do business for 6 months

Low Medium High

Key Finance Opportunities and Solutions

To accelerate electricity access, the Mozambican electricity sector requires financing solutions that address key sector challenges – specifically around the significant affordability gap for customers and finance need for the private sector, as summarized in Figure 42.

To address consumer-affordability challenges, the government can lower import and duty taxes on SHSs. SHS products in Mozambique are more expensive than in neighbouring countries given that they are subject to import duties and VAT. Lowering these barriers would immediately improve affordability for some households.

Development partners can explore demand-side subsidies. These could include voucher systems to pay for a portion of SHS cost for households, or direct donations for the upfront cost of a system. Tools should be tailored to encourage private companies to target the hardest-to-reach consumers and should be designed with the private sector to make sure they will achieve desired outcomes.

Development partners can expand catalytic grants. Expanding existing catalytic grant programmes (for example, BRILHO) for one-time grants to support market entry and help companies prepare for RBF.

To address insufficient funds, development partners could provide USD 445 million to private companies by 2030 to support the private sector's expansion into Mozambique's electricity market. These funds should be made available in the form of grants, including supply-side subsidies such as RBF structures once the private sector is able to absorb them. Development finance could also expand availability of concessional debt finance in local currency. Once the private sector matures, other financing instruments could be piloted in Mozambique including off-balance sheet financing secured by SHS collateral. Other levers for private sector support include expanding local debt and concessional finance to support the expansion of PAYG. Guarantees, first loss schemes, hedging facilities and other structures that encourage local banks to lend to energy access companies could scale the recently launched KFW/BCI partnership.

Government agencies could establish a clear framework for mini-grid development. The lack of a clear regulatory framework for mini-grids has severely limited private-sector development. A new regulatory framework could crowd in the private sector and increase mini-grids' contribution to electricity access. The BRILHO programme, under the leadership of the Government of Mozambique, initiated in December 2020 the development of the first off-grid energy regulatory framework (including regulation around concessions, registration, interconnections, tariffs, quality and technical standards, among others). Some stakeholders expect this new framework to be finalized and approved in 2021.

Additional work is required to improve gender equality in Mozambique including additional data gathering to evaluate the issue. Not enough gender-disaggregated data exist to inform good decision-making. Incubating more women-led energy enterprises and mobilizing more capital for women-led businesses can further improve the electricity sector's gender imbalance.

Introducing work-inclusive policies, flexible working hours and encouraging the take-up of paternity leave can increase the attractiveness of jobs for women in energy sector. Stakeholders can also create programmes to actively promote women's participation in commercial enterprises. Exploring innovative financing instruments such as supply-side subsidies that provide additional incentives when targeting female customers could also increase participation.

A gender-specific, people-centred design approach can help create the right products for women. Incorporating women in the design process and understanding their specific needs will lead to better product design and higher uptake.

FIGURE 42

Recommended instruments to address Mozambique's electricity challenges

Audience	Challenge	Recommendation
Government	**Low customer affordability**	Import duty and VAT exemptions for SHS products, or special economic zones granting temporary relief from taxes and other regulations.
Development Partners	**Low customer affordability**	Demand-side subsidies of up to USD 630 million.
	Insufficient funds	Additional local lending support to the private sector through grants, debt and equity.
	Market uncertainty	Mini-grid regulatory changes to enable private sector participation and financing of mini-grids (in progress with BRILHO support).
	Difficult last-mile distribution	In a later stage, RBF expansion. Once private market matures and customer base has expanded, incentivize expanding in harder to reach areas.
	Local capacity and know-how	Technical assistance and government advisory efforts.
Investors	**Insufficient funds**	Local debt and concessional finance expansion to private companies.
All	**Gender imbalance**	Expansion of financing for women-led businesses. Inclusive work policies, programmes and people-centred design that promote women's participation in the energy sector.

PART 2

TAKING THE PULSE OF CLEAN COOKING IN MOZAMBIQUE

KEY MESSAGES
The Cost of Universal Clean Cooking Access in Mozambique

Mozambique has seen steady growth in access to clean cooking. This report estimates that less than 4 percent of the population had access to Tier 4 clean cooking and less than 6 percent had access to Tier 2 /Tier 3 clean cooking in 2020. Under a BAU scenario, access to clean cooking will largely stagnate until 2030 both in terms of Tier 4 (4.4 percent access by 2030) and Tier 2/Tier 3 (7 percent estimated access by 2030).

Gender dynamics are especially salient for the clean cooking sector. Women rely mostly on biomass fuels such as firewood and charcoal for cooking and, in view of the gradual depletion of these fuels, they are obliged to walk increasingly longer distances to obtain them or pay higher prices, wasting time and being exposed to heightened safety risks.

Universal Tier 4 clean cooking access requires USD 8–12 billion. This is largely due to the cost of fuel (USD 7.4 billion), driven by the number of households that are not able to afford Tier 4 solutions.

Universal Tier 2/Tier 3 access to improved cookstoves (ICS) requires a much smaller amount of USD 570 million, mainly driven by an affordability gap of USD 300 million. Currently, 46 percent of the population lives under the poverty line, a figure that is not expected to change substantially in the next few years. USD 270 million is also needed for private-sector clean cooking solution providers. Half will be in the form of grants (USD 135 million) as the ICS sector remains small and sub-commercial.

It is critical for the government to develop a comprehensive strategy for clean cooking in which the private sector has a role. The strategy should clearly define and demarcate the need for end-user subsidies to address affordability constraints and invest in critical enabling reforms to slowly catalyze private-sector capacity. Additionally, all stakeholders should articulate energy access pathways that consider interdependencies between access strategies (e.g., electricity used as a cooking fuel) but also between access strategies and climate goals (e.g., impact of liquefied petroleum gas (LPG) universal access on the net zero country pathway).

Sector Context

The energy sector in Mozambique is regulated by the MIREME. There is no recent clean cooking strategy in Mozambique, although a 2012 biomass strategy developed by MIREME with the European Union Energy Initiative called for access to sustainable, affordable and clean wood fuel energy for all households, institutions and the private sector by 2025 (MIRME 2012).

Clean cooking initiatives in Mozambique are undertaken by two major development partners: Energising for Development (EnDev) and BRILHO (UNDP 2020). Unsurprisingly, grants are the most common form of funding for all ICS enterprises. EnDev provided flood-affected populations in Gaza, Inhambane, Manica, Sofala and Zambezia provinces with ICS at subsidized rates only slightly above the cost of traditional cookstoves. GIZ through EnDev also supports product standardization efforts, technology testing, and research and development (R&D) to improve stove quality. In addition, FUNAE had distributed nearly 154,000 improved stoves for home and institutional use by the end of 2017 (GET-Invest 2021). Garner Advisors is also focused on developing ethanol-based clean cooking solutions.

Overall, investments in the Mozambique clean cooking sector remain low. *Energizing Finance: Understanding the Landscape 2021* tracks total investment in clean cooking at USD 2.7 million for the period 2013–2019 (SEforALL 2021). However, this report estimates that a private finance need of USD 270 million is required to achieve universal access to Tier 2/Tier 3 clean cooking in Mozambique by 2030.

FIGURE 43
Key programmes financing clean cooking in Mozambique

Programme	Key features
SNV BRILHO	• Technical assistance, research and information • Support policy reform for ICS usage • Financial backing to ICS players via RBF-grant mechanism • Behavioral change support through awareness campaigns Catalytic grants. • Technical assistance for businesses to develop and enhance their business models, products, partnerships, and become investment ready
EnDev	• ICS market support via RBF mechanisms • Introduced subsidy-based programs to counter Covid 19 demand impact
Garner Advisors	• Ethanol cookstoves and fuel imports • R&D support for ethanol stoves • Third party vendors and distribution partner support • Awareness campaigns for bio ethanol stoves via ambassador program

Current State of Clean Cooking Access

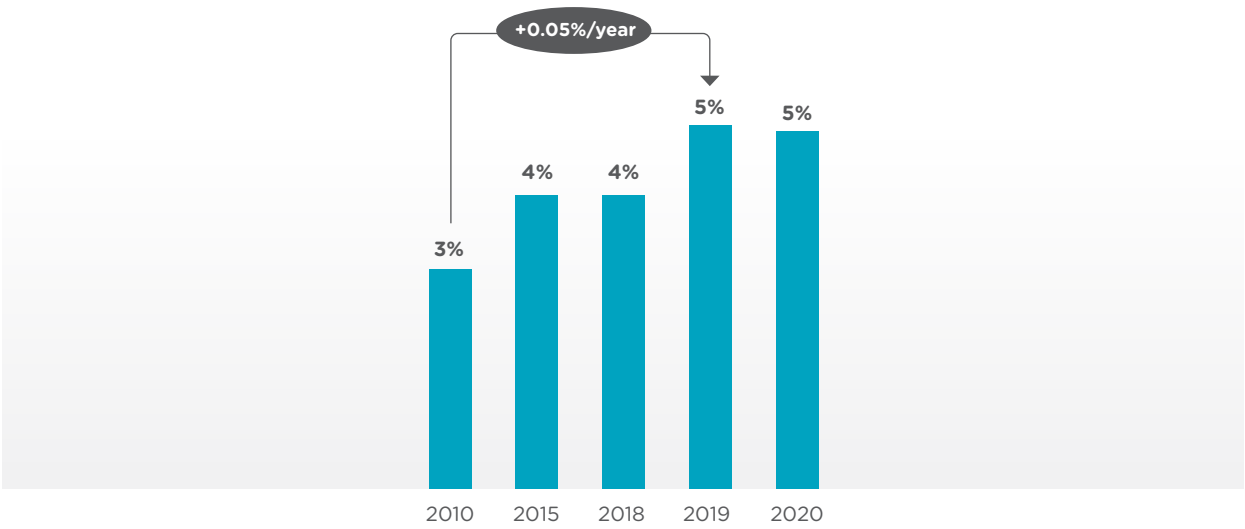
An overwhelming majority of households in Mozambique (95 percent) continue to rely on the use of biomass for cooking,[68] with little change noted in the past 20 years.

FIGURE 44
BAU and universal access scenarios for clean cooking in Mozambique[69]

		Mozambique		
		2020	2030 BAU	2030 Universal Access
Population (in millions)	Population	31	41	
	Households	7	9	
Access to clean cooking (% of households)	Tier 2 access	6%	7%	100%
	Tier 4 access	3.9%	4.4%	100%

In urban areas, households tend to use charcoal as their main cooking fuel, whereas in rural areas, firewood remains the main fuel due to charcoal's high cost and the wider availability of free firewood given Mozambique's extensive forest coverage. 85 percent of the urban population in the Maputo area relies on biomass to meet cooking energy needs.[70] Regardless of the type of biomass fuel used or their locations, households primarily use traditional stoves that only provide Tier 0/Tier 1 clean cooking access.

FIGURE 45
Historical access to clean cooking in Mozambique (percent of population)[71]



[68] Tracking SDG7 2021.
[69] World Bank World Development Indicators for population and household estimates. Author's calculation for access estimates.
[70] Market participant interviews conducted by authors.

Three primary challenges are slowing Mozambique's progress towards universal access to Tier 4 and Tier 2/Tier 3 cooking. These are: low consumer affordability, difficult last-mile distribution and insufficient funds.

- **Low consumer affordability:** LPG and other clean fuels are often too expensive, particularly when households are required to purchase a full gas canister. Mozambique is a very low-income country, with 46 percent of the overall population and 70 percent of the rural population living below the poverty line. 90 percent of households would be unable to afford to pay cash for an ICS. The lack of consumer finance options impedes the uptake of clean fuels, as does the low cost of substitutes since most households still use wood, which can be gathered for free or purchased at low prices. Despite the high cost of charcoal, there are strong cooking habits associated with charcoal, which creates resistance to change, including for households able to afford clean fuels.

- **Difficult last-mile distribution:** Developing LPG or other clean fuel transport and bottling infrastructure for rural areas is highly challenging and requires significant infrastructure investment. Also, private sector participation in ICS is concentrated in urban and peri-urban areas, where customers are easy to reach, and therefore there is very limited emphasis on rural customers.

- **Insufficient funds:** There is limited donor support for clean cooking, compared to electricity access, due to the lower profile of issue and limited appetite for LPG and fossil fuel support (see Case Study 6 in Appendix). Local financiers are unwilling to lend to the clean cooking sector and ICS due to the small size of enterprises and low margins. Further, smaller ICS producers have difficulty accessing carbon finance.

- **Lack of government strategy for "clean" fuels or access to carbon finance.** The lack of a holistic government strategy that encompasses other "clean" fuels or support mechanisms to leverage carbon finance has limited the expansion of clean cooking solutions.

- **Market uncertainty and political and economic instability:** Mozambique presents challenging operating conditions, with high setup and ongoing operating costs and limited customer demand information. This is exacerbated by political instability and currency volatility, which have limited the availability of funding. Recent insurgencies could also have a negative impact on funding availability by increasing political risk. Volatility in the local currency has also contributed to market uncertainty within the private sector. Between February 2021 and April 2021, the USD-MZN exchange rate dropped 23 percent (XE). Currency fluctuations have increased the cost of capital and made access to local funding critical to shore up private sector operations. Mozambique is ranked 138 out of 190 countries (World Bank 2020) in terms of ease of doing business.

- **Gender imbalance:** Increasingly, development partners and energy institutions in Mozambique are engaging in gender capacity building. Overall, there is growing recognition of how gender balance and social norms influence institutional decision-making and at project implementation level in communities. Stakeholder interviews confirm that gender norms in Mozambique are very pronounced. Although no comprehensive statistics exist, the following observations were shared:

  * Women in rural areas are responsible for fuel for lighting but they do not have decision-making power when it comes to purchasing stoves or cooking fuels. There is also a lower awareness by women of off-grid energy solutions and limited agency to purchase them.

[71] Author's analysis, Tracking SDG7. World Bank. Note that access to clean cooking as measured historically does not fully align with the MECS definitions of access introduced later in this section. 2020 data extrapolated based on local stakeholders' perspective.

* There are limited gender disaggregated data and limited female participation in the energy sector workforce, including energy access supply chains.

* During exercises conducted in focus discussions by gender specialists across multiple projects, women were shy and felt like they were not allowed to speak. Stakeholders believe that women are not used to having a voice in the decision-making process.[72]

* A gender pay gap in Mozambique exists; on average, men earn 17 percent more than women.

* Some programmes aim to encourage women's participation in the energy sector. EDM, for example, has launched an internal gender initiative with the goal of achieving a workforce that is at least 40 percent female by 2030.[73] In partnership with USAID through the Engendering Utilities programme, it is providing tailored coaching to employees on gender equity and business best practices. EDM has also implemented other initiatives such as "Bring your daughter to work" day and gender roadshows, where schools can participate in interactive learning sessions aimed at exposing girls to careers in energy.

- **Covid-19 affected the energy sector, with no known support for the cooking sector.** As mentioned in the Mozambique electricity section, while Mozambique's economy contracted by 0.8 percent in 2020, it is expected to return to pre-Covid growth by 2022 or 2023. In 2020 the government imposed restrictions, including limiting the number of people at the workplace and a mandatory 14-day quarantine for those entering the country. During this time, an estimated 850,000 households fell below the poverty line (World Bank 2021). EnDev conducted a survey of SHS and ICS companies and 90 charcoal vendors in April and May 2020. The survey found that 62 per cent of respondents faced financial constraints in maintaining their businesses during the state of emergency, and 31 percent were facing serious financial problems (ACETAF 2021). Stakeholder interviews indicate that the impact of Covid on the clean cooking sector is expected to last until 2022 or 2023. SME surveys undertaken by development partners in 2020[74] revealed that many companies in the sector saw a sharp decline in sales, as many households were no longer able to purchase charcoal and cooking fuels.

[72] Market participant interviews conducted by authors.
[73] Market participant interviews conducted by authors.
[74] Stakeholder interviews. Actual surveys not made available.

ACCESS TO TIER 4 COOKING SERVICES

About 4 percent of households currently use cleaner fuels, primarily LPG, as their primary fuels. Stakeholder interviews indicate that the main driver of LPG uptake in southern Mozambique is a decline in biomass availability, which has made charcoal expensive. Charcoal primarily originates from the country's forests. However, forests around Maputo have become largely depleted, requiring charcoal producers to seek raw materials further afield and increasing the cost of charcoal as a cooking fuel. This could be early evidence of the start of a charcoal-to-LPG transition in Mozambique, though this depends on future price movements for both fuels.

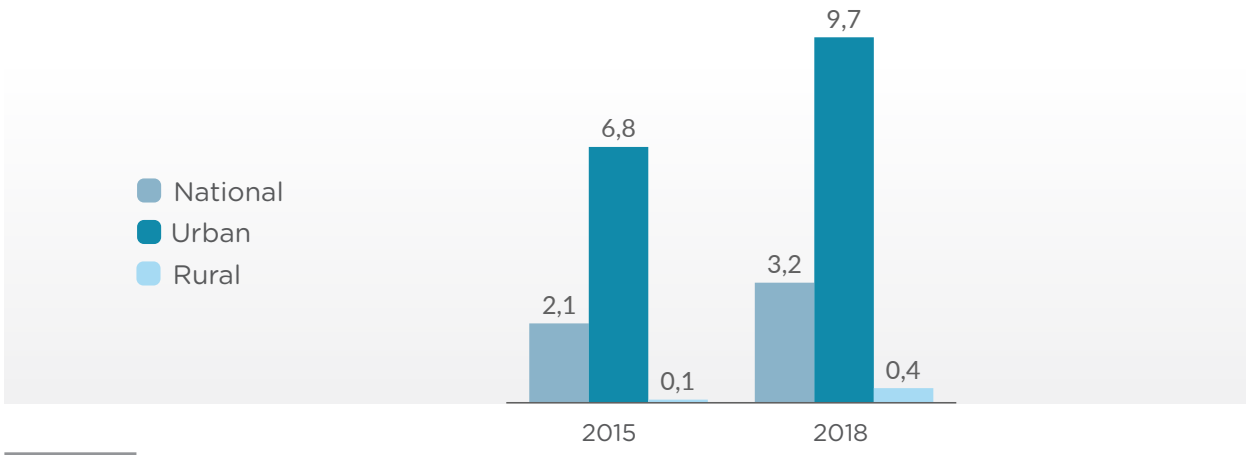
LPG distribution is costly in some parts of Mozambique, particularly in the north where several large population centres are located. PetroGas primarily focuses on distributing cylinders in the Maputo area. GALP and Vidagas, a non-profit organization, serve the rest of the country. Beyond urban centres, the low population density hinders the construction of filling plants; cylinders must also be transported, which increases cost and limits uptake. LPG import terminals are currently located in the south close to Maputo, with a new terminal set to be operational later this year. Another import terminal is located in Beira, also in the south. However, in the north, including in Zambezia, which at 5 million inhabitants is the second most populated region in Mozambique, there is no terminal. Finally, an LPG filling plan with a capacity of 30,000 tons per year is expected to be operational in the south by 2024.[75]

The government has put in place a price cap on, and controls the sale price of, LPG (SNV 2013). Prices are controlled for distributors and retailers, with an index formula adjusting the price on a month to month basis if costs increase by more than 30 percent.

LPG is currently cheaper than charcoal in Mozambique. Charcoal in Mozambique is nearly double its cost in Ghana, Kenya and Nigeria, and yet remains the most common cooking fuel in urban centres.[76] As of June 2021, LPG cylinders were cheaper than charcoal. One 9 kg cylinder refill cost MZN 500 (USD 8 as of July 2021), compared to MZN 1,000 to 1,200 (USD 16 to 20) for a 50 kg bag of charcoal. Interview results suggest that one household can cook as much with one LPG cylinder as with three bags of charcoal, suggesting that spending MZN 500 on LPG is equivalent to spending over MZN 3,000 on charcoal. However, most households purchase small quantities of charcoal daily, which makes their spending on charcoal higher, since small charcoal bags cost more per kg than 50 kg bags. Additionally, the upfront cost of switching to an LPG stove is unaffordable for many households since they must purchase both a cylinder and a stove, which costs a minimum of MZN 1,000 (USD 16). The primary gas cylinder used is the 9 kg, which is expensive for most households. Petrogas is experimenting with smaller LPG cylinders of 3 and 6 kgs, to increase LPG affordability. The experiment is ongoing.

FIGURE 46

LPG Uptake as a percent of households in Mozambique (percent of population)



[75] Market participant interviews conducted by authors.
[76] Market participant interviews conducted by authors.
[77] Instituto Nacional de Saúde. 2014, 2018.

Mozambique also experimented with large-scale ethanol fuel and stoves and despite private-sector challenges, a small portion of urban households still use ethanol for cooking. Maputo experimented with a large-scale commercialization of ethanol for cooking. Starting in 2012, CleanStar, an ethanol cooking company, promoted ethanol stoves and fuel as an alternative to charcoal. Ethanol stoves rapidly penetrated the market, driven by 160 ethanol distributors, reaching 34,000 households at its peak. CleanStar also built an ethanol production facility in the city of Beira in central Mozambique using as feedstock cassava sourced from smallholder farmers from the north of the country.

CleanStar discontinued local production in 2013 and ethanol was instead imported from South Africa. While this imported fuel was cheaper, it was also of lower quality, often causing the underperformance and malfunction of canisters and eventually influencing users to switch back to charcoal or LPG. Eventually, CleanStar ceased operations. It is estimated that despite these setbacks, by 2015 there was still a strong ethanol demand from 10,000 households (Gasparatos et al. 2020). As of 2020, this number had likely declined to 2–3,000 households.[78]

BRILHO is supporting a new business initiative entering the Mozambican market, Yazu, which offers an ethanol stove. Garner Advisors in collaboration with the UN has recently started work on reintroducing ethanol cooking in Mozambique. Building on the CleanStar experience, the Garner project aims to exchange old ethanol stoves with new ones imported from South Africa, together with the ethanol itself. Ethanol prices are estimated to be competitive with charcoal in 2021.

Electricity-based cooking exists but remains limited given poor overall access to the central grid and reliability issues in areas where the grid is present. According to the United Nations Development Programme (UNDP), 17 percent of adults in urban areas use electricity to cook, but the number falls to just 2 percent in rural areas (UNDP 2020). However, stakeholder interviews suggest that electric cooking is not widespread due to grid reliability issues and the fact that the grid cannot absorb large scale electric cooking in its current state. Some pilot projects involving the national utility are ongoing.

ACCESS TO TIER 2/TIER 3 COOKING SERVICES

Access to Tier 2/Tier 3 cooking can typically be achieved through ICS using biomass fuels. ICS penetration in Mozambique is largely concentrated in urban areas, where the cost to deploy the stoves is low and the high cost of charcoal makes the value proposition of fuel savings attractive.

FIGURE 47
ICS companies and non-profit organizations in Mozambique[79]

	Est. sales (mkt. share)	Origin	Fuel	Business model
KULIMA	30,000 (20-30%)	Local	Wood, Charcoal	Cash sales
MozCarbon	30,000 (20-30%)	International	Wood, charcoal	Semi-industrial production facility Finances ICS with carbon credit

[79] Source: Market participant interviews conducted by authors, company websites.

AVSI	10,000 (10-20%)	International	Charcoal	Cash sales at subsidized prices
ENVIROFIT SMARTER LIVING	N/A	International	Charcoal	Cash sales Present through local end-to-end assembly partner
Other micro-distributors	30,000 (30%)	Local	Biomass	
Total	**100%**			

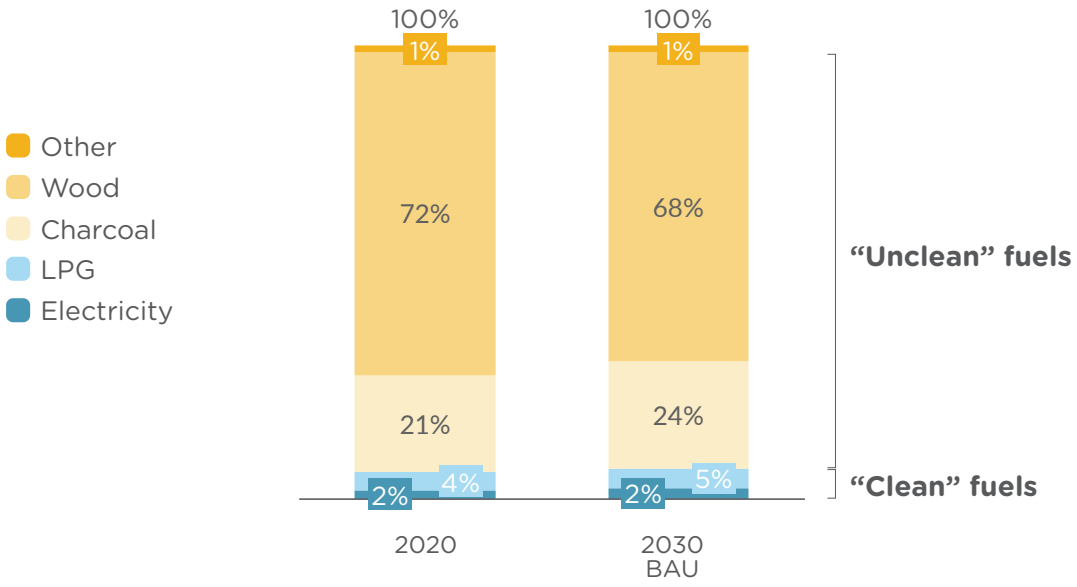
The Mozambique ICS market remains small and driven by non-profit organizations. There are five primary companies, which provide both charcoal and firewood ICS with prices in the USD 5–15 range. Some of these stoves may not meet the Tier 2/Tier 3 access definition. Stakeholder interviews indicate that most private companies continue to rely on RBF mechanisms, including from EnDev and BRILHO. Mozcarbon is the only private organization that has reached scale in Mozambique. With an estimated 30 percent market share, it relies on carbon credit sales to obtain additional finance and lower the cost of stoves. Additional companies with funding from BRILHO include Burn, Pamoja and Yazu, which focuses on ethanol stoves.

