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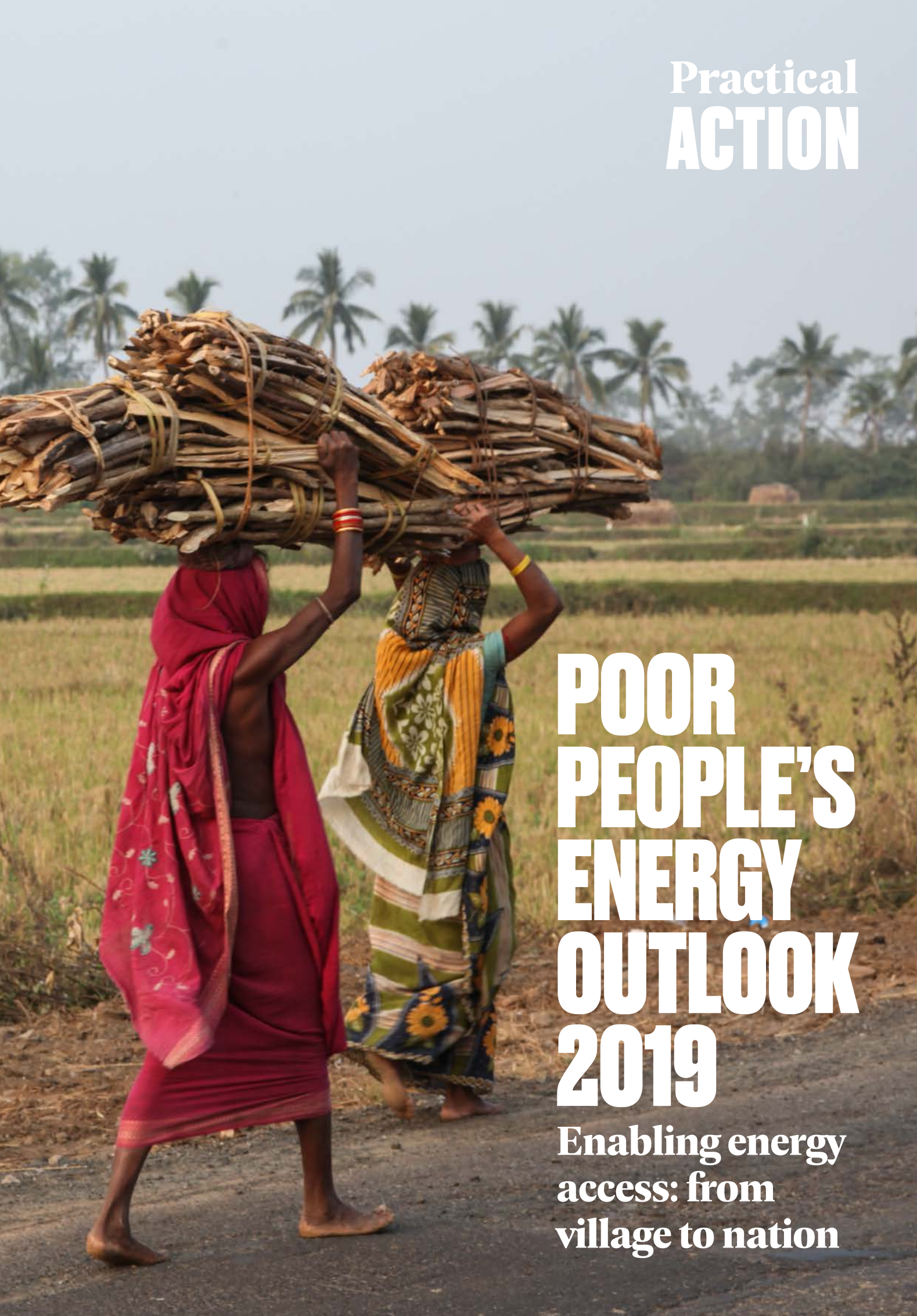