Stakeholder interviews suggest that with development partner support, new businesses are entering the market offering higher tier stoves that use different fuels and offer consumer finance. This includes advanced stoves with fan-assisted capabilities (Tier 3). Envirofit for instance is present through a local distributor, but sales are limited given the higher (USD 50) price point of their stoves.

BAU and Universal Clean Cooking Access by 2030

Mozambique is expected to fall well short of universal Tier 4 clean cooking access by 2030 as the transition away from wood and charcoal would take 100 + years at the current pace. In line with historical trends, no meaningful change is expected in the fuel mix in Mozambique by 2030. Overall, this report finds that the share of households using clean fuels as primary fuels will remain stable at about 7 percent. This results in limited progress towards Tier 4 access, as explained in the following section. Progress in Tier 2/ Tier 3 access is also expected to be limited by the scale of the affordability challenge in Mozambique.

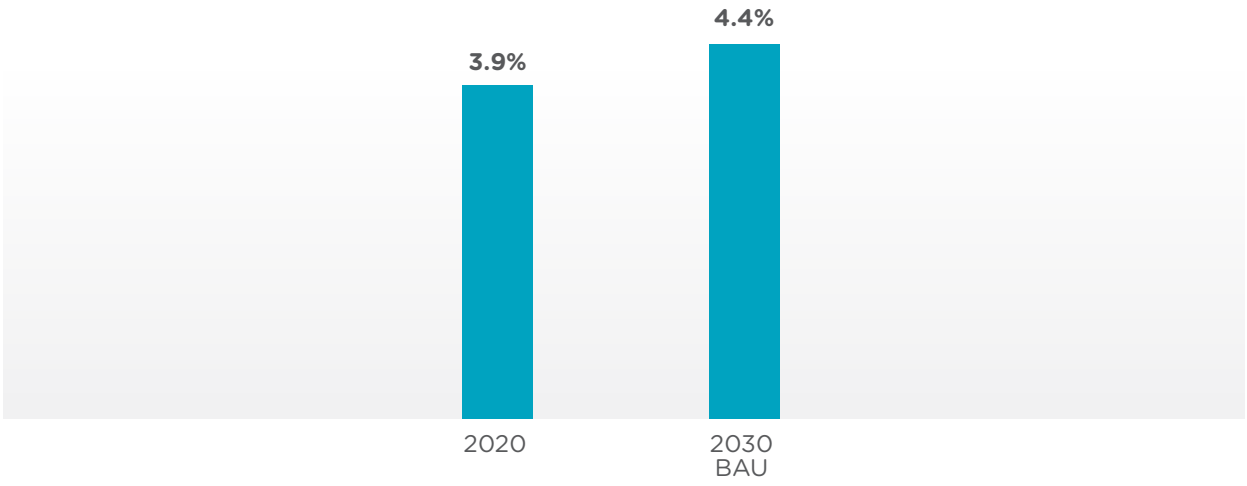
FIGURE 48
Mozambique 2020 and 2030 BAU primary fuel mix (percent of households)[80]



2030 ACCESS TO TIER 4 COOKING SERVICES

Tier 4 cooking is likely to experience low levels of growth in the future in a BAU scenario. In the BAU scenario, the use of clean fuels, primarily LPG, is concentrated among urban households, who have access to LPG infrastructure and services. A new LPG import terminal set to open in 2021 should increase supply. Beyond this ongoing capital investment, no significant additional infrastructure investments have been announced towards clean fuels. The growth of other clean fuels, including ethanol and electricity, is also assumed to be very small, in line with historical trends. This results in a limited increase to Tier 4 cooking from 3.9 percent of the total population in 2020, to 4.4 percent in 2030.

FIGURE 49
Access to Tier 4 cooking as a percent of households in Mozambique (2020,2030e – BAU)



[79] Source: Market participant interviews conducted by authors, company websites.

Although not measured as part of this report, it is acknowledged that it is possible that Tier 4 access levels in 2030 may be higher than described above, because of several projects under consideration, which are described below.

Adding LPG imports in the north of Mozambique could increase LPG uptake in that region. According to a stakeholder interview, if four more filling facilities were built in central and northern Mozambique, with corresponding increases in cylinder inventory, another 600,000 households could convert to using LPG, which is equivalent to a 6 percent increase in access to LPG, although not necessarily a commensurate increase in access to Tier 4 cooking since households may not meet all the criteria associated with Tier 4 access (including access to affordable fuel). The cost of these facilities is not publicly available.

The Government of Mozambique is also exploring a LPG massification project, which was announced in 2020 but has not yet been formalized or received donor backing. Under this massification project, the government would provide subsidies of up to 80 percent of the acquisition cost of the first LPG kit including a cylinder and a stove. With lower upfront costs, LPG uptake could increase, although ongoing fuel subsidies may also be necessary since fuel accounts for the largest share of the cost of switching to cleaner fuels. However, without subsidies, uptake in northern Mozambique is expected to be low given that there is no LPG import terminal and transportation to the north of the country would increase costs.

In addition to the BAU forecast, this report evaluates three scenarios:

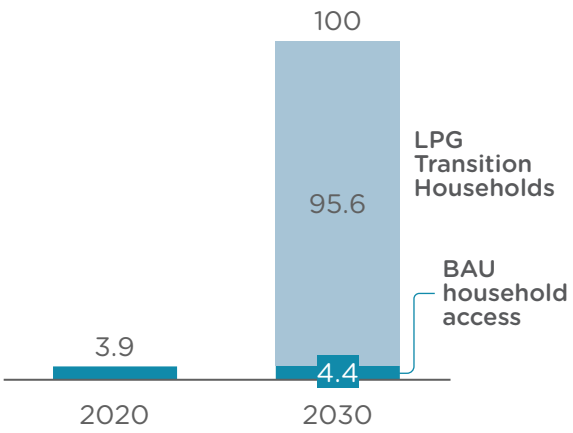
- A universal access to a Tier 4 scenario through a full LPG transition for households without access.
- A universal transition to cooking with ethanol in which all households currently without clean cooking access transition to ethanol-based cooking solutions.
- A universal transition to electric cooking in which all households with grid connection are equipped with induction stoves and achieve Tier 4 access. Households with access to electricity through mini-grids or SHSs are equipped with an electric pressure cooker since induction stoves require high voltage that cannot be provided by mini-grids and SHSs. As a result, this corresponds to a partial-access scenario.

These scenarios are costed in the following section. This report does not provide a perspective on the potential "clean" fuel mix of Mozambique by 2030. Rather, it provides a high-level estimate of the cost associated with a universal transition to clean cooking using LPG, ethanol and electricity.

FIGURE 50
Three additional scenarios reviewed for universal Tier 4 clean cooking access in Mozambique

Scenario 1
Universal LPG Transition

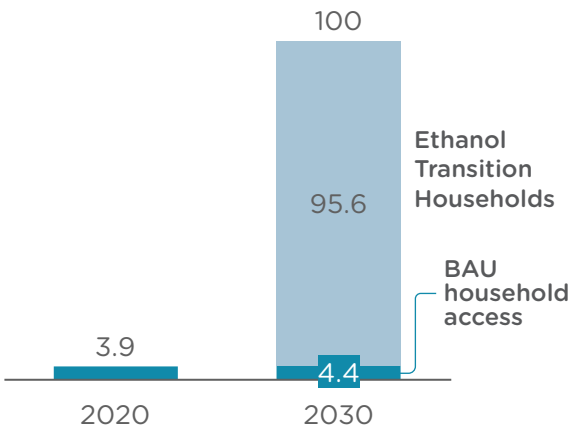
2020 & 2030 Tier 4+ cooking access
% households



- Universal LPG access scenario
- Sizes the financing cost of universal shift to LPG in Mozambique, both in rural and urban areas
- Calculates the cost of shifting all households to LPG stoves, required infrastructure investments, and implied cost of fuel subsidies for 5-10 years

Scenario 2
Universal Ethanol Transition

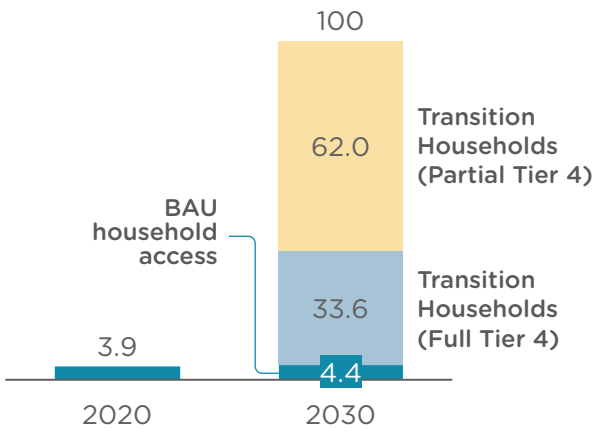
2020 & 2030 Tier 4+ cooking access
% households



- Universal ethanol access scenario
- Sizes the financing cost of universal shift to ethanol in Mozambique, both in rural and urban areas
- Calculates the cost of shifting all households to ethanol stoves, required infrastructure investments, and implied cost of fuel subsidies for 5-10 years

Scenario 3
Universal Electric Cooking Transition

2020 & 2030 Tier 4+ cooking access
% households



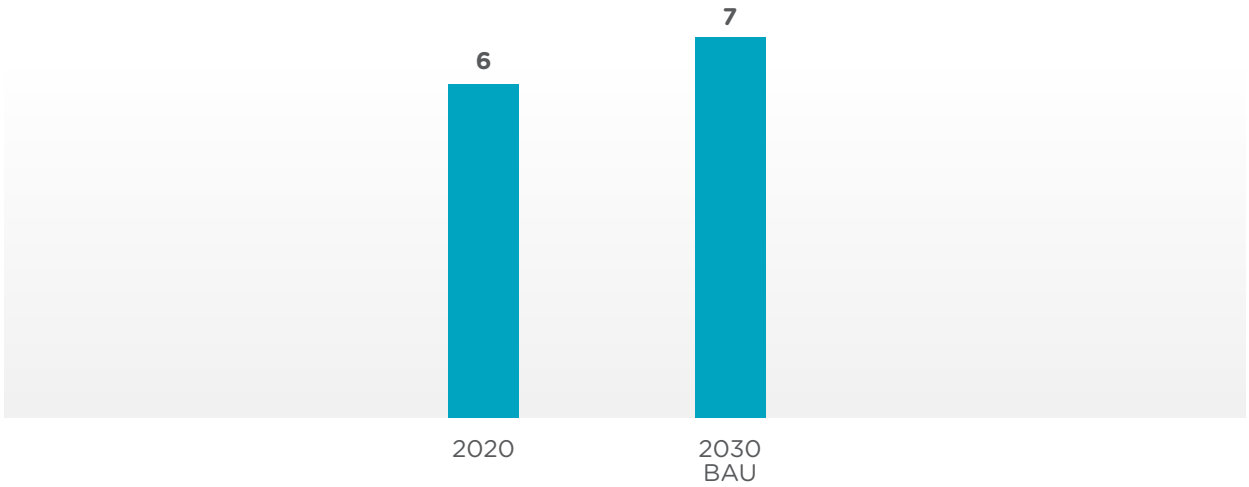
- Universal electric cooking access scenario
- Sizes the transition cost of moving grid households to induction stoves, mini-grid and SHS households to EPCs
- Calculates the cost of shifting households to induction stoves/ EPCs, implied cost of fuel support and additional burden on projected grid production

2030 ACCESS TO TIER 2/TIER 3 COOKING SERVICES

While universal access to Tier 4 cooking should be the standard, accessing Tier 2/Tier 3 where Tier 4 is not feasible represents an alternative, albeit less desirable transition path. This report estimates the cost of Tier 2/Tier 3 access as a 'second best' option.

The share of households with access to Tier 2/Tier 3 cooking in Mozambique is expected to largely stagnate from 6 percent in 2020 to 7 percent in 2030, in line with historical trends (FinMark Trust 2019). Affordability represents a major impediment to the growth of the ICS sector in Mozambique, as explained in the following sections.

FIGURE 51
Percentage of Mozambique households with access to Tier 2/Tier 3 cooking (2020,2030e – BAU)



Financing Universal Clean Cooking Access in Mozambique

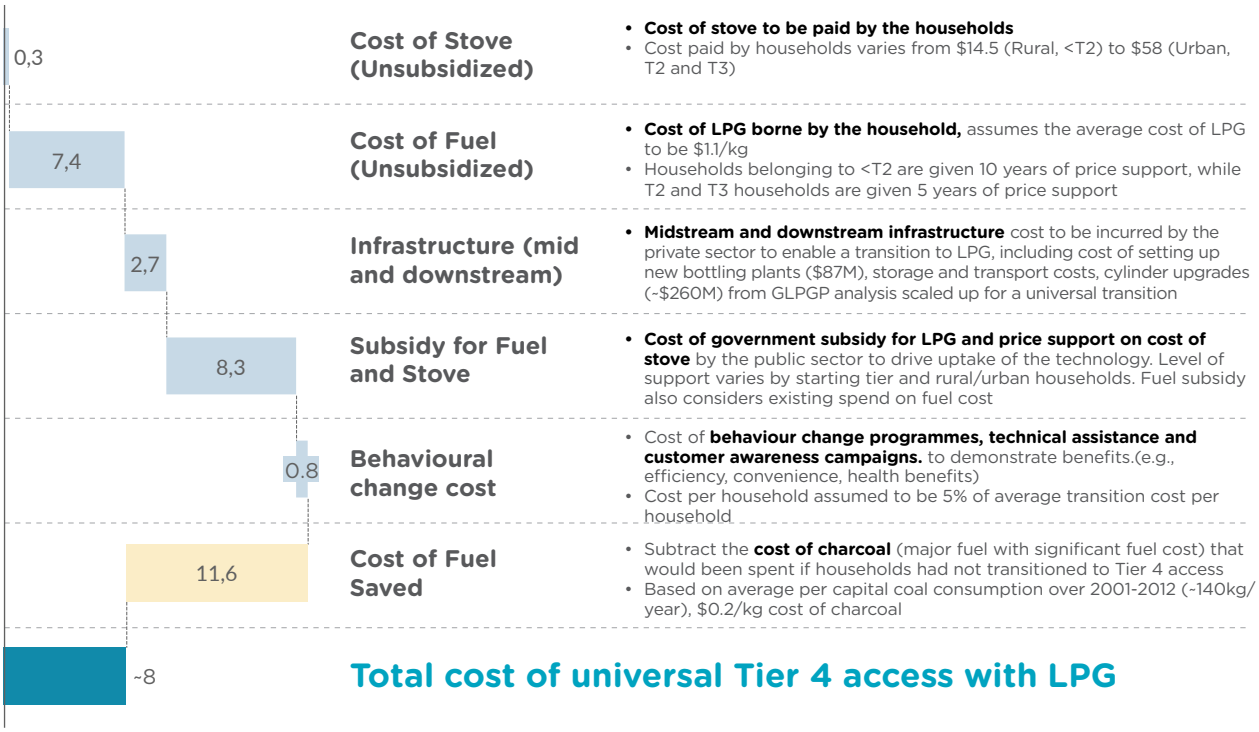
TRANSITION TO TIER 4 COOKING ACCESS

This report finds that the cost of achieving universal Tier 4 access through LPG by 2030 is high at USD 8 billion. This compares with an estimated cost of USD 9–12 billion for a transition to universal access with ethanol, and an estimated USD 3 billion for partial Tier 4 access with electricity. The cost of the electricity scenario is much lower because just 38 percent of the population with access to grid electricity would achieve Tier 4 access, whereas households equipped with mini-grids and SHSs would only be equipped with an electric pressure cooker that would not provide Tier 4 access. These households would be provided with lower-cost stoves (electric pressure cookers instead of induction stoves). SHS-equipped households would also not receive fuel subsidies for clean cooking since there is a cost of "fuel" associated with a solar-power electric pressure cooker. As a result, the cost of clean cooking access with electricity is lower than for other fuels, but it does not provide universal Tier 4 access.

A transition to LPG to enable universal Tier 4 access in Mozambique is costly, given the need to support the transition of approximately 95 percent of households to "clean" fuels. This transition cost includes savings from decreased consumption of charcoal that would otherwise be spent by households if they did not transition to Tier 4 access. Funding such investments may be challenging, given the limited availability of donor finance for LPG (see Case Study 6 in Appendix).

FIGURE 52

Cost of universal Tier 4 clean cooking access with LPG in Mozambique (USD Billion)[81]



As is the case in Ghana and most other countries, the cost of LPG is primarily driven by the cost of fuel and required subsidies for households. The largest cost required for the transition is the ongoing cost of LPG fuel borne by households. Given affordability constraints, the government would likely need to provide a subsidy to cover a significant portion of the fuel and stove cost. The level of support provided to various households could vary, based on households' starting Tier of cooking access and existing expenditure on fuel. Other major cost drivers include the midstream and downstream infrastructure needed to bring LPG to rural areas, including the development of new bottling plants, storage, cylinder upgrades, and behavioural change campaigns. This figure does not include upstream investments, including production or importation.

Similarly, the cost of universal access to Tier 4 clean cooking through ethanol and electricity is also primarily driven by the cost of fuel. As with the LPG calculation, these scenarios estimate that households that currently have Tier 2/Tier 3 access would require a five-year fuel subsidy before they can transition to Tier 4 independently. Households with Tier 1 access or below are estimated to require 10 years of subsidies.[82]

In addition, electric cooking would increase Mozambique's projected 2030 electricity demand by 10 percent. This is lower than in Ghana because fewer households (38 percent compared with 100 percent) would be able to switch to electric cooking and would therefore consume less electricity.

[81] Assumes the average cost of LPG to be USD 0.99/kg, households belonging to <Tier 2 are given 10 years of price support, while Tier 2 and Tier 3 households are given five years of price support. Calculations based on average per capita charcoal consumption (900kg/year) with a cost of charcoal of USD 0.31/kg.

[82] This report assumes that 10 years are required to achieve full displacement of basic cooking technologies and practices, in line with prior reports on this topic, including: Energy Sector Management Assistance Program (ESMAP) 2020 The State of Access to Modern Energy Cooking Services.

TIER 2/TIER 3 COOKING ACCESS

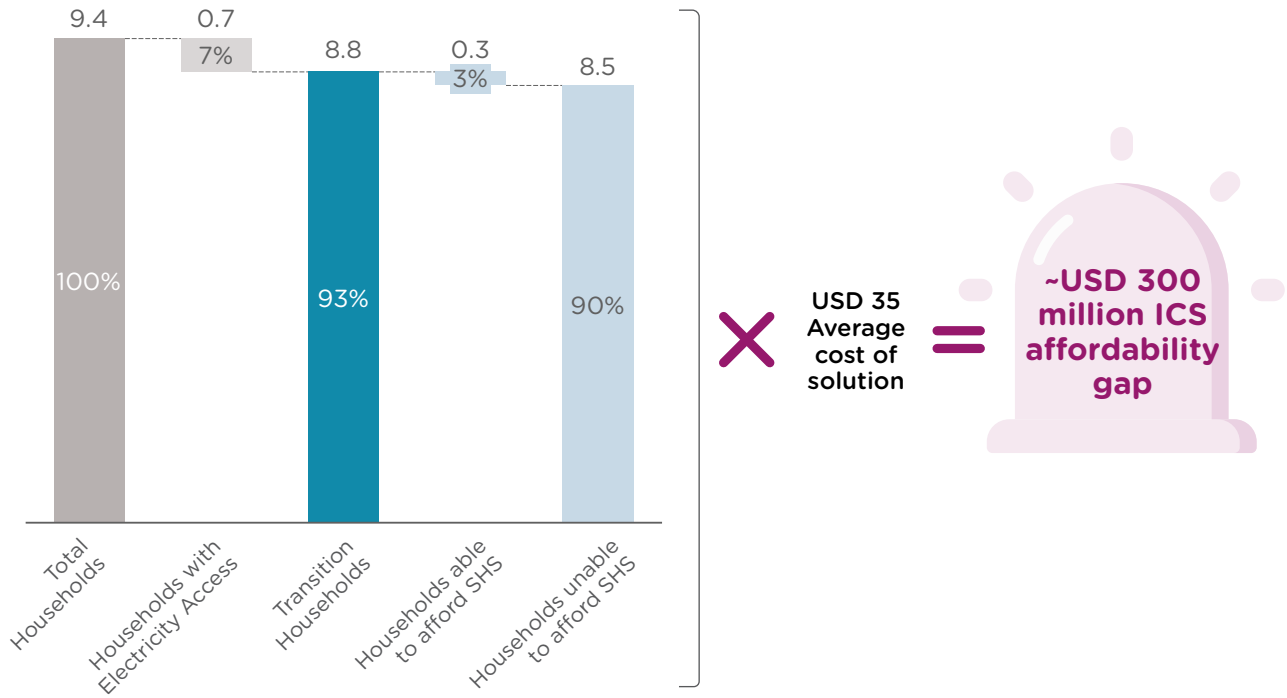
While universal access to Tier 4 cooking should be the standard, accessing Tier 2/Tier 3 where Tier 4 is not feasible represents an alternative transition path. This report estimates the cost of Tier 2/Tier 3 access as a 'second best' option.

ICS are a viable solution to extend clean cooking to households that are unlikely to be reached by LPG, but 90 percent of households are unable to afford them. ICS must be purchased in cash due to a lack of available consumer finance solutions. PAYG models are not offered in Mozambique because of the lack of mechanisms to ensure customer repayments. This report assumes that households would purchase an ICS by saving 4 percent of their overall household consumption expenditure for three months. Purchasing decisions are mostly based on an understanding of the potential fuel cost savings; studies found that customers are less motivated by health benefits or emission reduction (SNV 2020). This suggests the need for consumer-awareness and behavioural-change programmes to facilitate the sustained adoption of ICS.

AFFORDABILITY GAP

The Tier 2/Tier 3 affordability challenge represents a USD 300 million gap to reach all households using ICS.[83] An improved Tier 2/Tier 3 charcoal stove on average costs up to USD 35 in Mozambique, with advanced stoves from international companies costing up to USD 50.

FIGURE 53
Mozambique ICS affordability gap calculation (2030 households USD million)



[83] Note that the model calculates the financing cost of only one stove per household given that further replacements can be financed through on-going fuel savings.

ENTERPRISE FINANCE

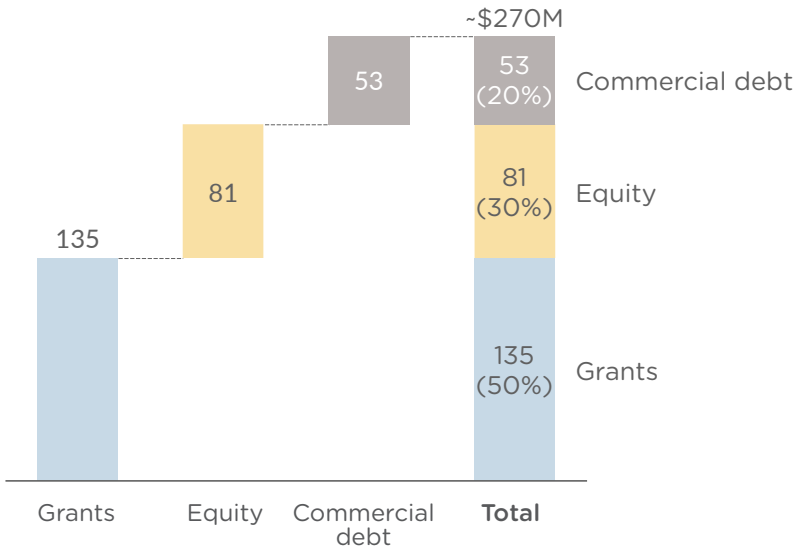
This section focuses on universal Tier 2/Tier 3 access; enterprise finance needs are only calculated for this scenario.

Scaling ICS requires USD 270 million to support the private sector, with 70 percent in the form of debt and grants. To date, the ICS market is made up of small local producers. By 2030, the growth of the ICS sector will have generated larger, more mature companies; these will provide 40 percent of ICS stoves. These companies require significant commercial debt to finance their working capital needs, including scaling production and distribution. A large portion of consumer demand will be serviced by companies in the start-up stage and will account for 60 percent of total sales, relying heavily on grant funding.

According to private-sector market participants interviewed, grants must remain a core source of funding for many clean cooking companies until 2030. Mozambique's private ICS sector remains small and grant dependent. As private enterprises expand, they are expected to increasingly be able to leverage debt, equity and carbon finance as sources of funds. Currently, local debt is not readily available or only at very high cost. Local institutions are mostly unwilling to lend to enterprises focused on low-cost clean cooking solutions. Where debt is available, interest rates for loans from private banks and multilateral financial institutions (MFIs) in Mozambique are around 30 percent, making debt prohibitively expensive for most clean cooking enterprises. Accessing lower cost international finance is a challenge given currency volatility. However, as ICS manufacturers scale, they are expected to generate higher margins, and rely on profits to finance expansion. As margins improve, the availability of commercial finance is also expected to increase.

Access to grant funding, which may be substantial, is expected to be limited to a strict number of uses. Grants are most likely to be secured to catalyze public goods and pay down the cost and risks of infrastructure investments. These public goods include quality testing and certification, establishing carbon finance verification, and above the line consumer-awareness campaigns – though other grant uses could include deploying systems, building sales networks or buying vehicles. RBF could be provided to attract private companies to regions where they would not otherwise go quickly enough.

FIGURE 54
Mozambique Tier 2/Tier 3 clean cooking enterprise finance needs (USD million)



Carbon finance is an attractive option for clean cooking, but only larger, more mature companies can currently access it. In Mozambique, only Mozcarbon and AVSI have leveraged international carbon finance to date.[84] Carbon credits can provide a steady income flow for ICS enterprises, as they can generate one to two tons of carbon emissions reduction per stove sold, depending on the efficiency of the stove. However, securing carbon finance is an onerous process, requiring the verification of each stove to an individual customer, and therefore requires significant scale. It is challenging for smaller ICS providers to qualify for carbon trading, based on existing carbon market certification requirements. Additionally, increasing concerns about the integrity of offsets may present more complex and detailed monitoring requirements to access carbon finance. Overall, this remains an untapped source of finance for clean cooking solutions in Mozambique and one that can be explored further.

Key Finance Opportunities and Solutions

Appropriate financing tools are needed to address these challenges. New tools could be designed and piloted – specifically to address affordability gap and last-mile delivery challenges, as summarized in Figure 55.

To address consumer affordability challenges, development partners could provide demand-side subsidies. As explained above, customer affordability is a key issue. Given limited market penetration to date, demand-side interventions should be considered to expand the existing customer base, including cash subsidies or voucher systems. This is precisely what the Government of Mozambique's LPG massification plan is looking to achieve. These subsidies could be linked to entry-level products sold by existing major market providers, as was the case for the CIZO programme in Togo (see Case Study 3 in Appendix).

To address consumer affordability challenges, development partners could also support the rollout of more PAYG models for LPG and develop consumer finance options for ICS users, as well as support the development of a profitable model for LPG companies based on smaller cylinders. PAYG LPG reduces the cost paid by a consumer, making LPG purchases far more affordable on a monthly basis, although consumer cost per month is generally higher with PAYG than with conventionally distributed LPG, for the same amount of LPG used, given the cost of finance.[85] This model requires working capital debt to finance LPG companies that front the full cylinder cost. ICS providers, on the other hand, are unable to provide PAYG schemes but can partner with local consumer finance institutions to offer systems on credit. Development partners should focus on new risk-sharing mechanisms to help unlock more finance for these purposes. Additionally, smaller cylinders would increase affordability for households but may not be profitable for LPG distributors given the fixed costs associated with filling no matter the size of the cylinder, and the price restrictions on LPG in Mozambique. Exploring ways to create a profitable, small-cylinder market for LPG retailers would significantly increase demand and reduce affordability challenges.

To address last-mile delivery challenges, RBF mechanisms could be explored. Development partners could explore replicating the SNV clean cookstove RBF mechanisms implemented in Ghana and Vietnam with specific geographic targeting to areas with the highest need. Key success factors would require, among other things, the availability of a network of individuals to support verification of emissions reduction.[86]

To address insufficient private sector funds, development partners could explore supply-side subsidies. RBF facilities have shown promise as supply-side subsidies to help enterprises address the increased cost of operations due

[84] Market participant interviews conducted by authors.
[85] Total cost is likely higher driven by the cost of operations and of the smart meter.
[86] An upcoming MECS report will likely shed more light on the topic. MECS. Results-based financing for modern energy cooking solutions: An effective driver for innovation at scale 2021.

to challenging local conditions. These facilities have attracted new clean cooking companies to Mozambique, despite challenging operating conditions. However, committed finance to date falls short of the USD 135 million total grant finance needed to achieve universal Tier 2/Tier 3 access to clean cooking. Scaling these facilities through increased commitments and improved donor coordination would be key to finance the growing sector. [87]

To address insufficient funds, development partners could also explore new grant, debt and equity funding on concessional terms. Many donor programmes (e.g., EnDev, BRILHO) include clean cooking under the broader umbrella of energy access, limiting the funds available specifically for clean cooking. Increasing the size of dedicated funds for clean cooking could be effective in further promoting the sector. Supporting local and international financing institutions with financial instruments such as guarantees, first loss schemes or hedging instruments could increase the flow of capital into this market. This can be coupled with increased technical assistance to local financial institutions to understand the energy market in Mozambique. Market uncertainty and an unstable political environment remain key challenges in the market, hindering the availability of local commercial debt.

Finally, to address insufficient funding, development partners could explore mechanisms to aggregate carbon credits from small manufacturers to generate carbon finance in volumes they are unlikely to secure on their own. Verification and pooling of credits are time consuming and expensive for newer companies. Small companies typically lack the scale to generate enough carbon credits to attract carbon investors. Supporting smaller companies by pooling carbon credits on their behalf could expand financing sources. Additionally, development partners could explore lending against future carbon finance proceeds to provide funds to private companies more quickly.

[87] Market participant interviews conducted by authors.

FIGURE 55

Recommended instruments to address Mozambique's cooking challenges

Audience	Challenge	Recommendation
Government	**Clean cooking strategy**	Incorporate into national clean cooking strategy pathway for "clean" fuels beyond LPG and support ICS sector growth with clear guidelines.
Development Partners and Government	**Low customer affordability**	Demand-side subsidies of up to USD 300 million.
	Difficult last-mile distribution	Once private market matures and customer base has expanded, RBF mechanisms can incentivize expansion in harder to reach areas.
	Insufficient funds	Additional support to the private sector through grants, debt and equity of USD 270 million. Carbon credits expansion for private sector financing. Carbon credits pooling from small manufacturers.
Investors	**Customer affordability**	R&D funding for more efficient ICS stoves sold at a similar cost based on future carbon financing to increase consumer willingness to pay. PAYG expansion for clean fuels, consumer finance options for ICS.
	Insufficient funds	Additional support to the private sector through grants, debt and equity.
All	**Gender imbalance**	Expansion of financing for women-led businesses. Inclusive work policies, programmes and people-centred design that promote women participation in the energy sector.

CHAPTER

4

TAKING THE PULSE OF CLEAN COOKING IN VIETNAM

The Vietnam chapter is focused on clean cooking only given that the country has reached universal electricity access.

KEY MESSAGES
The Cost of Universal Clean Cooking Access in Vietnam

Compared to the other focus countries, Vietnam has made significant progress in access to clean cooking, primarily driven by growth in LPG usage and electric cooking. This report estimates that less than 43 percent of the population had access to Tier 4 clean cooking and 69 percent had access to Tier 2 /Tier 3 clean cooking in 2020. Under a BAU scenario, access to clean cooking will continue to increase until 2030 both in terms of Tier 2/Tier 3 (79 percent estimated access by 2030) and Tier 4 (51 percent access by 2030).

Gender dynamics in Vietnam are different from the other focus countries. Vietnam leads the Asia-Pacific region on several gender equality indicators (e.g., economic participation, involvement in household decision-making). However, some gender inequalities continue to persist including issues of vulnerability and the wage gap.

Universal Tier 4 access will cost USD 19–22 billion cost, which is higher than in Ghana and Mozambique. This is largely due to the cost of fuel and stoves (USD 18.5 billion), driven by the larger number of households that still need to transition. While the percentage of transition households in Vietnam is lower than in the other focus countries, in absolute numbers there are more households in Vietnam as the population is three times higher.

Universal Tier 2 /Tier 3 access to improved cookstoves (ICS) requires a much smaller amount of USD 185 million. This is driven by the consumer affordability gap of USD 40 million and private sector finance needs of USD 145 million. Donor and private finance have remained low in Vietnam, partially driven by achieving universal electricity access and reaching middle-income status. Stakeholder interviews also suggest that commercial debt is unobtainable by ICS enterprises, due to their small size and perceived risk. As a result, some level of grant finance is required to help the private sector scale by 2030. Carbon finance also represents a significant source of funds that could finance clean cooking expansion in Vietnam, but few enterprises have managed to benefit from this scheme due to difficulties with the limited scale of ICS companies

Beyond funding, it will be critical to resolve additional end-user barriers. This includes awareness campaigns and technical assistance for reaching ethnic minorities and isolated groups as well as exploring additional clean fuel technologies.

Sector Context

Vietnam's move to a market economy from one that was centrally planned has transformed it from one of the poorest countries in the world to a lower middle-income country that has one of the most dynamic emerging economies in the East Asia region (World Bank). With a population of 97 million (World Bank), Vietnam has a significant opportunity to further energy access goals, particularly in clean cooking.

While there are currently no government policies geared towards clean fuels, past government policies and large-scale support around ICS and clean cooking have pushed households to clean cooking solutions. Development partners have been key implementers of ICS programmes, as summarized in Figure 56.

Overall, there appears to be no single point of responsibility within the government for ICS programmes. This suggests a lack of policy prioritization, which can translate to stakeholders as lack of political will. The Institute of Energy under the Ministry of Industry and Trade has been running ICS biogas programmes with the Vietnam Women's Union since the 1990s. These programmes are focused on improving ICS technology and performance. The Ministry of Agriculture and Rural Development has also been engaged with cookstove projects in the past.

In terms of LPG support, historically Vietnam provided high levels of direct and indirect subsidies for fossil fuels that encouraged the use of these fuels as a primary source of energy consumption – though residential use was likely not a prime motivator. Government support for LPG was provided under the form of LPG price stabilization. However, the government has significantly reduced these subsidies to encourage uptake of renewable energy sources. While this was not targeted at LPG for cooking, it likely had an indirect impact. From USD 4.3 billion in 2011, fossil fuel subsidies declined to USD 1.1 billion in 2014 and USD 271 million in 2020 (IEA). Additional research on the policies and subsidies that led to the rapid adoption of LPG and a decline in charcoal consumption would be helpful to further understand the drivers of change in Vietnam.

Understanding the Landscape 2021 tracks total finance commitments in Vietnam for clean cooking at USD 7.3 million for the period 2013–2019 (SEforALL 2021). However, this report estimates USD 145 million in private financing is required to achieve Tier 2/Tier 3 universal access by 2030.

FIGURE 56
Key programmes financing clean cooking in Vietnam

Provider	Key Programmes
SNV / EnDev	• Vietnam Biogas Programme (2003-2017) to explore biogas technologies and develop a commercially viable biogas sector • Market Acceleration of Advanced Clean Cookstoves in the Greater Mekong Sub-region (ICS), results-based scheme for new supply chain actors
Care International Vietnam / Global Cookstove Alliance Women's Empowerment fund	• Grant facility that provides funding and capacity building to enterprises to increase the participation of women in businesses • Technology assistance and market access support to local enterprises

A robust regulatory framework can effectively support private-sector entry into LPG for cooking. There have been limited government-led initiatives to promote LPG for residential use. Growth has primarily been driven by fuel companies and private-sector distributors. Yet a robust LPG regulatory framework exists. A 2018 decree opened the sector to more private competition by loosening existing regulations that had set out certain minimum requirements on size, ownership of facilities and distribution networks. For instance, a rule requiring distributors to have at least 100,000 gas canisters was eliminated.[88] Per industry best practices, stakeholder interviews suggest that relaxing these rules is appropriate in a relatively mature market such as Vietnam's.

Gender norms in Vietnam are different from the other focus countries. It leads the Asia-Pacific region on several gender equality indicators and has one of the highest economic participation rates for women in the world with 82 percent of men and 72 percent of women aged above fifteen working.[89] On average, Vietnam performs well in terms of delivering education and health services to women. School enrollment data show little difference between boys and girls and the gap between male and female literacy rates has been decreasing over time.

However, some gender inequalities continue to persist. Issues include the vulnerability of female-headed households to poverty and women working longer hours than men and for less pay. The situation of ethnic minority women is also stark. Members of ethnic minority groups make up 15 percent of the country's population but account for 70 percent of the extreme poor.[90]

According to interviews, women tend to be more involved in household energy decision-making in Vietnam than in other countries. In the ICS sector, stakeholder interviews also suggest higher women's participation; one ICS manufacturer mentioned that 85 percent of sales agents are women and that 70 percent of the time, buyers are women. Circumstantial evidence suggests that women-centric sales strategies where female agents promote ICS directly to other women can be successful in increasing women's participation as customers in the clean cooking sector in Vietnam.

The Vietnam Women's Union is one of the organizations that has been successful in increasing the presence of women in the energy sector. Originally founded in 1930, its goal is to defend the rights of women. With 17 million members as of 2019,[91] it is present across the country through over 10,000 local unions. It partners with international organizations including SNV in energy, and Women for Water and Thrive Networks/East Meets West in sanitation and hygiene campaigns. The Vietnam Women's Union has also contributed to the advancement of clean cooking in Vietnam with close to 30,000 cookstoves distributed in the northern region where it has served as a verification partner for development organizations.[92]

SPECIFIC FEATURES OF THE VIETNAM MARKET

The Vietnam clean cooking market has distinct features from the other focus countries:

- **Higher penetration and affordability for ICS:** As a percentage of the population, a higher share of households can afford ICS (95 percent) due to Vietnam's middle-income country status and overall higher consumer expenditure.

- **Difficulties in reaching ethnic minorities:** Ethnic minorities tend to be more geographically-isolated groups and providing them with access to clean cooking solutions requires additional costs including translation, awareness campaigns etc., increasing the cost of distribution.

[88] NTilleke & Gibbins. 2018. New Decree May Open Up LPG Business in Vietnam.
[89] World Bank. 2019. Gender-based labour participation.
[90] World Bank. 2013. Why is ethnic minority poverty persistent in Vietnam?
[91] Heart. 2019. Celebrating gender transformative water, sanitation and hygiene in Vietnam.
[92] SNV. 2012. ACCS in Greater Mekong Sub-regions.

- **Limited carbon finance availability:** The ICS sector in Vietnam remains too small to attract international carbon finance, compared to Ghana and Mozambique where some local companies can sell their credits.

- **More mature LPG market:** LPG infrastructure including distribution, bottling etc. is more advanced that in the other focus countries. There is an active private sector involved in LPG distribution. As a result, the cost of additional LPG infrastructure required on a per household basis is lower than it is in the other focus countries.

- **Universal electricity access:** Vietnam has achieved universal electricity access, making access to universal electric cooking a plausible scenario.

Current State of Clean Cooking Access

FIGURE 57
BAU and universal access scenarios for clean cooking in Vietnam[93]

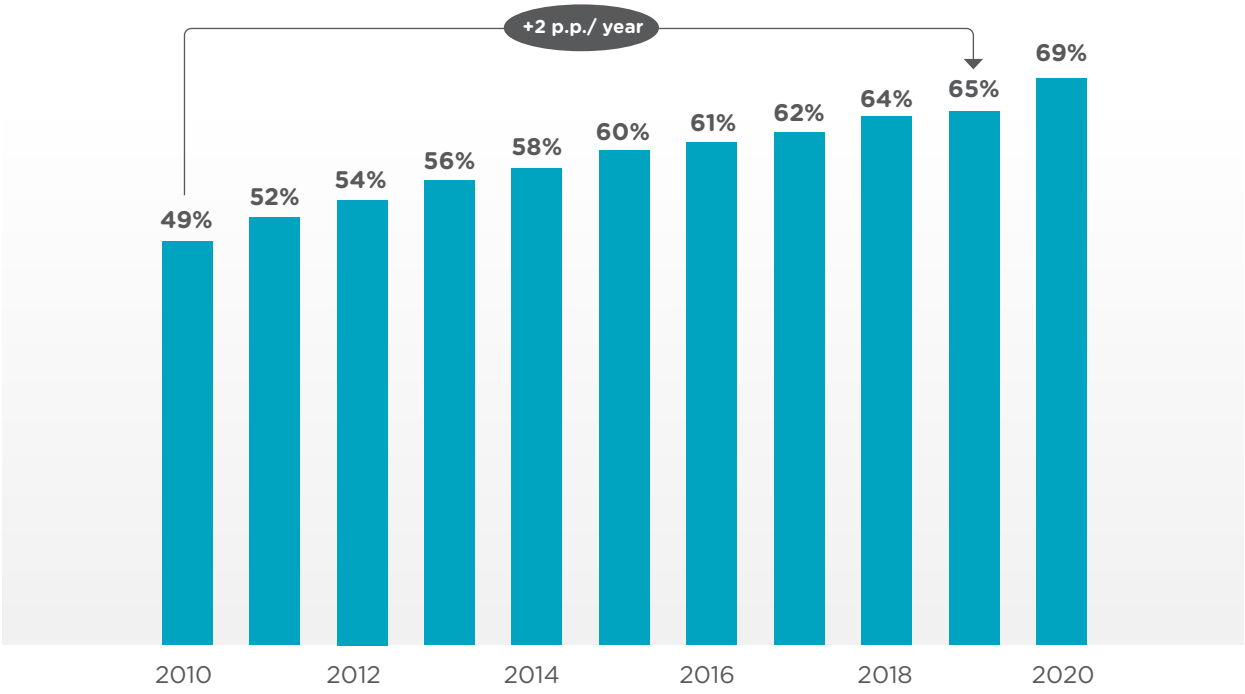
		Vietnam		
		2020	2030 BAU	2030 Universal Access
Population (in millions)	Population	97	104	
	Households	26	28	
Access to clean cooking (% of households)	Tier 2 access	69%	79%	100%
	Tier 4 access	43%	51%	100%

Clean cooking access in Vietnam has primarily been driven by a shift from wood fuel to LPG. In 1992, 43 percent of the population relied on charcoal. This share fell to just one percent by 2016 (Scott 2020). Vietnam introduced LPG cooking in the 1990s and the government has since invested in its production and distribution (Accenture 2012). Despite this domestic production, as of 2018, approximately 55 percent of LPG consumption domestically was imported (Vietnam Plus 2018).

Access to clean cooking solutions steadily increased to 69 percent by 2020, driven primarily by growth in LPG uptake and electric rice cooker usage. LPG usage is expected to continue to increase significantly in the lowlands where access is easy and incomes are higher. Achieving Vietnam's transition to clean cooking will require extending access to remote, mountainous areas that face hardware access and affordability barriers and continue to rely on biomass.

[93] World Bank World Development Indicators for population and household estimates. Author's calculation for access estimates.

FIGURE 58
Historical access to clean cooking in Vietnam (percent of population)[94]



Similar to other countries globally, households in Vietnam commonly practice fuel stacking, using different fuels for different cooking tasks. Additionally, interviews suggest that it is common for rural and peri-urban households to raise animals and pigs and to cook animal feed for them. This type of cooking tends to be done on wood-burning iron bar stoves.

FIGURE 59
Cooking technology use across Vietnamese households (percent of population)[95]

	% households owning technology	Key usages	Advantes	Disadvantages
LPG	70%	Higher income, urban households: used for majority of cooking needs In lower income or rural households, used for quick cooking tasks e.g., frying an egg	Quick cooking Easy to clean kitchen and pan Comfortable and easy cooking Easy to turn on and adjust heat	Perception of high fuel cost Proximity to refueling point an issue for some households

[94] Tracking SDG7 2021. Note that access to clean cooking as measured historically does not fully align with the MECS definition of access introduced later in this section. 2020 data extrapolated based on local stakeholders' perspectives.
[95] Market participant interviews conducted by authors.

Electric cooker 	85%	Primarily appliances for rice cooking Some availability of broader electric cookstoves (e.g., induction) but only for higher income market	Quick cooking Easy to clean kitchen and pans Comfortable and easy cooking Easy to turn on and adjust heat Takes advantage of electricity subsidy	Low affordability (except low-cost rice cookers)
Biomass (wood) 	30%	Longer cooking tasks (e.g., simmering) Preparation of animal feed, particularly pig feed for small or subsistence pig farmers (<50-60 pigs)	Fuel is cheap or can be self collected Can be used for different types of low cost cookstoves (e.g., iron bar) Traditional and familiar	Smoky, esp. in raining season Time consuming and hard to collect and cook Deforestation making fuel more expensive and of worse quality
Biogas / Other 	2%	Agricultural households with biodigesters: used for lighting and cooking	Low (no) cost Easy to clean kitchen and pans Comfortable and easy cooking Quick cooking	Not applicable for those who do not raise pigs and cattle May produce uncomfortable smell

Three primary challenges are slowing Vietnam's progress towards universal transition to Tier 4 and Tier 2/Tier 3 cooking.

- **Insufficient ICS private-sector finance and access to carbon finance:** The ICS private sector in Vietnam remains small, with few companies able to sell stoves at scale. These companies are unable to expand due to the lack of availability of finance, both commercial and concessional, given the lack of appetite of local banks, and limited donor support for clean cooking. Understanding the Landscape 2021 tracks total finance commitments in Vietnam for clean cooking at USD 7.3 million for the period 2013–2019 (SEforALL 2021). However, this report estimates USD 145 million in private financing is required to achieve Tier 2/Tier 3 universal access by 2030. These companies are also unable to access carbon finance because of the limited number of stoves sold and monitored.

- **Few private ICS companies:** With the end of donor programmes supporting the ICS market, few private-sector companies have been able to maintain their activities. As a result, there are few companies focused on ICS distribution.

- **Difficult last-mile distribution:** Developing LPG transport and bottling infrastructure for rural areas is highly challenging and requires significant infrastructure investment. Reaching ethnic minorities that typically live in more remote areas and are typically more isolated

also requires additional efforts e.g., translation, awareness campaigns etc. which increases the cost of clean fuel distribution.

- **Low ICS consumer affordability in select hard-to-reach areas; low "clean" fuel consumer affordability:** LPG and other clean fuels remain too expensive for low- income households. In the ICS sector, there are limited affordability challenges for less than 5 percent of the population, yet this represents approximately 1.3 million households unable to afford ICS stoves.

The impact of Covid-19 in Vietnam was less pronounced on its economy than in the other focus countries. Vietnam's response to the pandemic was effective, driven by a proactive containment strategy based on comprehensive testing, tracing and quarantining. The country's annual GDP growth slowed in 2021 to 3 percent, compared to 7 percent on average over the past five years. In response to Covid, the government reduced electricity prices by 10 percent (Vn Express 2020). ICS sales in Vietnam are linked to crop sales and are therefore seasonal, and a two-week nationwide lockdown in April 2020 prevented the sale of cookstoves. The peak of the pandemic coincided with the busy sales season, resulting in a decline in sales of some ICS producers of up to 70 to 80 percent. This was due to lack of demand and short-term value chain disruptions including staff shortages.[96] Stakeholder interviews indicated that small ICS manufacturers with no grant or debt funding were negatively impacted by the restrictions and will emerge from the pandemic considerably weaker. This may negatively impact the growth of the ICS sector in the short-term, although no long-term impact is anticipated (IMF 2021).