POOR PEOPLE'S ENERGY OUTLOOK 2019

Enabling energy access: from village to nation

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Practical ACTION

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Praise for PPEO 2019

The PPEO *is a highly anticipated contribution to a now active conversation around inclusive energy access at scale. It is a unique publication, with a focus on how emerging technologies and approaches can improve the lives of marginalized people that often remain left behind in energy policy and planning. The Alliance is pleased that clean cooking solutions continue to feature prominently in the* PPEO*, as innovations in clean cooking solutions must mature to ensure the poorest do not continue to suffer the health, environmental, and economic burdens associated with a lack of affordable, reliable, and clean energy access.*

Peter George, Director, Enterprise Development and Investment, Clean Cooking Alliance

Once again Practical Action is unafraid to grapple with truly wicked problems. How can we both reduce carbon emissions and increase marginalised people's access to energy? How can we move with the scale and pace that justice demands, while yet involving communities in shaping local solutions? Changing hard realities – including the lack of attention and finance directed towards clean cooking and under-funding of off-grid solutions – needs the PPEO *2019's cool, hard-headed data, new research, facts and figures. The report's clear recommendations for action combine dealing head on with complex financial challenges, while also bringing forward the views of women in rural areas. That's an all too rare combination – and therefore all the more welcome. We have the information; now we need to get on and implement the recommended actions.*

Harriet Lamb, CEO, Ashden

Energy access is critical for development, especially for poor people. Currently, cooking accounts for a major part of the energy consumption of poor people; still it is largely overlooked in energy plans and policies, and most notably in public finance. The PPEO *helps to change the focus. It is a much appreciated resource for Hivos and we hope it will be for all who are involved in policy-making, energy planning, and in tracking progress of the SDGs.*

Harry Clemens, Programme Officer, Green Society, Hivos

If we are to achieve Sustainable Development Goal 7, approaches must be both integrated and inclusive. The Poor People's Energy Outlook report series provides a unique and necessary perspective that focuses specifically on the energy needs of those that are at risk of being left behind in the energy transition. The PPEO *takes a bottom-up approach to shed light on the lived experience what it means to be without access to energy, particularly for vulnerable groups and the rural poor. By sharing experiences and case studies of what is working in select markets, the* PPEO *is an important yearly contribution to the data and evidence that underpins the sustainable energy sector.*

Glenn Pearce-Oroz, Director of Policy and Programs, Sustainable Energy for All

Bringing together the topics of energy access planning, finance, and delivery, this PPEO *successfully conveys the relevance of taking a people's perspective to identify opportunities for decision makers in contributing to a reduction of energy poverty. By paying attention to the needs and aspirations of the women and men who are most likely to be left behind in conventional approaches, this* PPEO *also illustrates many of the gender issues that are central to ENERGIA's work, and provides thoughtful guidance for all of us interested in inclusive sustainable development.*

Annemarije Kooijman, Research Programme Coordinator, ENERGIA

FOREWORD

Despite progress on certain fronts, the world is not on track to achieve universal energy access by 2030. At current progress rates, 650 million people will still lack electricity access by the end of the next decade. As the latest tracking report for Sustainable Development Goal 7 (SDG7) highlights, the outlook for clean cooking is even less promising, with over 2 billion people – mostly women – still expected to continue relying on inefficient stoves using dirty fuels.

Along with health damage and gender imbalances, insufficient energy access means fewer business opportunities. Many communities, consequently, will not be able to lift themselves out of poverty and create better lives and futures. Policy-makers should note, however, that SDG7 is still achievable. With a sustained ramp-up of renewables and energy efficiency solutions, the unserved millions, mainly across Africa and South Asia, can be reached. More finance is needed, especially for decentralized renewables to serve communities off the established power grid.

In recent years, off-grid renewable energy solutions, including both stand-alone systems and local mini-grids, have emerged as a mainstream, cost-competitive option to expand electricity access. At the International Renewable Energy Agency (IRENA), we have examined the key drivers of successful deployment, including the policies and regulations to nurture off-grid renewables.

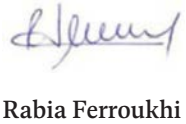
Over the past three years, Practical Action's *Poor people's energy outlook* has considered planning, finance, and deployment opportunities that can help to meet the needs of vulnerable people, women, and the poorest, most remote communities. Based on a rich selection of case studies, the analysis draws on the organization's direct experience with energy access programmes which place the priorities and perspectives of energy-poor communities at the heart.

This latest edition updates key findings and provides fresh insights on energy access challenges and opportunities. While recognizing distinct challenges for electricity and clean cooking, it stresses the need for integrated policy-making to unlock both public and private funds. Across the board, the drive for scale goes hand in hand with a focus on inclusivity.

The transformation of the world's energy system holds enormous potential to advance sustainable development. Governments, donors, energy planners, and developers are advised to look beyond technical deployment challenges. The shift to renewables has a broad socio-economic footprint, with modern energy access unequivocally improving people's livelihoods.

To ensure that no one is left behind, people's energy needs and community-level development aspirations must take centre stage in policy-making. Clean cooking, in particular, requires closer attention, as well as greatly increased funding.

I am excited by the *PPEO*'s central contribution on energy access and am sure that readers will find the recommendations very valuable.



Rabia Ferroukhi
Director of Knowledge, Policy and Finance
International Renewable Energy Agency (IRENA)

ACKNOWLEDGEMENTS

Poor people's energy outlook (PPEO) 2019 was produced by Practical Action with support from the UK Department for International Development. It was compiled by a core team at Practical Action comprising Dr Lucy Stevens, Dr Ute Collier, and Charlotte Taylor.

PPEO 2019 brings together and updates conclusions and recommendations from *PPEOs 2016*, *2017*, and *2018*, which explored the realities of delivering universal access to modern, sustainable, and affordable energy. Our first thanks therefore go to the women and men in Bangladesh, Ghana, India, Kenya, Nepal, Peru, South Africa, and Togo who participated in the research for *PPEOs 2016*, *2017*, and *2018* and on whose insights *PPEO 2019* draws. This includes a range of stakeholders: from community members to local-level implementers, and national policy-makers and planners.

PPEO 2019 benefits from valuable insights from a number of talented and dedicated peers. Thank you to Donee Alexander (Senior Director of Evidence and Impact at the Clean Cooking Alliance), Harry Clemens (Programme Officer, Green Society at Hivos), Christine Eibs Singer (Special Advisor on Energy Access to SEforALL), Peter George (Director, Enterprise Development and Investment at the Clean Cooking Alliance), Aaron Leopold (Chief Executive Officer, Africa Minigrid Developers Association), Charlie Miller (Energy Access Policy Consultant), Asna Towfiq (Gender, Demand and Policy Consultant at the Clean Cooking Alliance), and Susie Wheeldon (Research Advisor at the Global Off-Grid Lighting Association). Your feedback, challenges, and words of encouragement were appreciated in equal measure! A special thank you also to the Practical Action Consulting (PAC) team for all their research work and valuable insights on *PPEO*s 2016–18.

Thanks to Mercer Design for producing the infographics and accompanying poster and the Practical Action Publishing team for their continued dedication to the *PPEO* series. To the talented photographers who provided us with wonderful photographs to use in the report, thank you. We hope these images will help readers to visualize the diverse stories of energy access, and energy poverty, across the world. Finally, thank you to all those individuals and organizations who shared information from their work and allowed their data and references to be used for *PPEO 2019*.

ABOUT PRACTICAL ACTION

We are an international development organization putting ingenious ideas to work so people in poverty can change their world.

We help people find solutions to some of the world's toughest problems, including challenges made worse by catastrophic climate change and persistent gender inequality. We work with communities to develop ingenious, lasting and locally owned solutions for agriculture, water and waste management, climate resilience and clean energy. And we share what works with others, so answers that start small can grow big.

Practical Action is a global change-making group. The group consists of a UK registered charity with community projects in Africa, Asia and Latin America, an independent development publishing company and a technical consulting service. We combine these specialisms to multiply our impact and help shape a world that works better for everyone.

The Poor People's Energy Outlook is an example of just that. This report series combines expertise across Practical Action, to address the big issue of energy access for all: rooted in our community-level initiatives as well as connections and interactions at national and global levels, we create and utilize this original research to enable people living in energy poverty to enjoy the transformational power of energy.