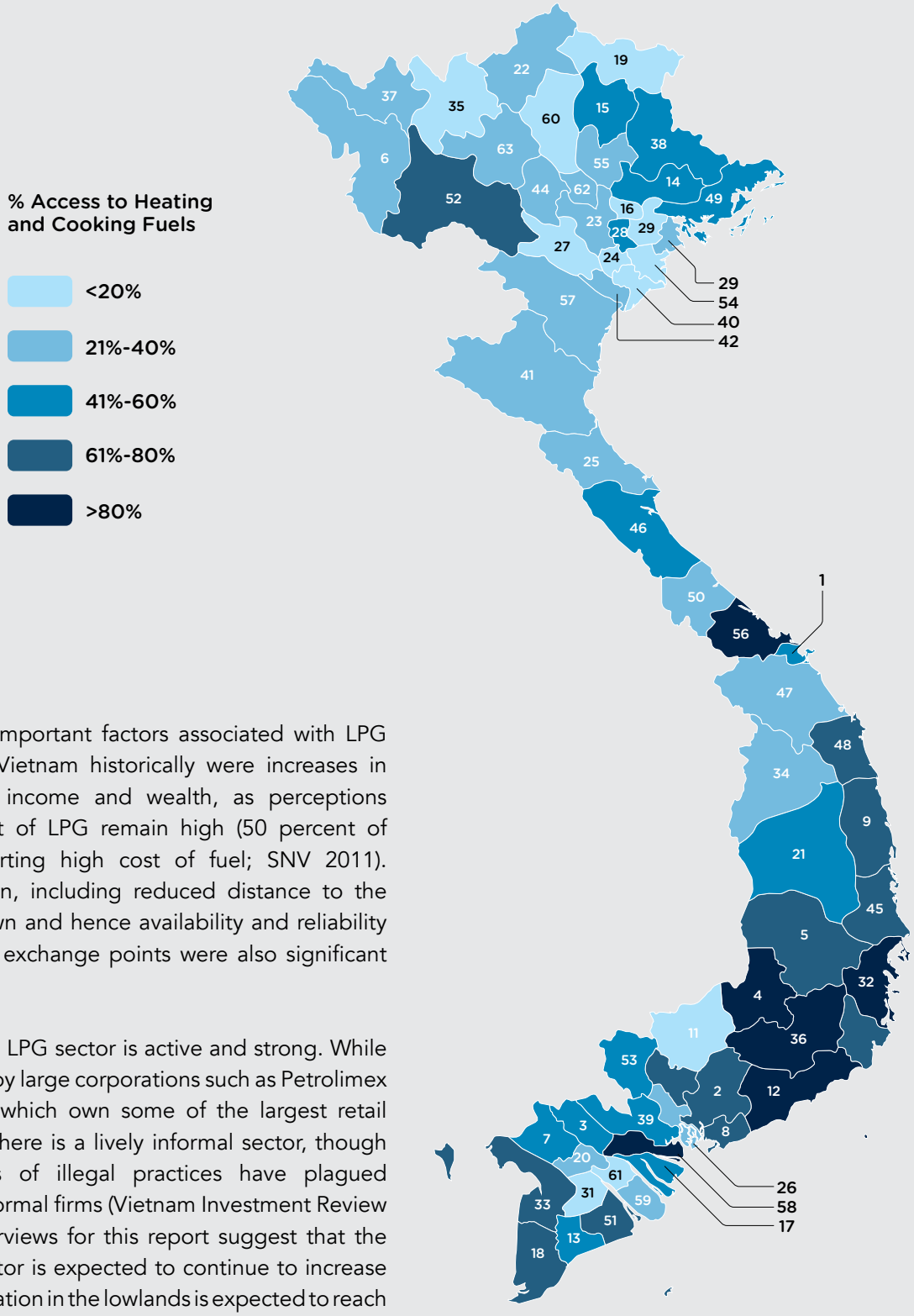
ACCESS TO CLEAN COOKING FUELS

LPG fuel usage is highest in urban areas. **With growing urbanization, an increasing number of households have access to LPG, decreasing their cooking time with wood.** LPG access remains uneven across Vietnam and geography is an important factor. Access is as high as 90 percent in the lowland regions, where distribution is easy and incomes are higher. In northern, mountainous provinces distribution is more difficult and costly, and access can be as low as 15 percent (Scott 2020). Finally, LPG remains expensive for lower-income households which limits uptake in rural areas.

[96] Market participant interviews conducted by authors.

FIGURE 60

Access to cooking fuels by provinces in Vietnam 2020[97]

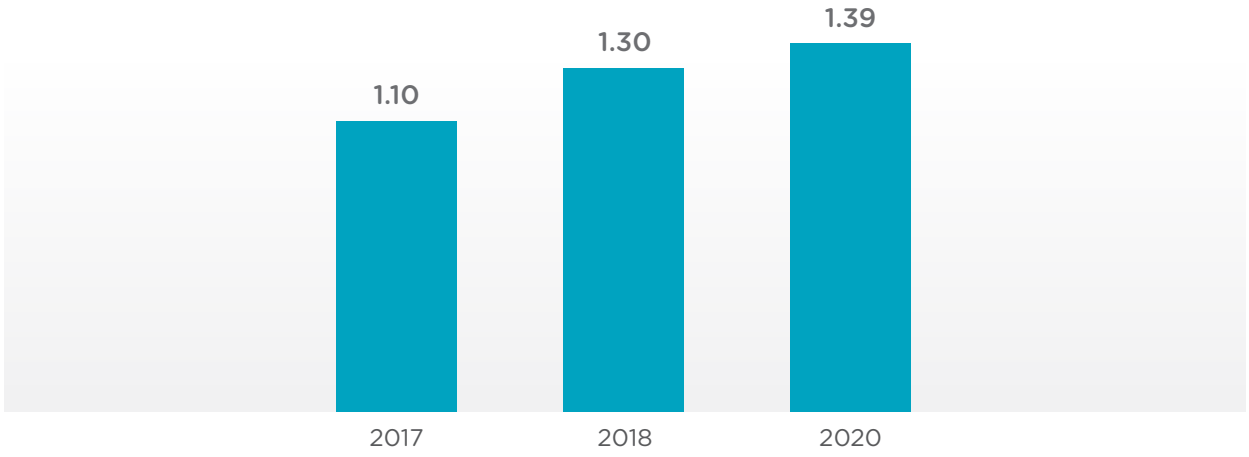


The most important factors associated with LPG uptake in Vietnam historically were increases in household income and wealth, as perceptions of the cost of LPG remain high (50 percent of users reporting high cost of fuel; SNV 2011). Urbanization, including reduced distance to the nearest town and hence availability and reliability of cylinder exchange points were also significant drivers.

The private LPG sector is active and strong. While it is driven by large corporations such as Petrolimex and Total, which own some of the largest retail networks, there is a lively informal sector, though accusations of illegal practices have plagued smaller, informal firms (Vietnam Investment Review 2018). Interviews for this report suggest that the private sector is expected to continue to increase and penetration in the lowlands is expected to reach close to 100 percent, which would translate into approximately 80 percent of the total population. However, more challenges are expected in ethnic minority areas that require additional support – for instance, translation and awareness campaigns in local dialects. LPG affordability has however been limited by increases in prices since 2017.

[97] Asian Institute of Technology 2021.

FIGURE 61
LPG prices in Vietnam, 2017-2020 (USD per kg)[98]



Given Vietnam's income status, pay-as-you-go (PAYG) models have been less of a consideration in LPG adoption than they have in other lower income countries, yet there is an interest in adopting such models. PayGo Energy, for example, plans on piloting a PAYG model in Vietnam in partnership with Saisan, a Japanese gas distribution company with a presence in Vietnam. The pilot goal is to drive down LPG fuel transaction size, which may lead to increased consumption or increased switching to LPG among the poor (WLPGA 2020).

Feed for animals is typically prepared in large pots of 60 to 70 centimetres. Market participants suggest that LPG or electric stoves of this size are not currently commercially available in Vietnam. However, they could be developed with adequate research and development (R&D). If such stoves are designed, experts believe households would likely switch given that obtaining firewood is an issue in Vietnam. It is only available for some part of the year and difficult to obtain at times. Additionally, while, until recently, 80 percent of pig meat production came from small farmers owning less than 50 pigs, continued urbanization is expected to gradually reduce small farmer animal raising and reduce demand for biomass.

Electric rice cookers are found in 85 percent of households. Electric rice cookers are widely available at prices as low as USD 5. Stakeholder interviews indicate that rice cookers are among the first household purchases made when electricity access is provided. Rice cookers are however often used as a complement to biomass or LPG stoves. Some market participants expect electric cooking to increase significantly in Vietnam. Cash transfers to poor households for electricity consumption, which were introduced in 2011 and have covered the cost of 30 kWh of monthly use since 2014, make electric cooking more affordable for lower-income households (see Case Study 7 in Appendix).

Biogas is emerging but remains a niche solution. A SNV programme trained local masons to develop biodigesters and install 250,000 of these amongst livestock farmers and areas with large amounts of manure (see Case Study 8 in Appendix). Stakeholders do not expect a meaningful increase in biogas given that it is only well-suited for specific areas. *Energizing Finance: Understanding the Landscape 2021* also provides an in-depth look at biogas stoves in Vietnam.

Other biofuels including ethanol are still in an early stage of development and are primarily used in the transportation industry. The Government of Vietnam launched a national programme for biofuel development as part of its Strategy for Biofuel Development in 2007. Its

[98] Market participant interviews conducted by authors and press reports.

Vision 2025 aims to improve biofuel technology to improve production standard and calls for biofuel to replace 5 percent of total demand for gasoline and diesel (ADB 2009). This strategy does not focus on biofuels for residential cooking. Vietnam has rich biomass resources and potential for biofuels production from sugarcane molasses, cassava and agri-residue. In particular, rice straw ethanol production has significant potential with some estimating the country could produce up to 200 million litres per year at a cost of USD 0.45 per litre, provided some technology investments are undertaken (Nhu 2015).

ACCESS TO TIER 2/TIER 3 COOKING SERVICES

Despite the growth in clean fuels, one third of the population, 30 million people, continues to rely on solid biomass. Wood is the fuel most used amongst households with Tier 2/3 access; on average each rural household consumes 361.5 kg firewood/ month, and over 50 percent self-collects this (SNV 2011). Firewood is a serious pollutant with the World Health Organization (WHO) claiming that the short- and long-term health effects associated with the smoke contributes to approximately 45,000 deaths per year in Vietnam. In contrast, charcoal usage has significantly dropped, with the approximately 4 percent of households using it as their primary fuel in 2012 down to 1–3 percent by 2016.[99]

FIGURE 62
Overview of ICS private sector in Vietnam[100]

	Cumulative Est. sales (mkt. share)	Ownership	Geo focus	Fuel	Business model	Efficiency	Retail cost ($)	Funding
THẾ HỆ XANH Green Generation	120,000 (73%)	National	National	Wood , Agricultural biomass	Manufacturing, door-to-door distribution	30-40%	$10-16	Initial grant Funding (Women's Empowerment Fund, SNV RBF), currently limited by lack of access funding
GREEN IMPACT	45,000 (27%)	National	Central & South	Wood , Agricultural biomass	Manufacturing, door-to-door distribution	30-40%	$30	Initial grant Funding (SEED, SNV RBF), currently limited by lack of access funding
Other micro-distributors	Unknown	National	National	Charcoal, Wood	Manufacturing, distribution	<30%	<$10	Limited by lack of access funding
Total	**100%**							

[99] Market participant interviews conducted by authors.
[100] Market participant interviews conducted by authors.

The most common type of cookstove in Vietnam is a traditional two-iron bar cookstove, followed by fixed cement cookstoves that typically provide the lowest levels of access according to Multi-Tier Framework (MTF) classification (Tier 0 or Tier 1). ICS take-up is limited to 15 percent of biomass users. With no large-scale government programme, ICS growth was primarily driven by SNV's ICS Market Acceleration programme. It provided results-based financing (RBF) to enterprises until it ended in 2019.

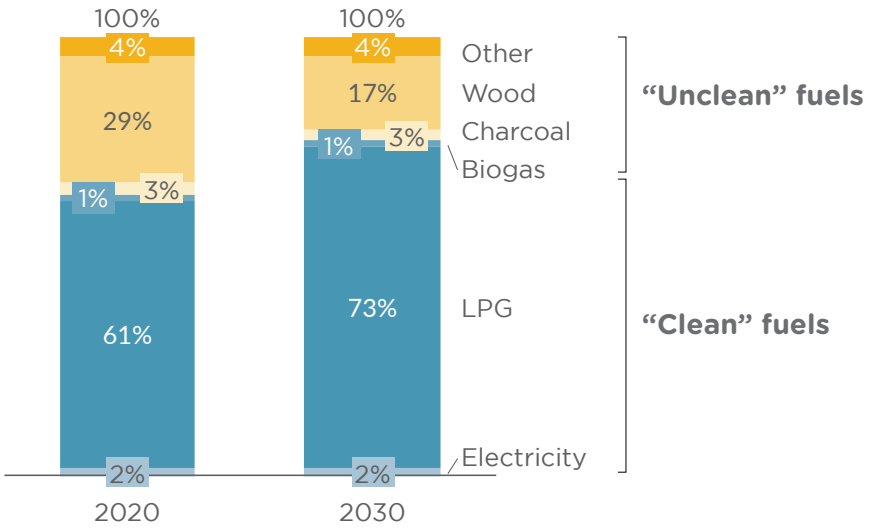
The ICS private sector in Vietnam is still at a nascent stage. There are two primary national manufacturers but no significant international company presence; stakeholder interviews indicate that fundamental challenges like finding proper and reliable distribution partners, product-market fit and strategy to cater to the vastly different geographic areas and demographics of Vietnam have slowed the entrance of international companies.

The two largest companies, THX-Green Generation and Green Impact were both initially incubated in the SNV ICS programme in Vietnam. Both operate on a similar manufacturing to door-to-door sales and distribution model with a strong focus on biomass-based ICS in rural areas. There are many smaller companies selling lower quality stoves.

BAU AND UNIVERSAL CLEAN COOKING ACCESS BY 2030

Fuel stacking is common in Vietnam. LPG is commonly used for quick cooking tasks given its ability to heat quickly. Households that have an LPG stove also usually own an electric rice cooker. Finally, biomass iron bar stoves tend to be used for animal feed cooking.

FIGURE 63
Vietnam 2020 and 2030 BAU primary fuel mix (percent of households)[101]



Vietnam is expected to fall short of universal clean cooking access by 2030, as the transition away from wood and charcoal to clean fuels and technologies would take 30+ years at the current pace, meaning that universal access would not be achieved until 2050. By 2030, the fuel mix will change as access to LPG expands, primarily driven by urbanization creating new potential customers.

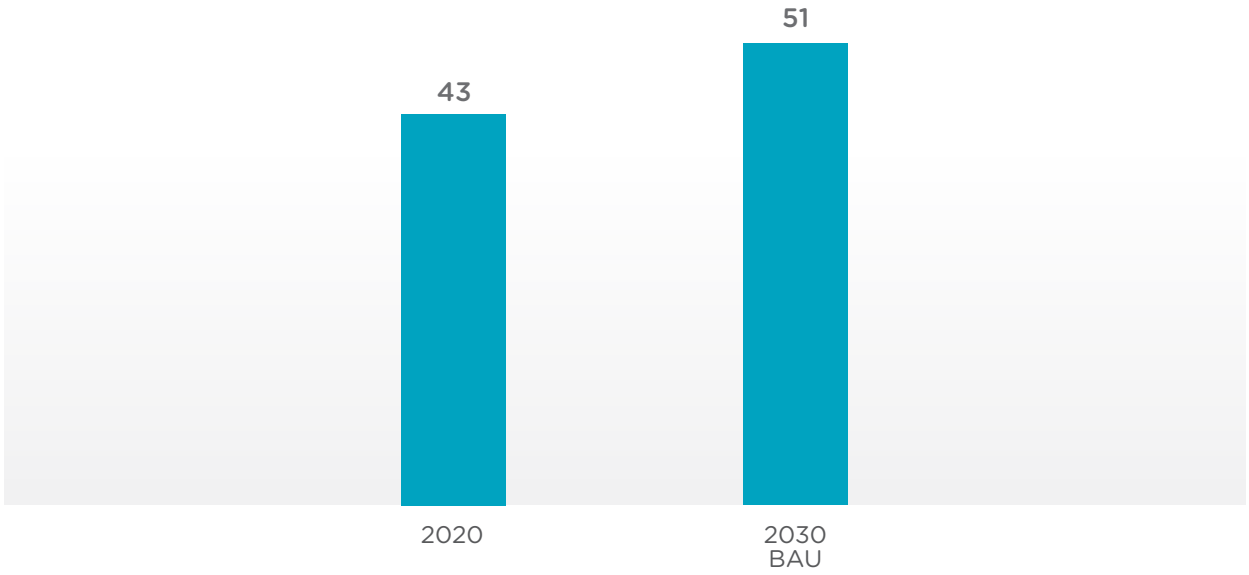
[101] Other fuels include other biomass fuels such as agricultural residue.

2030 ACCESS TO TIER 4 COOKING SERVICES

This report finds that Tier 4 cooking is likely to continue to increase in Vietnam driven by LPG uptake. In the BAU scenario, access to Tier 4 cooking in Vietnam will increase to 51 percent in 2030 (from 43 percent in 2020), driven by higher income levels and growing urbanization. It is estimated that urbanization will increase at a robust 2.7 percent annual rate of change until 2025 (CIA).

In the BAU scenario, the use of clean fuels, primarily LPG, is concentrated amongst urban households who have access to LPG infrastructure and services. Over the coming years, urbanization will be the key driver of increased use of LPG, as more households will be within easy reach of LPG services (e.g., re-bottling plants). The share of households using LPG as a primary fuel is expected to increase from 61 percent in 2020 to 73 percent in 2030. This scenario assumes no significant additional investments will be made towards clean fuels. The penetration of electric rice cookers will remain at 85 percent or higher, but electricity is unlikely to become the main fuel source for many households if it can only be used for cooking rice.

FIGURE 64
Access to Tier 4 cooking as a percent of households in Vietnam (2020,2030e – BAU)



LPG uptake will however remain low in mountainous areas and geographically harder-to-reach ethnic communities. Additional infrastructure development including filling plants would be required to support additional penetration, as well as a focus on supporting affordability, awareness raising and behavioural change.

In addition to the BAU forecast, this report evaluates three scenarios:

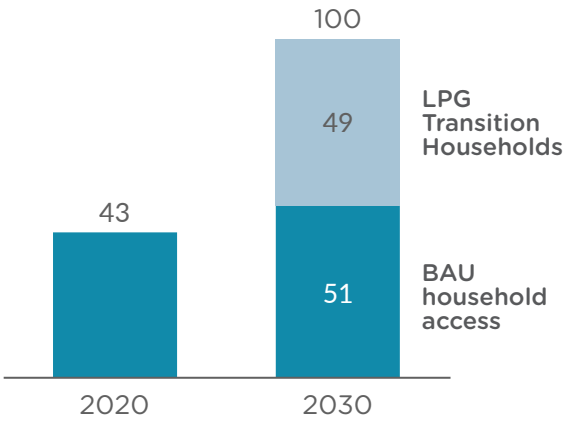
- A universal access to a Tier 4 scenario through a full LPG transition for households without access
- A universal transition with ethanol in which all households without access transition to ethanol
- A universal transition with electricity in which all households with grid connections are equipped with induction stoves and achieve Tier 4 access.

These scenarios are costed in the following section. This report does not provide a perspective on the potential clean fuel mix of Vietnam by 2030. Rather, it provides a high-level estimate of the cost associated with a universal transition with LPG, ethanol and electricity.

FIGURE 65
Three additional scenarios reviewed for universal Tier 4 clean cooking access in Vietnam

Scenario 1
Universal LPG Transition

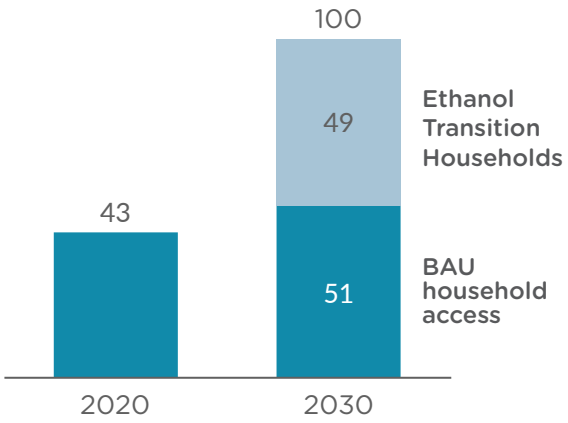
2020 & 2030 Tier 4+ cooking access
% households



- Universal LPG access scenario
- Sizes the financing cost of universal shift to LPG in Mozambique, both in rural and urban areas
- Calculates the cost of shifting all households to LPG stoves, required infrastructure investments, and implied cost of fuel subsidies for 5-10 years

Scenario 2
Universal Ethanol Transition

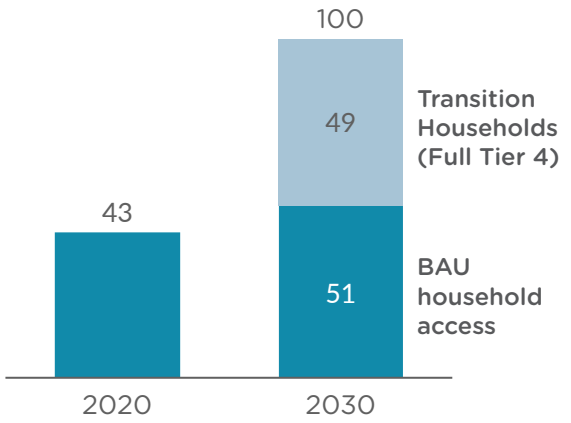
2020 & 2030 Tier 4+ cooking access
% households



- Universal ethanol access scenario
- Sizes the financing cost of universal shift to ethanol in Mozambique, both in rural and urban areas
- Calculates the cost of shifting all households to ethanol stoves, required infrastructure investments, and implied cost of fuel subsidies for 5-10 years

Scenario 3
Universal Electric Cooking Transition

2020 & 2030 Tier 4+ cooking access
% households



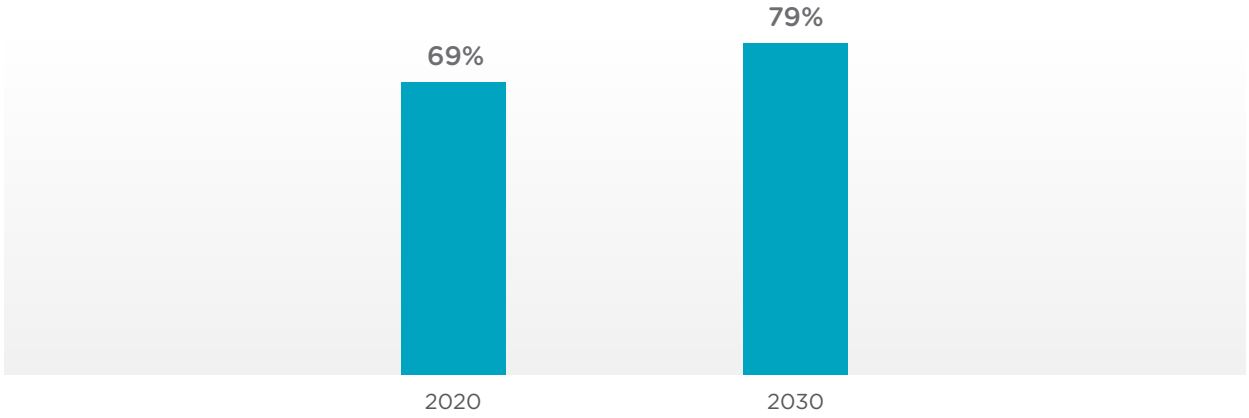
- Universal electric cooking access scenario
- Sizes the transition cost of moving grid households to induction stoves, mini-grid and SHS households to EPCs
- Calculates the cost of shifting households to induction stoves/ EPCs, implied cost of fuel support and additional burden on projected grid production

2030 ACCESS TO TIER 2/TIER 3 COOKING SERVICES

By 2030, in a BAU scenario, access to Tier 2/Tier 3 cooking solutions will remain below universal access, at 79 percent of households. This will primarily be driven by a continuation of historical trends, including continued urbanization in Vietnam.

Similar to Tier 4 access growth, the growth of Tier 2/Tier 3 access will primarily be driven by the growth in households gaining access to Tier 4 with LPG. This is due to the fact that by definition, any household that achieves Tier 4 access also has Tier 2/Tier 3 access. The growth of Tier 2/Tier 3 access through ICS will remain limited due to stiff competition from other cooking solutions like LPG, a lack of functioning cookstove testing labs and standards resulting in low quality products, a lack of large-scale donor programmes (particularly since the SNV programmes ended), a lack of access to commercial debt and the overall difficulty and cost of reaching the rural regions where ICS customers are most likely to be located.

FIGURE 66
Percent of households in Vietnam with access to Tier 2/Tier 3 cooking (2020,2030e – BAU)



Financing Universal Clean Cooking Access in Vietnam

TRANSITION TO TIER 4 COOKING ACCESS

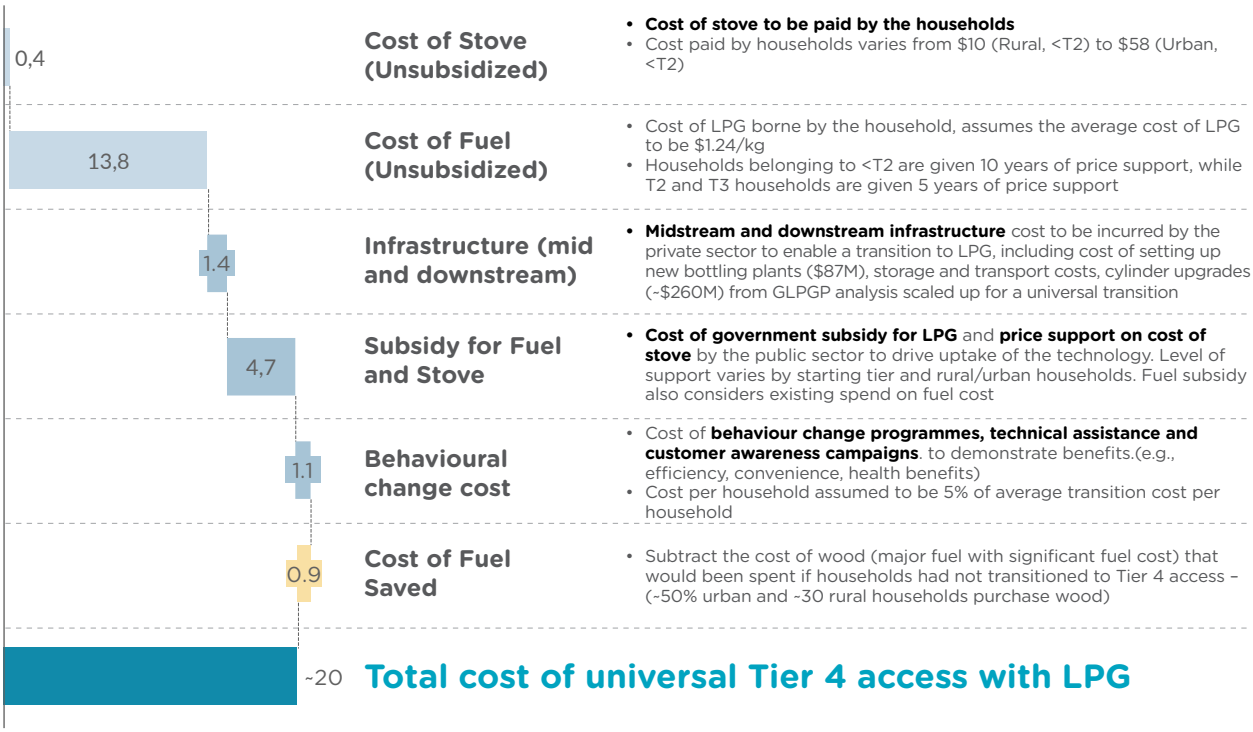
This report finds that the cost of achieving universal Tier 4 access through LPG is high at USD 20 billion. This compares with an estimated cost of USD 19–22 billion for acess with ethanol, and an estimated USD 19 billion for Tier 4 access with electricity. Compared to Ghana and Mozambique where the electric cooking scenario would only provide partial access, in Vietnam, given universal grid electrification, the electric cooking scenario is a "true" universal-access scenario, with a cost in line with LPG and ethanol clean cooking. However, this is based on two key assumptions that may underestimate the actual cost of the electricity scenario.

- Electric cooking would also increase current estimates of the 2030 electricity generation in Vietnam by 2 percent, which would in turn require additional generation investments which are not factored in this report.
- The cost of the electricity scenario is based on current tariffs, which may not reflect actual generation costs given the electricity subsidies provided to lower income households in Vietnam.

Similarly, the cost of universal access to Tier 4 through ethanol and electricity is primarily driven by the cost of fuel. These scenarios also estimate that households that currently have Tier 2/Tier 3 access require a five year fuel subsidy before they can transition to Tier 4 independently. Households with Tier 1 access or below are estimated to require 10 years of subsidies. While in Ghana and Mozambique cost savings from decreased consumption of charcoal reduce the overall transition cost, in Vietnam charcoal consumption is very limited, leading to much lower savings at the household level.

FIGURE 67

Cost of universal Tier 4 clean cooking access with LPG in Vietnam (USD Billion)



The cost is primarily driven by the cost of fuel and required subsidies for households. The largest cost required for the transition is the ongoing cost of LPG borne by the household.[103] Given affordability constraints, the government would likely have to provide a subsidy to cover a significant portion of the LPG and stove cost.

The cost of universal LPG transition is higher in Vietnam than it is in Ghana or Mozambique given the larger number of households and higher cost of LPG.[104] While the percentage of transition households in Vietnam is lower than in the other focus countries, in absolute numbers there are more households in Vietnam (approximately 26 million compared to 9 million in Ghana and 7 million in Mozambique) since the country is three times more populous than Ghana or Mozambique.

The level of support provided to various households could vary, based on households' starting Tier of cooking access and existing expenditure on fuel. Other major cost drives include midstream and downstream infrastructure needed to bring LPG to new, rural areas, including the development of new bottling plants, storage, cylinder upgrades, and behavioural change campaigns. This figure does not include additional investment on production or importation of LPG.

[103] Assumes the average cost of LPG to be USD1.24/kg, households belonging to <T2 are given 10 years of price support, while T2 and T3 households are given five years of price support.

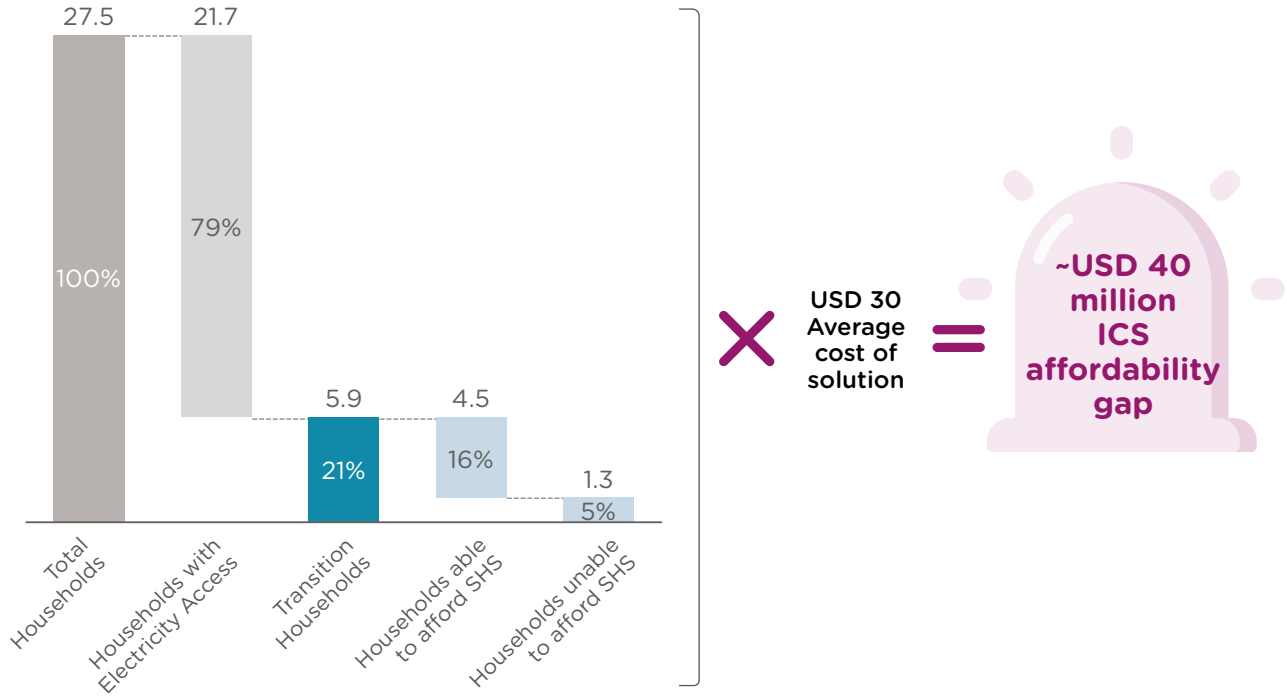
[104] While it may seem counterintuitive, a larger market does not necessarily bring economies of scale, since most of the cost is driven by LPG fuel costs.

TIER 2/TIER 3 COOKING ACCESS

While universal access to Tier 4 cooking should be the standard, accessing Tier 2/Tier 3 where Tier 4 is not feasible represents an alternative transition path. This report estimates the cost of Tier 2/Tier 3 access as a 'second best' option.

ICS are a viable solution to extend clean cooking to households who are unlikely to be reached by LPG, but 5 percent of households are unable to afford them. ICS must be purchased upfront in cash, due to a lack of available finance solutions for customers. The viability of PAYG for ICS is also still being tested in developing countries. The affordability gap amounts to USD 40 million.[105] An ICS costs an average of USD 15–30 in Vietnam depending on size and efficiency. In comparison, Tier 0/Tier 1 traditional iron-bar woodstoves cost USD 1.5–3.[106]

FIGURE 68
Vietnam ICS affordability gap calculation (2030 households USD million)



Assuming consumer finance is made available for ICS, this could lower the affordability gap to 1 percent of households, resulting in a USD 10 million affordability gap. If consumers were given the option to purchase stoves through a lower upfront payment, for instance by leveraging finance from multilateral financial institutions (MFIs) or should an enterprise PAYG model prove feasible, up to 99 percent of households could afford ICS. This would significantly expand the ICS market, despite the fact that the total cost of the stove would increase slightly due to financing costs. However, no ICS providers have developed consumer finance mechanisms, due to challenges accessing local debt for improved cooking solutions. This represents an area for further research and donor support.

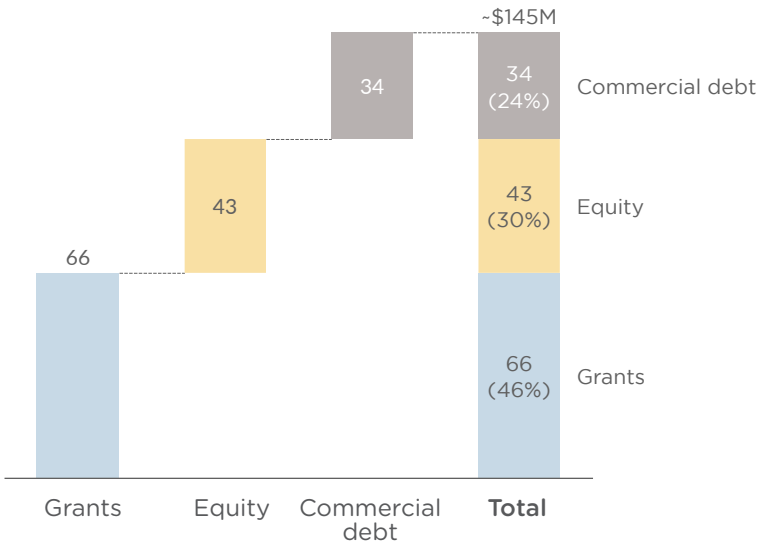
[105] Note that the model calculates the financing cost of only one stove per household given that further replacements can be financed through on-going fuel savings.
[106] Market participant interviews conducted by authors.

ENTERPRISE FINANCE

This section focuses on universal Tier 2/Tier 3 access; enterprise finance needs are only calculated for this scenario.

There has been almost no grant finance in Vietnam since the SNV programme ended in 2019. Official development assistance (ODA) declined from USD 3 to 4 billion a year during the period 2009–2014 to just USD 1 billion in 2019 (OECD) due to the country's lower middle-income status and significant progress on electrification. Few donor programmes have focused on access to clean cooking in the country. Understanding the Landscape 2021 tracks total finance commitments in Vietnam for clean cooking at USD 7.3 million for the period 2013–2019 (SEforALL 2021). However, this report estimates USD 145 million in private financing is required to achieve Tier 2/Tier 3 universal access by 2030.

FIGURE 69
Vietnam Tier 2/Tier 3 cooking enterprise finance needs (USD millions)



Access to finance for ICS companies in Vietnam is challenging. Interviews suggest that local banks are not willing to lend to local enterprises because of the perceived risk, small size of companies, and limited finance needs. Micro-finance institutions are willing to invest in smaller amounts but typically require hard collateral such as equipment, but private companies interviewed have not obtained microfinance funding so far.

Carbon finance is generally seen as a viable option, but private companies typically do not have the scale required to generate interest in the emissions savings generated. Typically, there is limited investor interest below 10,000 stoves, a scale only one or two companies have reached to date – but these companies have not tracked emissions savings historically. In practice, private-sector companies have noted that the carbon finance process is complex and slow, and that it takes up to two to three years to obtain funds. SNV's biogas project has attracted carbon investors due to its larger size. Additionally, increasing concerns on the integrity of offsets may present more complex and detailed monitoring requirements to access carbon finance.

Access to growth capital is very complicated for local companies as a result and local ICS companies are often financed 100 percent with equity from the founders, according to two leading ICS providers.

According to private-sector consultations, scaling ICS in Vietnam requires USD 145 million to support the private sector, with 46 percent of finance in grants. To date, the ICS market is made up of small local producers. By 2030, the Vietnam market is likely to be composed of a few larger, more mature companies, which will provide 20 percent of the overall stoves required. These companies will require significant commercial debt to finance their working capital needs, including scaling production and distribution. However, a large portion of the market will be equally serviced by smaller companies and start-ups. Start-ups will continue to account for 40 percent of sales, relying heavily on internal and grant funding.

Access to grant funding is expected to be limited to a strict number of uses. Grants are most likely to be obtained to catalyze public goods and pay down the cost and risks of infrastructure investments – though other grant uses could include deploying systems, building sales networks or buying vehicles for distribution. The public goods include quality testing and certification, establishing carbon finance verification and above-the-line consumer-awareness campaigns. RBF could be provided to attract private companies to regions where they would not otherwise go quickly enough. A finance requirement of USD 34 million and USD 43 million is also required in debt and equity respectively.

FIGURE 70
Overview of finance availability in the Vietnam clean cooking market[107]

	Description	Availability	Market perspective
Commercial debt	Local funding not available for ICS providers • Considered too small scale or unprofitable for financing • Personal loans taken through family and friends	 • Limited access to local financing • Collateral requirements a challenge	Commercial debt is completely "unobtainable" for us, we are considered too risky and too small
Equity	Equity primary source of funds for ICS manufacturers • ICS manufacturers are typically 100% equity funded	 • Investor appetite is limited; LPG and ICS enterprises viewed as high risk vs. expected return • No support from VC or commercial equity investors	Access to growth capital is very complicated. Typically, it is 100% equity financing from the founders
Grants	Small ICS enterprises were primarily financed through grants, but access has dried up • Gender-focused grants also provided an avenue for clean cooking providers (e.g., Women's Empowerment Fund)	 • Decrease in ODA for Vietnam due to economic progression	We had grants at the beginning, but now we just have to rely on our own cash flow

[107] Based on stakeholder interviews with private sector participants in Vietnam.

Carbon finance	Carbon financing could be a significant source of funds to finance ICS expansion in Vietnam, but few enterprises have managed to benefit from this • Limited scale of enterprises • Costs associated with verification mechanisms	• Few enterprises are able to capture this type of financing, due to complexity of verification, difficulty in finding carbon investors	Carbon finance is good in theory, but in practice it is complex and slow, with financing taking 2-3 years

Low Medium High

As mentioned in Figure 70, the size of the market and companies are perceived as risks by commercial lenders, resulting in limited lending to the sector. Market development support will therefore be critical to enable universal clean cooking access, as outlined in the recommendations section.

Key Finance Opportunities and Solutions

Appropriate financing tools are needed to address these challenges. New tools or adaptations of solutions that have worked elsewhere could be designed and piloted – specifically around addressing the affordability gap and last-mile delivery challenges, as summarized in Figure 71.

While the affordability challenge is less acute than other markets, the private sector for ICS remains very small and without access to finance, making a strong case for additional supply-side support including expanding previously successful RBF mechanisms.

To address the private-sector finance challenge, development partners and the government should explore increasing access to commercial and concessional finance, as well as support access to carbon finance through technical assistance and grants. The goal is to provide USD 145 million to the sector to enable universal Tier 2/Tier 3 access. To encourage local lending to the private sector and increase access to finance, development partners could work with local financing institutions through guarantees, first loss schemes, hedging facilities etc. As in Ghana and Mozambique, development partners could expand access to carbon credits by supporting small manufacturers through technical assistance. Other instruments could include pooling carbon credits for multiple small early-stage ICS companies, or lending against future carbon credits.

To crowd in private companies in the ICS sector and reach isolated communities that are less able to afford access to clean cooking, development partners could consider a blended finance approach. Similar to the Ghana access to electricity challenge, the ICS affordability issue in Vietnam could be addressed with a single USD 40 million facility. Development partners and the government could consider targeted demand-side subsidies for the 5 percent of the population unable to afford ICS stoves, combined with RBF to encourage the private sector.

Reaching ethnic minorities and isolated groups requires additional costs including translation, awareness campaigns etc., increasing the cost of distribution. Development partners could explore replicating and expanding results-based auction mechanisms to encourage the private sector to expand in these harder-to-reach areas. This could also address the limited number of ICS companies and crowd in more ICS companies.

Other lower-opportunity recommendations include supporting the rollout of more PAYG

models for clean fuels and developing consumer finance options for ICS or "clean" fuel users.

Although Vietnam leads the Asia-Pacific region on a number of gender equality indicators, additional work is required to improve gender norms in Vietnam including incubating more women-led energy enterprises and mobilizing more capital for women-led businesses to address the imbalance. Introducing work-inclusive policies, flexible working hours and encouraging the take-up of paternity leave can increase the attractiveness of job positions in the energy access sector for women. Stakeholders can also create programmes to actively promote women's participation in the private energy sector. Exploring innovative financing instruments such as supply-side subsidies that provide additional incentives when targeting female clients could also increase participation. A gender-specific, people-centred design can help create the right products for women. Incorporating women in the design process and understanding their specific needs will lead to better product design and higher uptake.

FIGURE 71
Recommended instruments to address Vietnam's cooking challenges

Audience	Challenge	Recommendation
Government	**Clean cooking strategy**	Incorporate into national clean cooking strategy pathway for "clean" fuels beyond LPG and support ICS sector growth with clear guidelines.
Development Partners and Government	**Low customer affordability**	Demand-side subsidies of up to USD 40 million.
	Difficult last-mile distribution	Results-based mechanisms expansion to encourage the private sector to expand in harder to reach areas and with ethnic minorities.
	Insufficient Funds	Additional support to the private sector through grants, debt and equity of up to USD 145 million. Carbon credits expansion for private-sector financing. Carbon credits pooling from small manufacturers.
Investors	**Low customer affordability**	R&D funding for more efficient ICS stoves sold at a similar cost based on future carbon financing to increase consumer willingness to pay. PAYG models for clean fuels, consumer finance options for ICS expansion.
	Insufficient funds	Additional support to the private sector through grants, debt and equity.
All	**Gender imbalance**	Expansion of financing for women-led businesses. Inclusive work policies, programmes and people-centred design that promote women's participation in the energy sector.

ENERGIZING FINANCE
RESEARCH SERIES

ENERGIZING FINANCE: TAKING THE PULSE 2021

Photo by SNV

APPENDIX

GLOSSARY

Term	Definition
Access to electricity	Access to electricity was traditionally measured based on household connections to the national electricity grid of their respective country. A recent move, driven by the World Bank's Multi-Tier Framework (MTF) for electricity access, seeks to understand electricity access not in binary terms, but as a continuum of service levels that may be satisfied by a range of technologies. The MTF captures more robust granularity of electricity access including capacity, duration of supply, reliability, quality, affordability, legality, and safety and is scored on Tiers 0-5.
Access to clean cooking	*Taking the Pulse 2021* relies on the MTF developed by the World Bank to define access to clean cooking. The MTF measures access to clean cooking solutions based on multiple attributes: health (based on household air pollution); convenience (based on fuel collection and stove preparation time); affordability (including expenditure on cookstove and fuel), safety, efficiency, quality, and availability. The MTF scores access to clean cooking on Tiers 0-5.
Business as usual (BAU)	A forward-looking scenario that is based on historical trends. Using these trends, the average year-on-year growth rate is projected forward, factoring in demographic assumptions related to population growth over time.
"Clean" fuels	This term refers to fuels able to provide Tier 4 access including biogas, liquefied petroleum gas (LPG), ethanol and electricity.
Fuel stacking	The parallel use of several fuels for the purpose of cooking.
Gender norms	Gender norms are social principles that govern the behaviour of individuals in society and restrict their gender identity into what is considered appropriate. Gender norms are neither static nor universal and change over time. Some norms are positive, for example, the norm that children shouldn't smoke. Other norms lead to inequality (Save the Children).
GOGLA affiliate	SHS companies affiliated to GOGLA, IFC Lighting Global or Efficiency for Access Coalition that meet defined quality standards.
Improved cookstoves (ICS)	Cookstoves are commonly called "improved" if they are more efficient, emit less emissions or are safer than the traditional cookstoves or three stone-fires. The term usually refers to stoves that burn firewood, charcoal, agriculture residues or dung.
Mini-grids	Electricity generation and energy storage systems interconnected to a distribution network that supplies electricity to a localized group of customers. Mini-grids can deliver higher tiers of electricity access (Tier 3 and above) and enable more productive uses.
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)	A typology that monitors and evaluates energy access by following a multidimensional approach. It defines energy access as the ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy and safe for all required energy services. Energy access is measured in the tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access).
Pay-as-you-go (PAYG)	PAYG refers to a business model that allows users to pay for their product via installment payments over time. Customers are frequently required to make a down payment, followed by regular payments over a period of months or years. Payments are usually made via mobile money, and non-payment is frequently enforced by disabling the system until payments resume.
PovCalNet	PovCalNet is an interactive online tool developed by the World Bank's Development Research Group staff to allow users to replicate the calculations made by the World Bank's researchers to estimate the extent of absolute poverty at different income/consumption levels,
Standalone solar	Single (typically referred to as "solar lanterns") or multi-light point systems (often called "solar home systems" (SHSs)) that generate power via photovoltaic panels, store power via batteries (increasingly using lithium-ion battery chemistries) and deliver lighting and power for small devices and appliances.
Transition households	Households that will not achieve universal access by 2030 in a BAU scenario.

CASE STUDIES

Case Study 1: Energrow energy access through productive use for micro-entrepreneurs

Description: Energrow's mission is to increase energy demand and empower households to earn money through asset financing for productive uses. Energrow provides tools such as saws, grinders and refrigerators at a low interest rate to enable micro-entrepreneurs to generate income. Customers are also provided with financial literacy training. These productive uses increase energy consumption, thereby also increasing the return on energy investments such as mini-grids.

Impact: Launched in 2020, Energrow is still in its pilot phase – so far, 50 businesses have signed up, and USD 200,000 has been deployed towards productive uses.

Key success factors:

- Ability to identify entrepreneurs: For instance, credit scoring using alternative data sources to identify the right potential clients.
- Training: Significant training required especially for new entrepreneurs who did not own a business prior to partnering with Energrow.
- Upfront financing: As a leasing business, Energrow is likely to experience negative cash flows from its leases for an extended period (loans cover a period between six months and three years).

Further research suggestions:

- Productive use: In less monetized communities, micro-entrepreneurs may lack a customer base able to pay for services. Research should be undertaken to identify the communities most likely to be successful.

Case Study 2: Off-balance sheet solar based securitization in Sub-Saharan Africa

Description: Multiple off-balance sheet financing structures have been used since 2015 to provide additional finance to the pay-as-you go (PAYG) off-grid solar sector. The first off-grid solar securitization deal was completed in 2015 between BBOXX and Oikocredit International, purchasing 2,500 customer installment sales contracts in Kenya for KES 0.5 million. In Rwanda, Access to Finance Rwanda and the Development Bank of Rwanda are exploring a securitization vehicle of up to USD 100 million that would finance electricity access for up to 2 million households (GOGLA 2016; Global Innovation Lab for Climate Finance 2019).

Receivables financing has also been experimented with. In 2020 in Côte d'Ivoire Zola Electricity launched a securitization facility with the goal of providing access to 100,000 households. The local currency loan is guaranteed by the African Development Bank and Credit Agricole Corporate and Investment Bank. Another example is Brighter Life for Kenya, a USD 65 million facility that purchases account receivables from d.light in local currency that could provide access to up to 1.9 million households.

Impact: If all the programmes mentioned above successfully raised the USD 165 million they set out to achieve, they could finance energy access for an estimated 4 million households in Côte d'Ivoire, Kenya and Rwanda.