PHOTO CAPTIONS AND CREDITS

Front cover. Women in Bangladesh transport firewood for fuel. Globally, women and children still spend a significant proportion of their time collecting, preparing, and using biomass fuel to cook and boil water. (Credit: Practical Action)

Executive summary. Lydia, a hairdressing business owner in Utumoni, Kenya, is one of only 5.9% of households and businesses in her community that was connected to the grid in 2017. (Credit: Practical Action / Edoardo Santangelo)

Introduction. A *PPEO 2018* community focus group takes place after dark in Baglung district, Nepal, with outdoor electric lighting illuminating the discussion. (Credit: Practical Action / Edoardo Santangelo).

The road to 2030. For children like these in Peru, energy access has transformational potential. It can improve their health, wellbeing and opportunities to learn and connect with others. (Credit: Practical Action).

Clean cookstoves and fuels. A group of Kenyan women manufacture *jiko* charcoal stoves out of clay, as part of a programme on improved biomass cooking technologies. (Credit: Practical Action).

Electrification. Silindikie Moyo is a technician working on the Sustainable Energy for Rural Communities (SE4RC) project in Gwanda, Zimbabwe, and was trained by Practical Action to manage the mini-grid. (Credit: Practical Action).

People-focused delivery. A kiosk shopkeeper in Nepal awaits customers in a village powered by a micro-hydro mini-grid. (Credit: Practical Action / Edoardo Santangelo).

Conclusions. India has seen a huge increase in grid connections in recent years, but marginalized groups are often still overlooked. (Credit: Practical Action / Edoardo Santangelo).

EXECUTIVE SUMMARY

With just over 10 years to 2030, the target date for the UN's Sustainable Development Goals, we are a long way from achieving the goal of universal energy access. Despite some progress, multiple obstacles remain and reaching the 'last mile' is proving particularly difficult; that is, those who will not be reached by business-as-usual approaches due to income, remoteness, or social discrimination. However, this issue is gradually receiving more attention from decision-makers and the evidence base of what is and what is not working has been growing.

We have aimed to raise the visibility of energy access challenges through our *Poor people's energy outlook* (*PPEO*) series, championing the perspectives and needs of the energy-poor. *PPEO 2019* is a compilation of the last three *Outlooks*, as well as an update, reflecting advances in knowledge over the last three years. It acts as a guide to delivering at national scales on the energy access agenda that will most directly and holistically meet the needs of energy-poor communities. It shows the connections between planning, finance, and delivery to provide a comprehensive framework and recommendations for a more bottom-up

approach to dealing with energy access. It focuses on what is required to listen to and meet the needs of those most likely to be left behind. We consistently apply a gender lens and deal with clean cooking and electricity on an equal footing.

Our analysis on planning and finance was based on case studies from three countries: Kenya, Bangladesh, and Togo; while for delivery we looked across a number of countries at programmes in particular sub-sectors to see whether scale and inclusivity can be combined. In this compilation, we first examine the findings for clean cooking and electricity and then more broadly. We also cover recent trends in the energy access sector, to provide the context for our case studies. Our goal is to support decision-makers to identify, adapt, and replicate the most appropriate mix of actions.

Our goal is to support decision-makers to identify, adapt, and replicate the most appropriate mix of actions

Clean cooking

Lack of progress in clean cooking remains a key obstacle to reaching universal energy access in 2030. While the share of the global population with access to clean cooking fuels and technologies reached 61 per cent in 2017, there are still around 3 billion people without access, with population growth outpacing the numbers gaining access. Clean cooking rarely receives much policy attention and our surveys found that in communities people also attach less priority to clean cooking than other aspects of energy access. Reasons for this are complex but include a lack of awareness about the health impacts of cooking with dirty fuels and less value being attached to women's work, such as collecting and chopping firewood and cooking.

It is therefore not surprising that clean cooking has long been chronically underfunded, with a lack of both public and private funding. It needs a higher profile in planning discussions, and to be integrated more effectively with electrification strategies. More funding is also needed urgently. Our case studies of Kenya and Bangladesh have suggested that providing the types of clean cooking people want can actually be more costly at the national scale than providing clean electricity. While financing solutions are often country and context specific, the need to focus on gender mainstreaming and empowerment applies everywhere. This should include supporting women's greater involvement in roles higher up the energy value chain. It must also ensure that consumer and entrepreneurial finance for clean cooking and fuels is tailored to women's needs and does not increase the barriers they face.