Key success factors:

- Minimum securitization size: Typical securitizations usually have USD 100 million and above portfolios, which justify the cost of structuring these transactions. Investors may be interested in lower amounts for solar home systems (SHSs) but the amount needs to be big enough to justify investor due diligence.
- Mature private SHS providers have the ability to scale: Most appropriate for larger, more mature SHS providers looking to expand their PAYG portfolios. Not compatible with cash sales since these do not have receivables.
- Ability to provide funding in the local currency: Borrowing in USD with receivables from customers in the local currency would expose SHS providers to currency risk, making these facilities most efficient in local currency.
- Investor appetite for SHS products: To effectively scale these facilities, a robust investor appetite will be required. This requires significant investor education on the investment profile, typical default etc. for SHSs.

Case Study 3: CIZO SHS programme in Togo including demand-side voucher programme

Description: The COZO SHS programme, launched by the Government of Togo in partnership with the AfDB, aims to increase rural electrification to 40 percent by 2020 by distributing 550,000 SHSs. Its focus is on growing the SHS market through concessional debt and guarantees. The programme targets households for subsidies based on the geo-spatial analysis of off-grid areas that the grid is unlikely to reach in the near future, distributing vouchers to potential companies and working with major SHS providers including BBOXX, Soleva, Fenix, Solergie and Moon (GSMA 2021).

Impact: The subsidy or 'CIZO Cheque' allows households to access a monthly subsidy of CFA 2,000 (USD 4) from authorized providers for the SHS payment plan.

Key success factors:

- Nascent market with limited potential for distortion: Voucher programme initially targeted a single company, then expanded to include four companies that account for the vast majority of the market. Given full participation from market actors, there was limited potential for distortion.
- Verification mechanisms: All SHSs sold through the scheme included GSM chips that allowed for the remote verification of new installations, system use and to ensure monthly subsidy uptake.

Further research suggestions:

- Phase-out effects of subsidies: The use of the subsidy has helped build up the SHS market in Togo, attracting new companies and building customer and brand awareness of products. Overtime, the programme aims to phase out the subsidy and transition to a purely commercial market. The appropriate mechanism for this remains under discussion.

Case Study 4: Envirofit's SmartGas technology for PAYG LPG payments

Description: In Ghana and across its other markets, Envirofit has launched a 'pay-as-you-cook' model that allows customers to pay for liquefied petroleum gas (LPG) in small amounts using mobile money. Customers effectively pre-pay for the gas they use. Gas canisters come equipped with a GPS-enabled smart valve, which communicates with Envirofit software and provides customers with the amount of LPG they purchased. The system also alerts Envirofit to schedule a new canister delivery before the customer runs out of gas.

In Ghana, Envirofit competed with lower-cost, widely available gyapa-improved cookstoves (ICS). The company introduced pay-as-you-cook as a strategy to increase customer affordability and improve price

competitiveness compared with ICS. Pay-as-you-cook was introduced in 2018 and initial sales were successful, with sales doubling every month in the first year. Other Ghanaian companies are also piloting PAYG models for LPG distribution, including XPress Gas.

Impact: Increased affordability for customers, who can purchase LPG in regular, small increments, rather than needing to cover the upfront cost of a full larger canister. Customers also save money on travel to re-bottling centres and are less likely to stop using LPG when their canister runs out, given the at-home replacement service.

Key success factors:

- Access to mobile networks and mobile money: Customer access to mobile money services to make regular payments, and digital skills to do so.
- Extensive network of agents for cylinder replacement: Extensive distribution networks in areas of operation, to ensure timely cylinder replacement and good customer service.

Further research suggestions:

- Reducing the costs of the operating model: Operating a PAYG LPG model has higher product and operating costs than a regular LPG model, whereby the customer re-fills the cylinder when empty. Additional costs include running the at-home cylinder replacements, and the hardware cost of adding a GPS smart valve to each cylinder. The model requires new scale economies in smart valves to be created in order to ensure refill margins (and other fee income), are adequate and at a competitive consumer price to cover both operating and capital costs as well as generate required investor returns.
- While companies like Envirofit are effectively operating the model at scale, more research is required on possible cost efficiencies in this model.

Case Study 5: Off-grid solar-powered telecom towers in rural Africa

Description: The Telecom Infra Project, in partnership with Clear Blue Technologies, a smart mini-grid company, develops solar off-grid power systems to power telecom cell towers in areas where they cannot be connected to the grid. It is working with South African telecom company MTN among others to roll out 500 new off-grid, 2G and 3G cell towers in rural Congo, Ghana and Nigeria. Clear Blue estimates it can install cell towers for USD 10,000 per site, compared to the USD 50,000 for traditional setups.

The cell towers can provide continuous energy access without a diesel backup. They are driven by software that optimizes energy usage remotely via cloud tech by conducting energy forecasting on site using data analytics and weather forecasts.

Impact: Despite delays due to Covid-19, the programme is expected to increase mobile access to new areas in Sub-Saharan Africa. If successful, it could eventually replace diesel-powered cell towers. Expanding cell tower coverage could also increase mobile uptake and therefore the ability to leverage PAYG financing.

Key success factors:

- Feasibility studies: Without a diesel backup, feasibility studies must be conducted to ensure minimum solar generation can support the energy requirements of cell towers.

Further research suggestions:

- Explore ways to leverage the mini-grid network built for cell towers to provide electricity access to nearby communities.

Case Study 6: Declining development partner financing for fossil fuel projects

Development partner financing for fossil fuel may become less available – including for LPG for clean cooking. A knowledge brief on coal finance published as part of this year's Energizing Finance series also references this issue.

A growing list of international organizations are calling for an end to fossil fuel investments. In May 2021, the United Nations Secretary-General António Guterres called for an end to all financing of fossil-fuel projects from funding agencies. Alongside calls to multilateral development banks, lending agencies and the G7 to stop financing these projects and invest in cleaner energy, the Secretary-General has also been repeatedly calling for a global end to the use of coal for power production by 2040 and putting a price on carbon. Also in May 2021, the International Energy Agency (IEA) called for an end to all new oil and gas, coal and mining projects and extensions by 2021 in order to be able to reach net zero emissions by 2050.

Additionally, over 15 development agencies have announced restrictions on fossil fuels. While most of these restrictions exclude gas for the time being, and just three agencies had announced full fossil finance bans as of May 2021, more announcements could be forthcoming.

Restrictions on most fossil fuels, with exceptions for gas

DFC U.S. International Development Finance Corporation
EDFI European Development Finance Institutions
BIO
CDC Investment works
KFW DEG
finnfund
OeEB
IsDB Islamic Development Bank
PROPARCO
THE WORLD BANK

Ban on all fossil fuels (including gas)

DANISH SDG INVESTMENT FUND
Swedfund
European Investment Bank

Case Study 7: Vietnam's targeted electricity consumption subsidies

Description: Vietnam subsidizes electricity consumption for its lowest-income households. Cash transfers to poor households for electricity were introduced in 2011 and have covered the cost of 30 kWh of monthly use since 2014. The cash transfer is paid on a quarterly basis.

Impact: Vietnam's programme is one of only a few examples of government cash transfers for electricity consumption; many countries subsidize electricity only through lower tariffs. With means-based testing, Vietnam has been able to better target its subsidies than a universal tariff structure could.

Key success factors:

- Household identification: Ability to identify households that qualify for subsidies in a timely manner typically requires a national identification scheme that may not exist in all countries.

- Efficient delivery mechanism: Delivering subsidies may be costly in countries with low bank account ownership, and where the population lives in low-density regions such as Mozambique. Alternatively, distribution could be centralized in regional centres located at a reasonable distance from a large share of the population.

Further research suggestions:

- Targeting: The Vietnam cash transfer is based on 30-kWh consumption per month that does not factor in household size, location, etc. While this makes the subsidy easier to distribute, exploring mechanisms to tailor it to specific needs would allow for more precise targeting.
- Monthly payments: Quarterly payments may be far apart for households who struggle to pay monthly bills. Exploring more frequent payments while minimizing distribution costs could further increase the impact of such subsidies.

Case Study 8: SNV's results-based financing for cookstoves in Cambodia. Laos and Vietnam

Description: The Market Acceleration of Advanced Clean Cookstoves in the Greater Mekong Sub-region project was implemented by SNV with support from Energising for Development (EnDev). The goal was to start a sustainable market for clean smokeless cookstoves through the sale of 120,000 appliances in Cambodia, Laos and Vietnam over 2015–2019. The programme leveraged an RBF scheme for new supply chain actors.

The RBF incentives are allocated through an innovative incentive auction: Distributors bid for the stoves and subsidies based on the price at which they expect to be able to sell the stoves to consumers. Those who request the lowest subsidy amount win the auction. Producers of stoves are then guaranteed a good selling price, incentivizing production, while stove sellers receive an incentive for each stove that is sold to an end user.

Impact: The programme enabled the sale of 120,000 stoves through this mechanism over the 2015 to 2019 period.

Key success factors:

- Existing base of private companies: The auction mechanism works best when a private sector already exists and needs support for scaling.
- National verification network: In Vietnam, SNV partnered with the Women's Union organization to verify cookstove sales.

Further research suggestions:

- Long-term private-sector support: Once the programme ended, subsidies for local sellers and guaranteed prices for manufacturers disappeared. Covid also negatively impacted the private sector. As a result, few sustainable private companies have emerged. Finance is scarcely available, preventing the sector from growing in areas where demand would be strong. As a result, adaptations of the auction mechanism should look into how to create long-term impact in the private sector, for instance through additional grants and/or other financing mechanisms.

METHODOLOGY

***Energizing Finance: Taking the Pulse 2021* relies on a deeply contextual and empirical quantitative model to project finance needs for electricity and clean cooking in the three focus countries.** For access to Tier 1 electricity, it examines past trends on grid, mini-grid, and solar home system (SHS) electrification activities in each country to establish business-as-usual (BAU) scenarios that highlight the access deficit to SDG7. Building on this, the report develops forecast scenarios of the expected contributions of the three technology segments for universal electricity access. With respect to clean cooking, the report documents past trends on usage of clean fuel (including liquefied petroleum gas (LPG), biogas, electric cooking and ethanol) and improved cookstoves (ICS), which rely on wood and charcoal as fuel sources. It then develops scenarios for uptake of clean fuels and ICS to achieve universal clean cooking access by 2030. These scenarios underpin the report's forecasts on the volume and blend of capital required over the 2021–2030 period for enterprises to deliver energy services to individual households, as well as an estimate of the size of the affordability gap, which is the shortfall in ability to pay for access to energy – in other words, the amount required to equip all households that are not able to afford energy access services systems on a cash basis (for ICS) with their current income and with pay-as-you-go (PAYG) or consumer finance availability (for SHSs). It should be noted that the estimates in this report do not include the finance requirements associated with grid expansion. The private sector's finance needs are estimated based on its own estimate of finance needs by type of instrument in each of the three focus countries.

The quantitative research is informed and complemented by insights from over 40 qualitative interviews. Interviews were conducted with global and local experts on energy and clean cooking, senior-level government officials, enterprises, donors and funders, and development partners as well as civil society organizations (CSOs) in the off-grid and energy access sectors. These interviews cover a broad range of energy and clean cooking fuels and technology companies and provide a direct, on-the-ground perspective on key challenges for the private sector in expanding access to energy, as well as finance needs in each of the focus countries. These interviews were complemented by webinars during which some of the findings of this report were shared with stakeholders for feedback, which was then incorporated into the report.[108] These webinars also created an opportunity for various stakeholders to exchange views on key issues for energy access in the three focus countries and challenges.

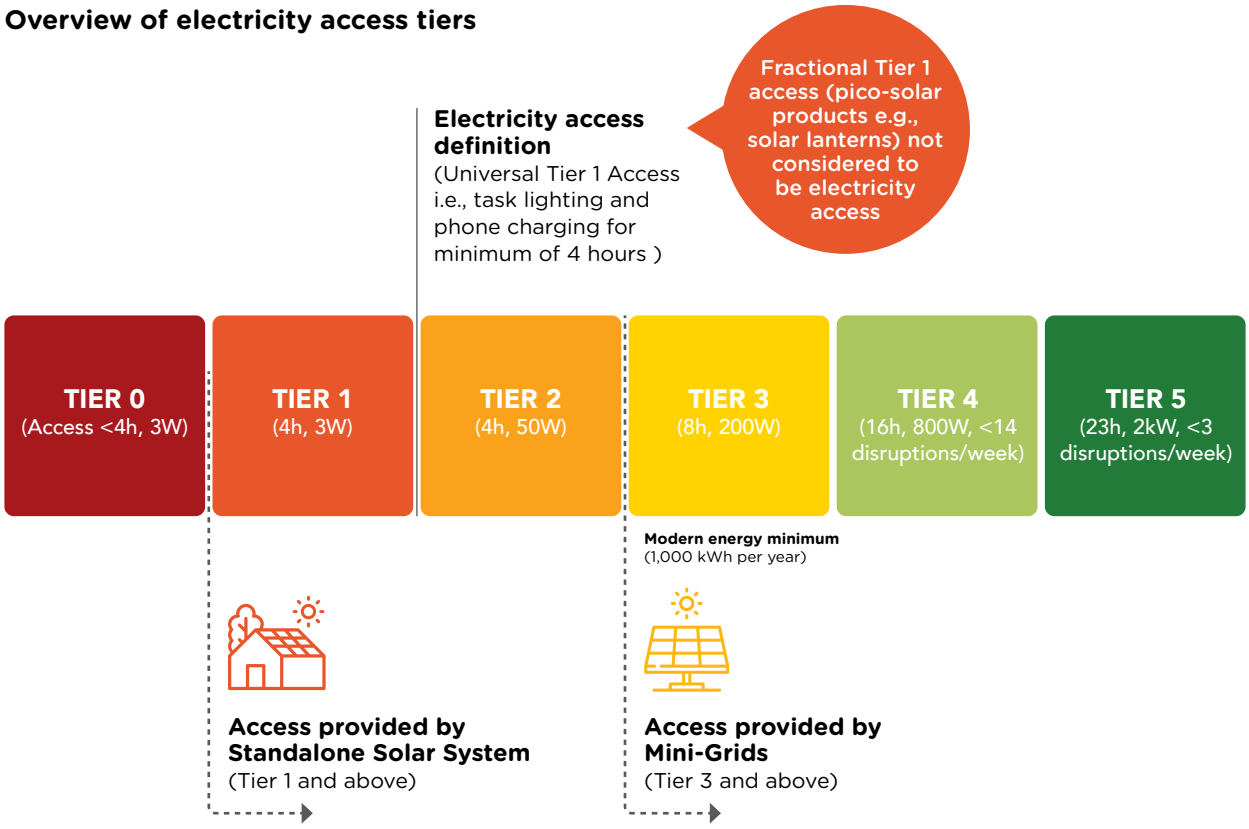
ELECTRICITY - DEFINING ACCESS

Taking the Pulse 2021 relies on the Multi-Tier Framework (MTF) developed by the World Bank to define access to electricity. The MTF measures access to household electricity supply based on seven attributes – capacity, availability, reliability, quality, affordability, formality and health and safety impacts.

Access Definitions: The report is anchored in the World Bank's widely recognized MTF to help define and map different levels of energy access across countries. For electricity, it measures the deficit to Tier 1 access. This corresponds to a minimum 12 Wh of electrical energy per person per day and lighting performance of 1,000 lumen-hours per person per day, which provides enough power for three to four lights, charging a phone and powering a radio.

[108] Webinar attendance varied from five participants for the Ghana clean cooking webinar to 30 for the Mozambique electricity webinar.

FIGURE 72
Overview of electricity access tiers



Mapping technologies to tiers: While all three technologies mentioned above enable at least Tier 1 access, grids and mini-grids are mapped to higher tiers than SHSs. In most cases, access to the grid maps to Tier 4/5 access based on the MTF, access to mini-grids maps to Tier 3/4 and access to SHSs map to Tier 1/2. Note that pico-solar products such as solar lanterns map to partial Tier 1 access. However, contrary to the 2019 Taking the Pulse report, the 2021 edition does not count pico-solar products contributing to Tier 1 energy access. This is in line with the broader conversation of moving away from a partial definition of electricity access to a basic minimum defined in this report as Tier 1 access. Figure 73 provides a mapping of what each Tier of electricity supply translates to for all indicators used by the MTF.

FIGURE 73

Multi-Tier Framework for measuring access to electricity[109]

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		At least 8 hours	At least 16 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	At least 4 hours	
Reliability		More than 14 disruptions per week			At most 14 disruptions per week or at most 3 disruptions per week with total duration of more than 2 hours	(>3 to 14 disruptions/ week) or ≤ 3 disruptions/ week with >2 hours of outage	At most 3 disruptions per week with total duration of less than2 hours
Quality		Household experiences voltage problems that damage appliances				Voltage problems do not affect use of desired 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		No bill payments made for the use of electricity				Bill is paid to the utility, prepaid card seller, or authorized representative	
Health and Safety		Serious or fatal accidents due to electricity connection				Absence of past accidents	

Understanding the approach and scenarios: The report first performs an historical access estimate, which takes a backwards-looking view of electricity access in the focus countries. The model uses electricity access data from the World Bank and breaks them down into three component technologies – grid, mini-grid and SHSs. It then anchors on two main scenarios for the electricity-access model.

- **BAU:** This scenario projects electricity access in 2030 broken down by technology based on historical trends and validation of government plans. The BAU scenario helps estimate the projected deficit in each country to achieve universal electricity access
- **Forecast Scenario:** Once the deficit is ascertained, the forecast scenario assumes that households access Tier 1 electricity through SHSs or mini-grids. In the primary forecast scenario, the contribution of mini-grids is limited due to the current unfavourable regulatory environment in two of the focus

[109] Bhatia, M. and Angelou, N., 2015.

countries (Ghana and Mozambique). These assumptions around the split are based on the potential of SHSs and mini-grids to unlock universal electricity access.

ELECTRICITY- MODEL METHODOLOGY

The first step in calculating the total finance needs focuses on determining the number of households that will not reach universal access by 2030 in a BAU scenario ("transition households").

Consequently, the first step in calculating the number of transition households is breaking down the historical access of electricity by technology – grid, mini-grid and SHS. After that, the model projects electricity access through grids, mini-grids and SHSs based on the vetting of government expansion plans and projected growth trends validated with market participant interviews as part of the BAU scenario. All households that cannot access Tier 1 electricity through existing technologies are considered to be "transition households". The model then projects which technology will be used to service these transition households through two technologies – SHSs and mini-grids (Forecast Scenario).

TREND ANALYSIS AND SCENARIO DETAILS:

The detailed methodology for all three scenarios is described below:

Step 1. Historical access estimate: The model first ascertains the historical access of electricity in the focus countries from 2015 to 2020, based on the World Bank's Development Indicators. Based on a qualitative review of the sector and stakeholder interviews, the model assumes limited growth for 2020 due to short-term implications due to Covid-19. The model then breaks down the electricity access into three components– SHS, mini-grid access, and grid access.

- SHS-access calculations rely on GOGLA sales data from 2015–2020, and the data are adjusted to remove pico-solar products and purchases made by households with access to the grid. Additionally, the model also builds in assumptions to include the contribution to access of unbranded market products, defined in this report as non-GOGLA affiliated products. These assumptions are sourced from the most recent Lighting Global Off-Grid Solar Market reports and market participant interviews.
- Mini-grid estimates are based on currently operational mini-grid sites, and the data are primarily sourced from market reports and stakeholder interviews.
- Grid access is estimated by subtracting the above calculations from the overall access figure and triangulating the analysis with a review of in-country household surveys. (e.g., Ghana Living Standard Survey).

Step 2. BAU scenario: Based on the 2020 estimates for each country and projected growth of each technology, the model projects energy access by 2030. Note that under the BAU scenario, the model assumes limited regulatory reforms and is based on the current capacity of the government/market to deliver electricity access by 2030. The breakdown of projection by technology is as follows:

- SHS access is projected considering the same exclusions and inclusions as the historical forecast. The model assumes a projected compound annual growth rate (CAGR) for the market, sourced from market interviews and validated by secondary research. For example, the Mozambique market has been gathering momentum, and the model assumes that the market grows with a CAGR of 20 percent. The SHS calculation also excludes replacements sales (assuming product lifetime to be seven years), as they do not contribute to enabling electricity access for new households.
- Mini-grid access projections are based on an extensive review of planned government/donor projects in the pipeline. The model assumes that all projects are likely to be operational by 2030 and counts them towards providing electricity access.
- Grid access projections are based on a review and assessment of the government grid expansion plans, with a primary focus on the feasibility of achieving the targets given available funding. For example in Mozambique, while the government targets 70 percent grid access by 2030, multiple

reports, including ones by the AfDB project, indicate that this target will not be met. Hence the BAU scenario assumes a more conservative estimate of 38 percent grid access.

Step 3. Forecast scenarios: Based on the calculation of the population that will not reach electricity access by 2030 under the BAU scenario, the model assumes that electricity access can be enabled through two technologies – SHSs and mini-grids. Assumptions around the split are based on the potential of SHS and mini-grid in the focus countries to unlock universal electricity access.

- The primary forecast assumes a limited contribution of mini-grids given the regulatory framework of the focus countries. For example in Ghana, the regulatory framework mandates that all new mini-grids must be government owned. Hence, the primary forecast scenario assumes no contribution of mini-grids to enable universal electricity access in Ghana.
- The model also calculates an aggressive mini-grid scenario where mini-grid contribution to universal access is higher based on stakeholders' expectations of what a best-case scenario for mini-grid could look like when assuming changes in the regulatory framework.

PRIVATE SECTOR FINANCE GAP (SHSS AND MINI-GRIDS)

The model builds bottom-up calculations for finance requirements for SHS and mini-grid enterprises. These calculations estimate the operating expense and capital expense costs per household, depending on the type of company servicing them (start-up, mid-sized, established). The model then assumes a 2030 market share by type of private company for both SHSs and mini-grids to determine the finance needs broken down by type of instrument (grant, equity and debt). Further details on the methodology are provided below; steps 4 and 5 are common for mini-grids and SHSs).

Step 4. Overall private-sector finance: As a reminder, step 2 calculated the number of transition households assumed to be serviced by a particular technology in step 3. Step 4 then calculates the finance required by the private sector to enable universal access. First, the model calculates the finance needs per transition household equipped for SHSs and mini-grids as follows.

- SHSs: This includes the capital expenditure corresponding to procuring the system based on stakeholder interviews in each focus country. In addition, the model estimates working capital needs per household, based on expected cash flows from sales. Some of the needs are offset by the revenue generated, but the remaining make up the finance requirement. The model also assumes a default rate for payments (given that most products are sold on a PAYG basis), affecting the amount of revenue realized by the company. The default rate varies with the stage of the enterprise. The cost of customer acquisition is implicitly included in the capex per customer but is not explicitly spelled out.
- Mini-grids: The initial capital expenditure corresponds to setting up the mini-grid, including generation and distribution network, site development, metering and other logistics costs. In addition, the model estimates an operating expense requirement per household, which is driven by operational and maintenance cost and central operations of the mini-grid.

Working capital needs and capex costs are split by the size of the company since larger companies can benefit from economies of scale on procurement, which reduces capex per household and typically generates a positive cash flow. In contrast, smaller energy access enterprises generate smaller profit margins. The finance needs by transition households, therefore, depends on the type of enterprise that serves them.

Step 5. Private sector finance by instrument type: The next step establishes the breakdown of the private-sector finance needs by instrument based on the finance breakdown per enterprise type. In the model, the finance needs of the private sector differ by level of enterprise maturity. For example mini-grid start-ups in Mozambique primarily rely on grants (70 percent of the overall finance mix) and the remainder is covered by equity. Debt finance only start-ups become a part of the mix at the mid-sized enterprise stage. The model then estimates the 2030 "market share" of

the SHS/mini-grid market in each focus country by 2030 between start-up companies, mid-sized businesses, and scaled enterprises. For example, of the transition households to be serviced by SHSs in Ghana, 65 percent will be serviced by established companies, reflecting the maturity of the market and the scale that some of the more prominent companies have been able to achieve. These assumptions were validated from the private sector market survey and stakeholder interviews with both SHS and mini-grid enterprises and experts in the electricity access sector in all three focus countries. These assumptions are also based on comparable countries where the energy access sector is more mature.

Figure 74 and Figure 75 summarize the key calculation steps for SHSs and mini-grids, respectively. Assumptions regarding different cost and revenue components were sourced primarily from the private-sector market survey and interviews with market participants, and validated with existing market studies, including the *Pricing Quality Report on the Off-Grid Solar Sector* by GOGLA, SEforAll's *State of the Global Mini-Grids Market Report 2020*, and *Benchmarking Africa's Mini-Grid Report* by AMDA. Note that for SHS, the model calculates the financing cost of only one SHS per household, given that further replacements can be financed through ongoing savings.

FIGURE 74
Illustrative finance requirement for SHS enterprises (Mozambique)

		Organization Type		
	Units	**Start-Up**	**Mid-Sized**	**Established**
Cost Assumptions				
Total Units Sold - End of Phase (A)	# of SHS	500	5,000	20,000
System CAPEX - per Customer (B)	USD	45	40	35
System Retail Price (C)	USD	170	170	170
Upfront Payment (D)	USD	12	12	12
Default Rate (E)	in percent	30 percent	20 percent	10 percent
Operating Margin (F)	in percent	(10 percent)	(5 percent)	5 percent
Financing Mix Assumptions				
of which Debt	in percent	0 percent	20 percent	40 percent
of which Equity	in percent	30 percent	30 percent	40 percent
of which Grant	in percent	70 percent	50 percent	20 percent
Total	in percent	100 percent	100 percent	100 percent
Calculations - Total				
Revenue (G=A*(((1-E) *C)+(E*D))	USD	61,300	692,000	3,084,000
OPEX - Total (H=G*(1-F))	USD	67,430	726,600	2,929,800
Operating Cash Flows (I=G-H)	USD	(6,130)	(34,600)	154,200
CAPEX - Total (J=A*B)	USD	22,500	200,000	700,000
Capital Needs - Total (I+J)	USD	28,630	234,600	545,800
Calculations - Per Household				
CAPEX - Total	USD	45.0	40.0	35.0
OPEX - Total	USD	134.9	145.3	146.5
Capital Needs - Total	USD	57.3	46.9	27.3

Calculations - Per Household Financing Mix				
Debt	USD	-	9.4	10.9
Equity	USD	17.2	14.1	10.9
Grant	USD	40.1	23.5	5.5
Total	USD	57.3	46.9	27.3

FIGURE 75
Illustrative finance requirement for mini-grid enterprises (Mozambique)

		Organization Type		
	Units	**Start-Up**	**Mid-Sized**	**Established**
Cost Assumptions				
Total Units Sold - End of Phase (A)	# of MG	1	10	40
Households Customers Per MG (B)	USD	350	350	350
CAPEX per Connection (C)	USD	3,000	1,500	1,000
System CAPEX - per Mini Grid (D= A*B)	USD	1,050,000	525,000	350,000
Total Households Connected	# of HH	3500	3500	14,000
Operating Margin (E)	in percent	(20 percent)	(10 percent)	5 percent
Financing Mix Assumptions				
of which Debt	in percent	0 percent	10 percent	30 percent
of which Equity	in percent	30 percent	40 percent	40 percent
of which Grant	in percent	70 percent	50 percent	30 percent
Total	in percent	100 percent	100 percent	100 percent
Calculations - Total				
Revenue – Total (F)	USD	63,000	1,050,000	5,040,000
OPEX - Total (G=F*(1-E))	USD	75,600	1,155,000	4,788,000
Operating Cash Flows (H=F-G)	USD	(12,600)	(105,000)	252,000
CAPEX - Total (I=A*D)	USD	1,050,000	5,250,000	14,000,000
Capital Needs - Total (H+I)	USD	1,062,600	5,355,000	13,748,000
Calculations - Per Household				
CAPEX - Total	USD	3,000	1,500	1,000
OPEX - Total	USD	216	330	342
Capital Needs - Total	USD	3,036	1,530	982
Calculations - Per Household Financing Mix				
Debt	USD	-	153	295
Equity	USD	911	612	393
Grant	USD	2,125	765	295
Total	USD	3,036	1,530	982

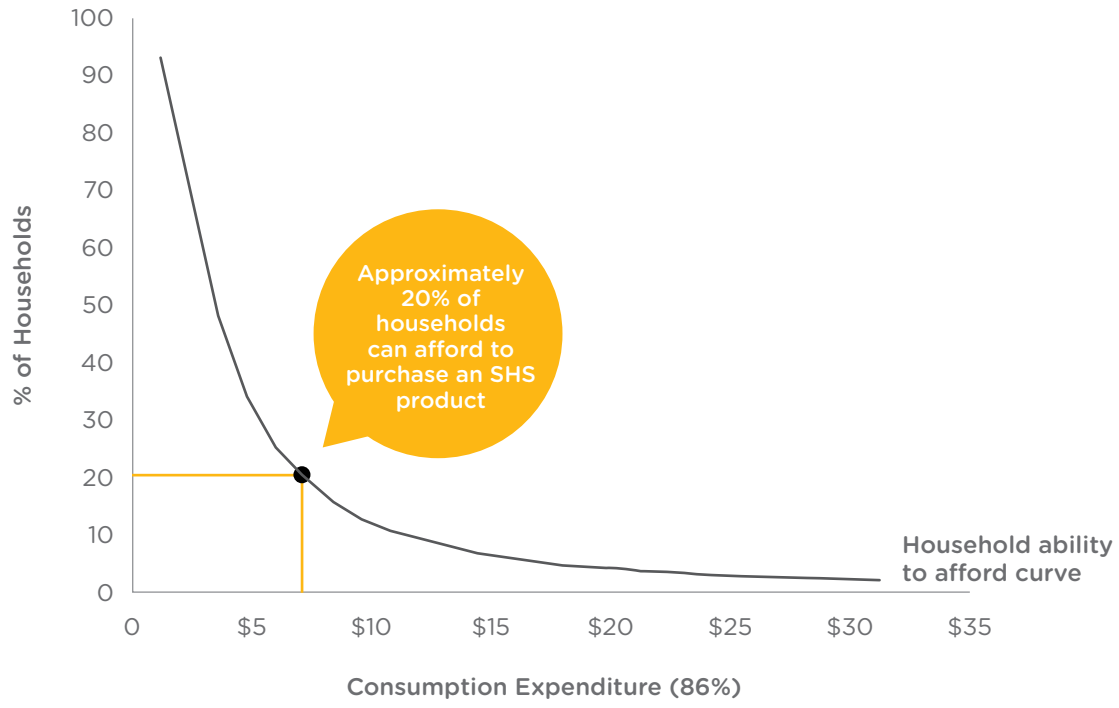
Step 7. Affordability Financing Gap: The affordability gap aims to calculate the financing required to enable SHS access for households that are unlikely to be able to afford it based on their current income. In line with the 2019 Taking the Pulse report, the affordability financing gap is estimated only for SHSs and not for mini-grids.

The model utilizes the World Bank tool, PovCalNet, for the affordability analysis. PovCalNet is an interactive online tool developed by the World Bank's Development Research Group staff to allow users to replicate the calculations made by the World Bank's researchers to estimate the extent of absolute poverty at different income/consumption levels. Note that the model does not take a view on future income levels, rather, the analysis is based on current consumption expenditures as provided by the PovCal tool.

Based on the analysis of existing reports documenting expenditure on electricity and phone charging (IRENA 2016) and validation through stakeholder interviews, the model assumes that households currently spend 8 percent of their consumption expenditure on electricity needs. The model uses these data to formulate a reasonable assumption on the share of expenditure households would be able to allocate to an SHS purchase. The model then converts this amount for each household to USD based on their current consumption level, using the World Bank PovCal tool. All households for which 8 percent of consumption expenditure is less than the total monthly payments for purchasing the SHS are deemed unable to afford it and they contribute to the affordability gap financing.

Figure 76 illustrates the affordability cut-off in Mozambique using the adjusted PovCal graph. This is based on a USD 170 Tier 1 SHS purchase on PAYG financing with the monthly repayments spread over a period of two years. To be able to afford an SHS, households must spend USD 170 over 24 months (USD 7.08 per month) on electricity. The PovCal tool shows that 20 percent of households in Mozambique qualify under that definition.

FIGURE 76
Illustrative SHS affordability curve (Mozambique)



All households unable to afford the SHS product contribute to the affordability gap. The affordability gap is then calculated by multiplying the product's retail price of USD 170 by the number of households that cannot afford the product as per the PovCal calculation. Figure 77 summarizes the affordability gap calculation.

FIGURE 77
Illustrative SHS affordability gap calculation (Mozambique)

Parameter	Unit	Value
Monthly Savings Cut-off	percent	8 percent
Retail Price (A)	USD	170
Monthly Installment for 2 years (A/24)	USD	7.08
Households that cannot afford product (B)	percent of HH	79.8 percent
Number of Households in 2030 (C)	Million	4.6
Affordability Financing Gap (A*B*C)	USD M	630

The total financing gap to enable Tier 2/Tier 3 access in each of the focus countries is defined as the sum of the private-sector financing gap (split into different types of capital) and affordability financing gap.

Step 8. Comparison with other sources: The International Energy Agency (IEA) estimates a cumulative investment need in Mozambique of USD 30–35 billion by 2040 to achieve universal access to clean cooking and electricity. These numbers are not immediately comparable to this report's analysis due to a different objective and methodology. Most of the cost calculated by the IEA comes from access to electricity driven by grid electrification as opposed to access to off-grid electrification calculated in this report, resulting in a higher cost of electricity access. IEA also assumes a specific fuel mix that includes ICS and does not size universal Tier 4 access or the cost associated with switching to clean fuels, resulting in lower access to clean cooking estimates. IEA estimates for Vietnam are not available (IEA 2019).

CLEAN COOKING - DEFINING ACCESS

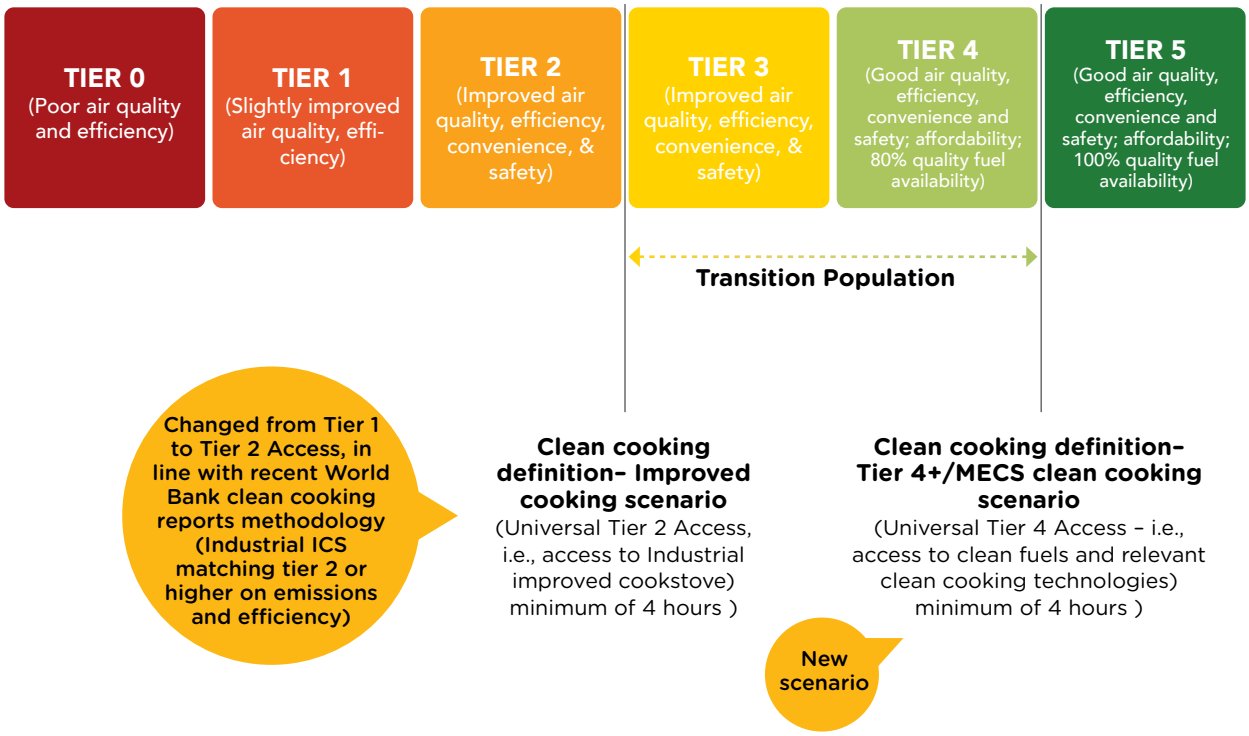
Taking the Pulse 2021 relies on the MTF developed by the World Bank to define access to clean cooking. The MTF measures access to clean cooking solutions based on multiple attributes: health (based on household air pollution); convenience (based on fuel collection and stove preparation time); affordability (including expenditure on cookstove and fuel), safety, efficiency, quality, and availability.

For clean cooking, this report measures the deficit in both Tier 2/Tier 3 and Tier 4 levels. While the report examines the status of Tier 2/Tier 3[110] access as a fundamental baseline for 2030, it also focuses on access to modern energy cooking services through a measurement of Tier 4 clean cooking access. Tier 4 encompasses a more comprehensive definition of "access" that includes higher levels of air quality, efficiency, convenience, and safety of the cookstove relative to ICS, as well as the affordability and availability of quality fuel. It is typically only achieved by the widespread use of clean fuels like electricity, liquefied petroleum gas (LPG), ethanol, gas pellets and biogas. Tier 4 access, which is undoubtedly the gold standard, remains currently elusive even in several middle-income countries with large unserved populations such as China and Vietnam. It represents an ambitious and expensive target, especially by 2030, because it requires large shifts in terms of fuel usage, which in turn

[110] This report anchors on a Tier 2/Tier 3 stove that costs USD 35 and provides additional efficiency compared with the cookstoves currently in use in Ghana (gyapa) or typical ICS found in Mozambique.

require significant subsidies, behavioural change within households, and additional infrastructure investments for some solutions. *Taking the Pulse 2021* focuses on Tier 2/Tier 3 given that in the three focus countries, there is already a local market for ICS (e.g., gyapas in Ghana) that provide increased efficiency; there is an opportunity to move gyapa stove users to higher-efficiency stoves and move these households further up the energy ladder. The cost of doing so has been factored into the estimated Tier 2/Tier 3 universal access finance needs.

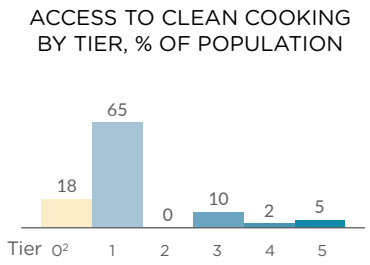
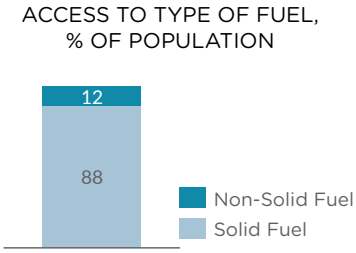
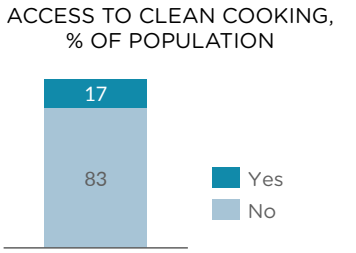
FIGURE 78
Overview of clean cooking access tiers



Unlike other approaches (Shell Foundation; Rockefeller Foundation 2021) that also provide a useful and consistent insight into the cost of transition for specific cooking fuel mix scenarios, this report does not take a perspective on future Tier 4 clean fuel mix for universal access. Instead, it provides a view of BAU 2030 fuel access by technology, then estimates the funding needed for universal Tier 4 transition across a range of fuels.

A more incremental pathway consists of providing universal access to Tier 2/Tier 3 cooking and focuses on moving households up the energy ladder gradually over time. This is in line with previous editions of Taking the Pulse and represents the minimum level of access that must be reached. Tier 2/Tier 3 access can generally be reached with ICS, which improve efficiency, reduce fuel costs, and lower emissions relative to conventional cookstoves (typically of 30 to 40 percent), but access typically still relies on biomass (that produces emissions and is often labour intensive for fuel gathering). Exposure to air pollution is a known risk and an estimated 4 million premature deaths occur annually due to household air pollution linked to cooking with traditional stoves and fuels (ESMAP 2020). Since ICS generate emission avoidance, they can yield carbon credits if use is monitored.

FIGURE 79
Comparing different definitions of clean cooking access

Definition	Methodology	Sources	Pros and cons	Example
MTF framework*	Access to clean cooking on a MTF (Multi-Tier Framework) non-binary scale	World Bank MTF Surveys	5 tiers of access based indoor air quality, cookstove efficiency, convenience, safety, affordability and availability of fuel Technologies and fuels split across tiers based on actual uptake and impact Country-specific data available in select countries only; may be less recent	
Access to Non-Solid Fuels	% of the population having access to non-solid fuels	• DHS Surveys • WHO Household Energy Database • National surveys	Does not account for the usage, availability and affordability of clean fuels No scope to include other technologies that lead to improved cooking like ICS	
Access to Clean Fuels	% population primarily using clean cooking fuels and technologies	• World Bank Indicator Database • IEA	Integrates primary usage and expands the cooking technologies in definition of access Does not include other dimensions that affect uptake, including convenience, affordability etc.	

*Developed by ESMAP. See annex for detailed framework
**Tier 0 implies no access to clean cooking

Mapping technologies to tiers: Different technologies help improve access to clean cooking, including clean fuels like LPG, ethanol, electricity and pellets, and cooking technologies like ICS. "Clean" fuels are usually mapped to higher tiers than access to ICS. However, primary fuel and stove type are not the only attributes that inform the eventual Tier of the household. The MTF framework also focuses on health, convenience, and affordability, which can propel or push down a household on the clean cooking access ladder. For instance, in Ghana, while 29 percent of the population uses clean fuels, access to Tier 4 and above is only 14 percent. This is primarily due to other household being pegged down due to concerns around either affordability, convenience or availability of fuel. Figure 80 provides a mapping of what each Tier of clean cooking translates to for all seven indicators used by the MTF framework.

FIGURE 80

Multi-Tier Framework for measuring access to modern energy cooking solutions

ATTRIBUTES		TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
Cooking Exposure	Emission: Fuel	Firewood, dung, twigs, leaves, rice husks, processed biomass pellets o briquette, charcoal, kerosene				Biogas, ethanol, high quality processed biomass pellets or briquettes	Electricity, solar, LPG
	Emission: Stove Design	Three-stone fire, tripod, flat mud ring, traditional charcoal stove	Conventional or old generation ICS	ICS + chimney, rocket stove or ICS + insulation	Rocket stove with high insulation or with chimney, advanced insulation charcoal stoves	Rocket stove with chimney (well sealed), Rocket stove gasifier, Advanced secondary air charcoal stove, forced air	
	Ventilation: Volume of Kitchen	Less than 5 m^2	More than 5 m^2	More than 10 m^2	More than 20 m^2	More than 40 m^2	Open air
	Ventilation: Structure	No opening except for the door	1 window	More than 1 window	Significant openings (large openings below or above the height of the door)	Veranda or a hood is used to extract the smoke	
	Ventilation Level	Bad			Average	Good	
	Contact Time	More than 7.5 Hours	Less than 7.5 hours	Less than 6 hours	Less than 4.5 hours	Less than 3 hours	Open air
		Bad			Average	Good	
Cookstove Efficiency	ISO's voluntary performance targets (TBC)	Less than 10%	More than 10%	More than 20%	More than 30%	More than 40%	More than 50%
Convenience	Fuel acquisition and preparation time (hours per week)	More than 7 hours		Less than 7 hours	Less than 3 hours	Less than 1.5 hours	Less than 0.5 hour
	Stove preparation time (minutes per meal)	More than 15 minutes		Less than 15 minutes	Less than 10 minutes	Less than 5 minutes	Less than 2 minutes
Safety		Serious accidents over the past 12 months				No serious accidents over the past year	
Affordability		Levelized cost of cooking solution (fuel) more than 5% of household income				Levelized cost of cooking solution (fuel) less than 5% of household income	
Fuel availability		Primary fuel available less than 80% of the year				Primarily fuel readily available 80% of the year	Primary fuel readily available throughout the year

CLEAN COOKING - MODEL METHODOLOGY

The first step of calculating the overall transition cost for both the scenarios (Tier 4 and Tier 2/Tier 3) is common. It focuses on determining the number of households that need to be transitioned by 2030 ("transition households"). Transition households are defined as the households that will be unable to access clean cooking technologies by 2030 under a BAU scenario.

To calculate the number of transition households, the model first estimates the number of households belonging to each tier by 2030 under a BAU scenario, estimating how many households would access higher clean cooking tiers. All households projected to be below Tier 4 and Tier 2/Tier 3 by 2030 are considered to be transition households.

Calculating the Tier distribution of households in 2030 involves four steps:

Step 1. Number of households belonging to each access Tier in archetype countries: The model first calculates the "archetype ratio" for a select set of archetype countries featuring reliable and recent World Bank MTF data. Archetype ratios provide a view on the tier distribution of households for a given primary fuel. These ratios are computed separately for urban and rural households. Figure 81 shows the tier distribution for urban households in Zambia based on their primary fuel. As evident from the table, almost all households (99 percent) using charcoal are below Tier 2. For those households using LPG, 77 percent are Tier 4 and above, while 23 percent are Tier 2/Tier 3, possibly due to issues around fuel convenience, affordability and availability. Similarly, for households using electricity, the households are split relatively equally across Tier 4 and above (44 percent) and Tier 2 and Tier 3 (56 percent).

FIGURE 81
Tier access for urban households in Zambia based on primary fuel used (MTF data)

Primary fuel	LPG	Electricity	Charcoal
Tier 4 and above	77 percent	44 percent	-
Tier 2/Tier 3	23 percent	56 percent	1 percent
Below Tier 2	-	-	99 percent
Total	100 percent	100 percent	100 percent

Step 2. Mapping Archetype and Focus Countries: Given that MTF data are available only for specific countries, the model mapped the three focus countries to one of the archetype countries for which MTF data are available,[111] The central idea behind this mapping is to ensure each focus country is tagged to its closest possible archetype based on: i) similarities in the distribution of households across tiers based on the primary fuel; and ii) similar fuel mix. The assessment was based on a qualitative review of the MTF reports, which break down the distribution of households into tiers based on primary fuel and stove type. Using these data, inputs from qualitative interviews in focus countries and vetting via quantitative indicators, the model generated the final mapping for all three focus countries. While the final assessment was qualitative, the mapping was validated by comparing the model results with the IEA estimates of clean cooking (the IEA definition closely match to Tier 2 and above access to clean cooking). The final mapping is as follows:

- Ghana – Nigeria[112]
- Mozambique – Zambia
- Vietnam – Nepal

Mapping Mozambique to Zambia. MTF data for Zambia suggest that a large population using biomass fuels uses open fire or traditional cookstoves, consequently leading to lower tiers of access (Tier 0/Tier 1). Additionally, there is limited penetration of industrially manufactured stoves in

[111] Cambodia, Myanmar, Nepal, Nigeria, Rwanda and Zambia.
[112] The MTF survey in Nigeria focused on north-western Nigeria.

the country. Both of these factors are consistent with the situation in Mozambique based on stakeholder interviews and in both countries LPG penetration is limited. The concentration of access to Tier 4 solutions in Zambia is in wealthier urban areas, similar to the situation in Mozambique where LPG is primarily used in Maputo. The country mapping is cross-checked against available third-party data for clean cooking access. Computing access tiers for Mozambique based on the mapping to Zambia, this report finds that Tier 2 access was 6.1 percent in 2020. This is consistent with the IEA's latest estimate of clean cooking access in Mozambique of 6.3 percent.

Mapping Vietnam to Nepal. Vietnam is mapped to Nepal due to similarities in fuel mix (high prevalence of LPG, limited charcoal usage), and the mapping is validated through stakeholder conversations. Computing access tiers for Vietnam based on the mapping to Nepal, this report finds that Tier 2 access was 69 percent in 2020. This is broadly consistent with the latest IEA estimate of clean cooking access in Mozambique of 73 percent.

Mapping Ghana to Nigeria. Ghana is mapped to Nigeria based on similarities in reliance on biomass fuels in rural areas and prevalence of ICS. The mapping is validated by computing access Tiers for Ghana, where the report finds that Tier 2 access is 32 percent, and the IEA estimates the access of clean cooking in Nigeria to be about 25 percent.

Step 3. Calculating Fuel Mix for 2030: Based on the latest available data for fuel mix for each focus country (sources include USAID Demographic Health Survey (DHS) and UNICEF Multiple Indicator Cluster Survey (MICS), the model projects the 2030 primary fuel mix for cooking in rural and urban areas. The model uses urbanization trends based on World Bank estimates, projections around the uptake of clean fuels, and inputs from stakeholder interviews to project the primary fuel mix. The forecast also considers the trajectory of the countries in the adoption of different clean fuels based on current investments and historical trends. For example, in Ghana, multiple rounds of DHS data (2014, 2017 and 2019) showed an increase in LPG uptake in urban areas. This trend in growth was factored into the projected mix for 2030 and checked with stakeholders. Additionally, stakeholder interviews with in-country experts were used extensively to validate the 2030 fuel mix. In Ghana, the rate of growth of LPG uptake is expected to slow based on stakeholders' perspectives.