While funding is important, clean cooking progress is being hindered by multiple barriers. To address these and to achieve scale, markets must be built holistically across demand, supply, policy, and finance. New business models and technical solutions (including electric cooking linked to off-grid solar) have begun to emerge, and need to be pursued boldly. However, at the same time we must not lose sight of more established solutions that can reach the 'last mile' quickly and improve lives as soon as possible. In the rush for 'scalable' solutions, we also need to find ways to reach the most challenging market segments: rural households who collect rather than buy fuel.

In the rush for 'scalable' solutions, we also need to find ways to reach the most challenging market segments

Electricity: still a long way to go

Access to electricity has advanced more rapidly over recent years, with the number of people without access dropping from 1.2 billion in 2010 to around 840 million in 2017. The falling costs of solar photovoltaic (PV) and batteries have been a major factor. Solar home systems (SHS), often based on

Even in the same country, there are inequalities of energy access within communities

pay-as-you-go distribution models, have shown impressive growth rates over recent years. Mini-grids are also expanding, as their costs are reducing. However, funding for electricity access is still a long way from what is needed, especially for off-grid solutions.

In our case studies we found striking differences in the levels of access between communities in the same country, highlighting the extent to which some are being left behind. The impact of geographic remoteness was evident, with income also important. Our modelling suggested that off-grid systems (a mix of mini-grids and stand-alone systems) would be the least-cost solution for the majority of unconnected people. However, in most countries it is grid extension that is subsidized, while off-grid solutions are expected to be delivered by the market. Yet, in Europe and the United States rural electrification required significant amounts of public funding. It is unrealistic to expect anything different in the developing world, especially considering the high levels of poverty in unserved households.

While electricity access programmes often focus on expanding supply, our work has shown that it is equally important to consider demand, help finance to flow, and ensure supportive policies are in place. Boosting electricity uses beyond household consumption and developing business opportunities makes electrification more affordable and sustainable in the long term. Mini-grids in particular can serve a mix of uses, but specific support programmes, including capacity building for communities, are needed to develop productive uses. It is increasingly clear that electrification strategies need to integrate and seek synergies between grid and off-grid solutions. They need to deliver on the types of electricity access that poor communities prioritize, including household connections, but also street lighting, water pumping for domestic consumption, and power to community services such as schools and health facilities.

Since we published the first *PPEO* of this series in 2016, there have been a number of welcome changes in the electricity access field. For example, in Togo the government has now completed an off-grid plan which is integrated into the national electrification plan. Meanwhile, new off-grid finance has been announced by several multilateral financing institutions and donors. These are important investments but they still fall short of the US$51 bn needed per year.

How to improve finance, planning, and delivery

Tackling the energy access challenge, and ensuring it meets the needs of energy-poor communities, will require a sustained effort across finance, policy, planning, and delivery. Whether for cooking or electricity, our research demonstrates that if provision were to be based solely on ability to pay, energy access would be highly restricted across energy-poor communities. Even in relatively well-developed markets, there are still hard-to-reach villages and people unable to afford even the smallest solar lanterns. Finance, planning, and policies need to focus much more on reaching the 'last mile'.

This will require concerted action by all stakeholders, including international donors, national governments, private investors, and developers, as well as civil society. We conclude *PPEO 2019* with a set of recommendations, including:

- Energy planning and financing needs to give equal emphasis to grid, off-grid, and clean cooking, and consider synergies between them.
- Planning needs to involve multiple ministries to develop productive and community uses of energy, and to ensure energy access achieves its transformational potential.

- More public funding needs to be allocated to off-grid electrification, recognizing that this cannot be left to the market alone.
- There needs to be support for 'market activation' approaches, promoting coordination between the private sector, consumer associations, and civil society.
- Programmes need to be proactively designed to focus on reaching the 'last mile', ensuring these have sufficient resourcing and skilled staff.
- Gender mainstreaming is needed to ensure that the issues women prioritize are addressed, and that women are provided with opportunities and empowered to participate at all levels in energy value chains.