Step 4. Calculating Tier Distribution: Multiplying the archetype ratios from step 1 (based on the relevant archetype country) with the primary fuel mix for 2030 from step 3, the model estimates the distribution of households across different tiers in 2030. Additionally, all households below Tier 4 are labelled as "transition households" for the aggressive and optimistic Tier 4 scenario, and all households below Tier 2 are marked as "transition households" for the more realistic Tier 2 scenario. The distribution also indicates the percentage of households projected to have access to Tier 4 and Tier 2 access to clean cooking in 2030 under a BAU scenario.

The model also performs a similar calculation with the 2020 primary fuel mix to ascertain the current levels of access to different tiers of clean cooking. The fuel mix data are primarily sourced from large-scale surveys like the USAID DHS for Ghana and Mozambique and the UNICEF MICS for Vietnam. The data are also consequently adjusted to account for the urbanization trends in all three countries.

SCENARIO: TIER 4 ACCESS

This section is a new addition to the Taking the Pulse report, with a focus on estimating the overall transition cost of enabling Tier 4 access to all households by 2030 using clean fuels. This methodology is largely in line with prior reports that have estimated the cost of universal access to clean cooking (ESMAP 2020). The model estimates the cost of universal transition for three clean fuels – LPG, ethanol and electricity. Based on the starting Tier of the household, the model assumes a specific transition time for the household to unlock Tier 4 cooking access during which these households receive fuel subsidies to account for the higher cost of clean fuel compared with Tier 2 and below fuels – primarily firewood. Households

below Tier 2 are provided transition support for 10 years, and Tier 2/Tier 3 households are provided support for five years.

The overall transition cost is divided into four new steps (steps 5 through 8).

Step 5. Fuel Cost: Ongoing fuel cost is the most significant contributor to the overall transition cost. The model assumes 10 years of fuel cost for households below Tier 2 and five years of fuel cost for Tier 2/Tier 3 households based on the report's BAU calculation. This report assumes that 10 years are required to achieve full displacement of basic cooking technologies and practices – in line with prior studies on the topic (ESMAP 2020).

Fuel costs also vary significantly by technology and country and have varying calorific values. Figure 82 summarizes fuel cost used per household for LPG in Mozambique. Fuel price assumptions are sourced through interviews with market participants and national statistics where available. Fuel consumption (in kilograms or litres) is assumed to be the same across countries. For electric cooking, the calculation assumes a yearly fuel usage of 960 kWh for induction stoves, and 250 kWh for electric pressure cookers. The cost of electricity is ascertained from the residential tariffs applicable in respective countries; Ghana: USD 0.16/kWh; Mozambique USD 0.14/kWh; and Vietnam USD 0.13/kWh.

Note that these costs are based on July 2021 LPG retail costs obtained from stakeholder interviews and national reporting statistics. LPG prices have moved in the past along with oil prices and can be volatile. Current LPG prices are not reflective of long-term average prices and do not represent a forecast of 2030 fuel prices. Unlike LPG, which is an established fuel, there are also multiple variables of uncertainty around ethanol prices because the technology is not used at scale. Therefore, this report relies on industry experts' expectations to determine a range of potential ethanol costs of USD 0.6 to 0.8 per litre.

FIGURE 82
Illustrative LPG fuel cost per household calculation (Mozambique)

Fuel transition cost per household	**Unit**	**Value**
Cost per kg of LPG		
45 kg cylinder at market price	USD/kg	0.96
11 kg cylinder at market price	USD/kg	0.93
8 kg cylinder at market price	USD/kg	1.09
Average LPG cost (A)	USD/kg	0.99
Annual LPG consumption per capita		
Yearly fuel usage per capita for 1 GJ	kg	38
GJ per capita	GJ	1
Yearly fuel usage per capita (B)	kg/per capita	38
Average household size (C)	#	4.37
<T2 support: years of price support (D.1)		10.0
T2+T3 support: years of price support (D.2)		5.0

Annual fuel cost per household		
<T2 Transition cost of fuel (A*B*C*D.1)	USD	**1,646**
T2+T3 Transition cost of fuel (A*B*C*D.2)	USD	**823**

Step 6. Stove Cost: This calculation models the cost of providing two-burner stoves for all households. The cost of a stove varies by transition technology (LPG, ethanol, electricity) and by country. The model uses data from interviews with market participants, research reports by key innovators in the clean cooking sector (SNV, GLPGP) and global benchmarks to arrive at the final cost of a stove for each scenario. The model assumes that for households that are projected to fall below Tier 2 in a BAU scenario, one stove will be required, consistent with 10 years of transition support. However, for households that are Tier 2 and Tier 3 under a BAU scenario, the model assumes that one stove will need to be provided for transition to Tier 4.

Step 7. Infrastructure Cost: The model also measures the marginal infrastructure cost per household to enable the transition to Tier 4 access, along with the total cost of infrastructure. The focus of the infrastructure cost calculation is primarily on midstream infrastructure, including collection, storage and distribution of fuel. The model extensively leverages existing research by in-country organizations like SNV in Vietnam and Mozambique and GLPGP in Ghana to calculate the infrastructure cost of enabling access to Tier 4 solutions in aggregate. The aggregate cost is then divided by the number of transition households. The cost is then scaled to reflect universal transition for each technology. For ethanol, the infrastructure cost is sourced from a bottom-up assessment of clean fuels in Kenya and adjusted for the context of each of the specific countries.

Step 8. Behavioural Change Cost: Given that these transitions are often challenging and require significant customer-awareness efforts and campaigns, the model also estimates the additional cost of efforts to encourage behavioural change. This cost is likely to be channelled through behavioural-change and customer-awareness campaigns, other technical assistance etc. This is assumed to be the same across technologies and is calculated as 5 percent of the overall transition cost for universal LPG transition. This assumption is consistent with the methodology used by the State of Access to Modern Energy Cooking Services report (Dalberg 2018).

Deep dive: Similarities and differences between clean fuels

The clean fuels evaluated in *Taking the Pulse 2021* share similar characteristics as well as some differences that impact both their applicability in specific country contexts and the overall cost of universal access. Some of the critical differences include infrastructure requirements, delivery costs, and available financing sources.

Infrastructure requirements: Highest among clean fuels are the distribution and filling infrastructure requirements associated with LPG. Beyond upstream infrastructure required to extract and, in some cases, import LPG, infrastructure needs are significant, including bottling plants and cylinder manufacturing plants to replace older cylinders. LPG must be bottled before it can be distributed and must be refilled frequently in cylinders of 3 kg, but more frequently of up to 15 kg. Ethanol can require more limited infrastructure investments since there is no bottling requirement. KOKO Networks in Kenya for instance leverages 600 "fuel ATM" distribution points from which consumers can directly refill an ethanol canister. The KOKO network model does

away with bottling investments and leverages small, retrofitted fuel tankers to transport ethanol in bulk to dedicated tanks at petrol stations. Fuel ATMs inside shops dispense ethanol into reusable containers. Overall, required investments for these technologies depend on a specific country's circumstances and pre-existing oil distribution network for ethanol, and LPG-specific infrastructure for LPG. For electricity, this report does not take into account the cost of additional generation associated with the universal electric cooking scenario.

Last-mile delivery: Across fuels, last-mile delivery remains complex and costly, particularly in rural areas and for liquid fuels as their weight makes them expensive to transport by road. In northern Mozambique where there is no import port for LPG, the cost of transporting LPG from Maputo in the south, where the LPG infrastructure is located, is prohibitive, resulting in very limited LPG uptake in the northern half of the country. In comparison, electricity can be delivered wherever grid solutions exist or where there are mini-grids with sufficient power. While some electric pressure cookers can run on SHSs, the level of access achieved is not defined as Tier 4.

SCENARIO: TIER 2/TIER 3 ACCESS

The approach to estimate the total finance needs for universal Tier 2/Tier 3 access is in line with the *Taking the Pulse 2019* report. It estimates the private-sector finance needs to enable Tier 2/Tier 3 access to all households by using high-end ICS.

The model anchors on the higher-cost products (USD 30–35) that enable Tier 3 transition provided other MTF criteria are met that are not connected to the stove, such as convenience of gathering fuel. If those criteria are not met, then the household would fall within the definition of Tier 2 access.

Calculating capital expense and operating expense costs per household, the model arrives at a finance needs per transition household that varies depending on the type of private company servicing them. The model then makes an assumption on 2030 market share by type of private company to determine the finance needs breakdown by type of instrument.

Calculating the tier distribution of households in for Tier 2/3 access involves the same four steps as for Tier 4 access. After step 4, the methodology differs.

Step 5. Overall private sector finance: As a reminder, Step 1 estimates the number of transition households. For Tier 2/Tier 3 access, all households below Tier 2 in the BAU scenario are assumed to be transition households for Tier 2/Tier 3 access. The model assumes that in this scenario, each household is provided with an ICS and therefore achieves Tier 2/Tier 3 cooking access. Step 5 then calculates the financing required by the private sector to enable universal access.

First, the model calculates the finance needs per transition household equipped. This includes the estimated capital expenditure required to procure the system, which is based on stakeholder interviews in each focus country. In addition, the model estimates working capital needs per household, which is based on expected cash flows from sales.

Working capital needs and capex costs are split by size of company, since larger companies are able to benefit from economies of scale on procurement, which reduces capex per household, and typically generate a positive cash flow where smaller energy access enterprises generate smaller profit margins. The finance needs by transition household therefore depends on the type of enterprise that serves them.

Step 6. Private sector finance by instrument type: The next step establishes the breakdown of the private-sector finance needs by instrument based on the financing breakdown per enterprise type. In the model, the finance needs of the private sector differ by level of enterprise maturity. Start-ups typically rely more on grants (up to 60

percent in Mozambique), while more established companies can leverage debt for up to 50 percent of their funding.

The model then estimates the 2030 "market share" of the clean cooking market in each focus country by 2030 between start-up companies, mid-sized businesses, and scaled enterprises. For example, in Mozambique, the model assumes that 60 percent of transition households will be serviced by companies in the start-up phase, reflecting the nascent maturity of the sector today. These assumptions were validated from the private-sector market survey and stakeholder interviews with ICS enterprises and experts in the clean cooking sector in all three focus countries, alongside reasonable assumptions based on comparable countries where the energy access sector is more mature.

Figure 83 summarizes the key calculation steps. Key assumptions around the retail price, capex per product, operational margin and the financing mix are sourced primarily through in-country stakeholder interviews and the private-sector market survey. Note that the model calculates the financing cost of only one stove per household given that further replacements can be financed through on-going fuel savings.

FIGURE 83
Illustrative finance requirement for ICS providers (Mozambique)

		Organization Type		
Description	**Units**	**Start-Up**	**Mid-Sized**	**Established**
Cost Assumptions				
Total Units Sold - End of Phase (A)	# Of ICS	500	5000	20,000
System CAPEX - per Customer (B)	USD	30	27.5	25
System Retail Price (C)	USD	35	35	35
Operating Margin (D)	in percent	(10 percent)	(5 percent)	5 percent
Financing Mix Assumptions				
of which debt	in percent	10 percent	30 percent	50 percent
of which equity	in percent	30 percent	30 percent	30 percent
of which grant	in percent	60 percent	40 percent	20 percent
Total	in percent	100 percent	100 percent	100 percent
Calculations - Total				
Revenue – Total (E=A*C)	USD	17,500	175,000	700,000
OPEX - Total (F=E*(1-D))	USD	19,250	183,750	665,000
Operating Cash Flows (G=E-F)	USD	(1,750)	(8,750)	35,000
CAPEX - Total (H=A*B)	USD	15,000	137,500	500,000
Capital Needs - Total (G+H)	USD	16,750	146,250	465,000
Calculations - Per Household				
CAPEX - Total	USD	30.0	27.5	25.0
OPEX - Total	USD	38.5	36.8	33.3
Capital Needs - Total	USD	33.5	29.3	23.3

Calculations - Per Household Financing Mix				
Debt	USD	3.4	8.8	11.6
Equity	USD	10.1	8.8	7.0
Grant	USD	20.1	11.7	4.7
Total	USD	33.5	29.3	23.3

Step 7. Affordability Financing Gap: The affordability gap aims to calculate the financing required to enable ICS access for households that are likely to be unable to afford it based on their current income. Like the electricity model, the model utilizes the World Bank tool, PovCalNet, for the affordability analysis.

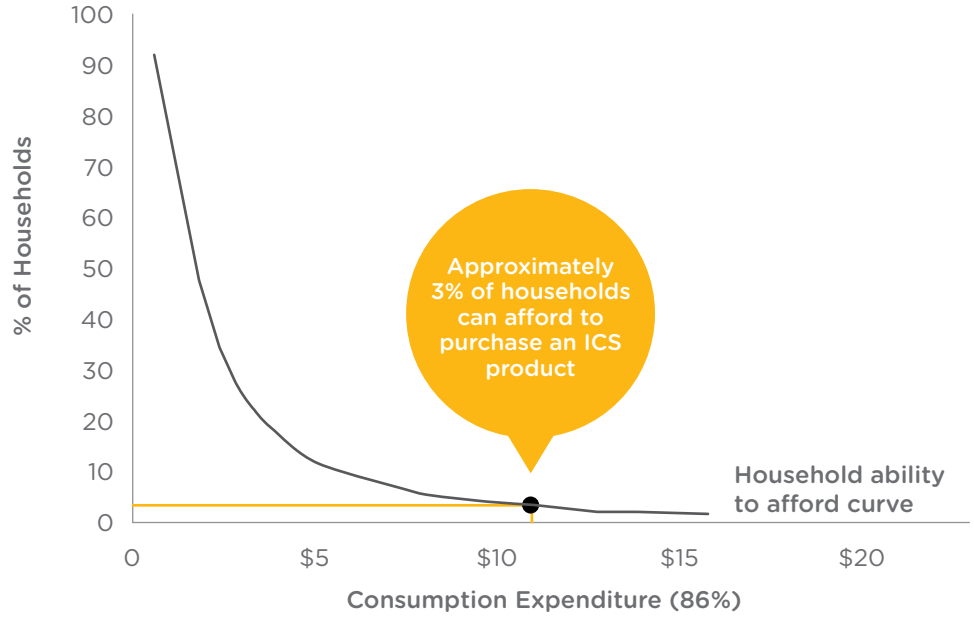
The model assumes no PAYG or consumer finance is available. The model therefore sizes a "worst-case" affordability gap equal to 100 percent of the system cost. However, it should be noted that when consumer finance is available, upfront payments are lowered, and more households are able to afford energy access systems. In these situations, the affordability gap would be lower.

The model also does not take a view on future income levels; rather, the analysis is based on current consumption expenditures as provided by the PovCal tool.

Based on external research validated through stakeholder interviews, households currently spend 4–6 percent of their consumption expenditure on cooking fuels. The model uses those data to formulate a reasonable assumption on the share of expenditure households would be able to allocate to a stove purchase. This amount is approximately 4–6 percent of household consumption over three months. The model then converts this amount for each household into USD based on their current consumption level, using the World Bank PovCal tool. All households for which 4–6 percent of their savings represents less than the total value of the stove are deemed unable to afford it and are considered transition households.

Figure 84 illustrates the affordability calculation in Mozambique. To be able to afford an ICS, households must be able to save USD 35 over three months (USD 11.67 per month) to be considered able to afford a stove per the methodology above. The PovCal tool shows that just 3 percent of households in Mozambique qualify under that definition.

FIGURE 84
Illustrative ICS affordability curve (Mozambique)



All households unable to afford an ICS contribute to the affordability gap. The affordability gap is then calculated by multiplying the product's retail price of USD 35 by the number of households that are unable to afford the product as per the PovCal calculation. Figure 85 summarizes the affordability gap calculation.

FIGURE 85
Illustrative affordability gap calculation (Mozambique)

Parameter	Unit	Value
Monthly savings cut-off	percent	4 percent
Retail price (A)	USD	35
Monthly savings for 3 months (A/3)	USD	11.7
Households that cannot afford ICS (B)	percent of HH	96.9 percent
Number of households in 2030 (C)	Million	8.8
Affordability Financing Gap (A*B*C)	$M	300

The total financing gap to enable Tier 2/Tier 3 access in each of the focus countries is therefore defined as the sum of the private-sector financing gap (split into different types of capital) and the affordability financing gap.

POTENTIAL IMPROVEMENTS IN METHODOLOGY AND RESEARCH QUESTIONS

In a bid to continue to push the analysis forward, suggestions for further research and potential methodology improvements are outlined in this section.

Size multiple electricity access scenarios: While the current report takes a step forward in refining the electricity access definition by excluding pico-solar products, subsequent versions can build on that by defining multiple Tier scenarios for electricity (as illustrated for clean cooking in this report). A higher tier scenario such as Tier 3 electricity access can help capture the nuances of electricity usage beyond household lighting.

Calculate the cost of Tier 4 access with other clean fuels: The current report measures universal Tier 4 transition through LPG, ethanol and electricity. However, a few other technologies like pellet gasification or biogas could also become relevant in enabling universal Tier 4 access. While these technologies are currently in a nascent stage, subsequent versions could include some of these technologies as part of the universal transition solution set.

Incorporate carbon pricing into Tier 4 access cost estimates: While this report provides qualitative commentary on the linkage between Tier 4 access and carbon financing, further research could quantitatively assess the impact of carbon credits through a more thorough scenario analysis.

Adjust affordability calculations to include price and GDP growth: The current model calculates the private-sector financing and affordability gap based on the current income distribution and assumes a constant retail price of the system (SHS and ICS) up until 2030. However, there is scope to account for the change in prices given improvements in technology (e.g., decreasing cost of solar batteries) and projected GDP growth to ascertain affordability and finance needs for SHSs/ICS by 2030.

Validate private-sector assessment of its grant finance needs: Test by how much the share of grant financing needed by the private sector would reduce the cost of hardware for households and how that compares to their ability to pay.

Incorporate long-term LPG forecasts to estimate future LPG prices: Use long-term LPG forecasts in addition to current LPG prices to calculate a range for the LPG Tier 4 cost scenario.

GENDER LENS: REPORT APPROACH AND KEY OBSERVATIONS

This edition of Taking the Pulse uses a gender lens to analyze the energy access sector of the focus countries. The report largely validates existing research. It confirms that women's participation in the energy sector remains low, whether as customers, employees or entrepreneurs. Stakeholder interviews indicate that when women can participate, the outcome is positive in terms of increased incomes for them and additional revenue for enterprises – although stakeholders recognize that additional data are required to quantify these impacts. Policies to encourage women's participation have been implemented in select companies in the three focus countries successfully and focus on actively creating work conditions that are adapted to women, including tailored hours and shortened sales trips (e.g., PEG in Ghana). This confirms the findings from *Energizing Finance: Understanding the Landscape 2021* that greater financing is also needed for gender-focused energy-access initiatives.

Additionally, more research and data collection are needed to clearly frame the issues women face in the energy sector in these countries and design appropriate responses. However, few policies have focused on increasing women's participation as customers, which could be an area for further research. Stakeholder interviews recommend leveraging people-centred design to include women in developing products best suited to their needs.

Women's participation as electricity customers continues to remain low. A multi-country study, not specific to these three countries, determined that 68 percent of electricity customers are men and men are decision-makers in 61 percent of homes (60 Decibels 2020). Clean cooking access reflects traditional cooking roles, with women accounting for 52 percent of clean cooking customers. Clean cooking enterprises interviewed stated 60–70 percent of customers are women[113] and women in particular benefit from energy access for productive uses and income generation. A study in Ghana found that the number of women entrepreneurs increased by 29 percent once electricity became accessible, with women's incomes increasing up to 11 times (Power Africa 2019). PAYG could be an opportunity to better target women customers since women have less available income to purchase hardware but tend to have mobile ownership and internet access. However, limited evidence has been collected to date (CGAP 2020).

Additionally, while further research is needed, there are some indications that successful gender strategies require further segmenting. Female customers have different needs and require different approaches; women should be targeted if they are involved in the household's decision-making process.

Women's participation in the energy sector as entrepreneurs and employees remains low with access to capital as one of the critical barriers faced by female entrepreneurs. Research for this report encountered few female entrepreneurs in the focus countries, with one notable exception in Ghana (Black Star). A few female-owned enterprises were identified in other countries, including Madagascar, Sierra Leone and Liberia, such as Easy Solar and AMKA. Support groups for women exist and actively support women in the field, for example, Women in Energy Mozambique and international organizations, donors, private companies and governments are beginning to incorporate a gender lens into their energy policies and strategies.[114]

[113] Market participant interviews.
[114] Notable examples include Greenlight, Enabel and Mireme that elaborated recommendations for the acceleration of gender mainstreaming (SDG5) on the efforts to achieve SDG7 by 2030 in Mozambique.

Some companies interviewed are promoting women in management teams. Mentorship programmes for mid-level managers and specific targets for women in leadership are some of the tactics used in the three focus countries by some companies, e.g., PEG in Ghana. Policies actively working around female employees also need to successfully increase their share, such as accommodating work trips to be shorter for women as they may conflict with other duties.

Other organizations focus on female entrepreneurship in the energy sector and provide training and support for women to sell solar lanterns in their communities, contributing to income increases and enhancing agency for these women entrepreneurs.

Key recommendations to increase women's participation include:

- Ensure energy and financial solutions that overcome barriers and meet women's needs. Use a people-centred design approach to include women in developing products, policies and financing instruments intended to serve their needs.
- Enhance tracking of finance to energy-access projects with a gender equality objective. To accomplish this, projects could be required in the project documentation to meet specific criteria as outlined in SEforALL's 2020 Energizing Finance edition:
    - Setting out the context of gender inequality in the sub-sector and region where the project will be implemented, referencing the types of inequalities listed.
    - Establishing and stating the project's intent to address the identified gender inequality in each element of the project cycle – from planning to implementation to monitoring/reporting.
    - Demonstrating a direct link or outcome between the identified gender inequality context and the financed activities (SEforALL 2020).
- Incubate more women-led energy enterprises and mobilize more capital for female-led businesses. Existing initiatives include the 2X challenge, which aims to mobilize USD 3 billion for companies that focus on women as consumers, employees, leaders or owners. Other options include mandatory investment levels in women-owned businesses in the energy sector or incubators explicitly targeting women.
- Build strong female talent pipelines, create more equitable policies including longer maternity leaves with a return-to-work guarantee and flexible working hours, and ramp up female recruitment efforts. An example of this includes USAID's Engendering Industries, an innovative initiative to improve gender equality in the global energy sector. The initiative is committed to unlocking economic opportunities for women in their organizations and now works directly with 17 partners in 14 countries.
- Replicate and expand sales, distribution, and financing strategies targeting female customers. Successful strategies include working with women's networks for distribution, customer service and RBF verification, similar to how SNV partnered with the Women's Union in Vietnam to verify stove installations before payments were made to private enterprises.
- Explore financing instruments specifically targeting female customers. These could include results-based financing (RBF) mechanisms explicitly targeting women, for instance, providing additional incentives for successfully reaching female customers. Other tools to be explored could include gendered credit scores to account for bias for customer financing.
- Encourage women's participation in the energy sector through additional education, training and internship opportunities. Government, private companies and universities can actively encourage female student internships in the energy sector. For example, SEforALL provided funding for Strathmore University in Kenya to conduct solar and energy management training for women.
- Expand mentoring programmes that allow women to be mentored by individuals across the energy value chain, and in varying stages of their careers. This helps women gain experience, foster innovative ideas and benefit from career-enhancing activities to support their goals. An example of this is the Women in Clean Cooking (WICC) Mentorship Program organized in partnership with the Clean Cooking Alliance, Sustainable Energy

for All (SEforALL) and the Global Women's Network for the Energy Transition (GWNET), which aims to advance the role of women as agents of change in the clean cooking sector.

- Conduct additional research to understand key challenges and needs for women. Overall, gender experts interviewed in focus countries find that additional data are needed to understand the magnitude of the challenge, design appropriate policies, and drive decisions for investors, enterprises and governments to allocate resources to the most viable solutions.
- Meaningful engagement with men and boys is critical to gender equality, equity and women's empowerment. A growing consensus (ICRW 2018) is focused on engaging men as stakeholders or co-beneficiaries of gender equity programming. Male champions and mentors could understand and advocate for the benefits of gender equity that both men and women will experience. Advocacy and training that challenge the traditional role of women in the household and focus on the positive aspects of what it would look like if women participated more actively and on a more equal footing could help change gender norms.

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Vienna (Headquarters)
Andromeda Tower, 15th Floor
Donau City Strasse 6
1220, Vienna, Austria
Telephone: +43 676 846 727 200

Washington, DC
1750 Pennsylvania Ave. NW
Washington, DC 20006 USA
Telephone: +1 202 390 0078

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Please cite this work as follows: Sustainable Energy for All (SEforALL) and Dalberg Advisors 2021. *Energizing Finance: Taking the Pulse 2021*.

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