Greater focus on the 'last mile' is critical to ensure no one is left behind in 2030

With just over a decade to go to 2030, we cannot afford to lose any time. The *PPEO* has contributed to the growing evidence base on the most effective energy access approaches. Progress has been made over recent years but much of this has focused on grid extension to those that are relatively easy to reach. The 'last mile' needs to receive a much greater focus, to ensure there is no one left behind in 2030.

INTRODUCTION

Since its inception in 2010, the *Poor people's energy outlook* (*PPEO*) series has been unique in drawing attention to the energy access needs and priorities of often overlooked and under-represented people around the world. By 2014, the series had pushed the debate further–clearly highlighting the need to consider not just household energy, but the sorts of energy access services required in community facilities as well as enterprises and other productive spaces to enable energy-poor people to lift themselves out of poverty. This concept of Total Energy Access (Practical Action, 2014) was presented in 2010–14 to guide energy policy-makers and practitioners towards action, to enable poor communities to not only survive but to thrive. The centrality of energy services rather than supply is now built into the Multi-Tier Framework for measuring energy access, and holistic ideas about energy service needs are often part of the narrative from global players such as SEforALL and the World Bank.

With this strong foundation, and a desire to push the envelope further, we carried out research to investigate existing evidence and remaining knowledge gaps in the energy access space in order to inform the direction of travel for future editions of the *PPEO*. There was clear demand from stakeholders for credible energy access evidence on financial modelling for integrated energy plans in accordance with end user demand and willingness to pay, as well as on what has and has not worked in

programme design and delivery. We therefore decided to focus the second suite of *PPEO*s on bottom-up energy access planning (2016), financing national energy plans (2017), and delivering inclusive energy access at scale (2018). *PPEO*s 2016–19 put the Total Energy Access framework to work to demonstrate how a theoretical understanding of energy access could be translated into reality, challenging business-as-usual approaches along the way.

A framework for action in a changing world

The energy access space is dynamic and fast moving. Since we began working on this series of three reports, much has changed. Globally, the numbers without electricity access are falling. The falling price of solar photovoltaics (PV) means it is increasingly cost-competitive with fossil fuels both on- and off-grid. There have been rapidly growing numbers of companies involved in decentralized renewable electricity at national and international levels, and, albeit from a low base, levels of investment have grown. In clean cooking, there has been a shift to a greater focus on fuels, a rise in the role played by liquid petroleum gas (LPG) in some countries, and the emergence of new business models. Debates about energy access have reached new sectors with new partnerships with humanitarian agencies in particular. At the same time, huge challenges remain and make it difficult to achieve the 2030 Sustainable Development Goal of universal energy access, in particular reaching the more remote communities who would otherwise be left behind.

This edition is a compilation of the last three, but also an update, reflecting advances in knowledge over the last three years. It shows the connections between planning, finance, and delivery to provide a comprehensive framework and recommendations for a more bottom-up approach. We are convinced that this is what will help us collectively achieve our global goals sooner and for everyone. It is an approach that is more responsive to the expressed needs and priorities of energy-poor communities, unpicking and highlighting throughout how we should address the different gendered needs and priorities of men and women. It focuses on what is required to reach those most likely to be left behind and deals with clean cooking and electricity on an equal footing.

In the three previous editions we structured our analysis around our case study countries: Kenya, Bangladesh, and Togo, or (for 2018) around delivery programmes in particular sub-sectors. For this report, we add value to and update our analysis by organizing the material around the two overarching themes of clean cooking and electricity. Within each we look at issues of planning, finance, and delivery, making recommendations for each sector. In our analysis chapter we again bring these together to consider where there are common issues and emerging opportunities for synergy.

The *PPEO* series offers approaches that are more responsive to the expressed needs and priorities of energy-poor communities

Our inclusive approach

The central values and perspectives that we bring to this research have remained the same since the inception of the *PPEO* series in 2010. They inform the whole research process from the design of methodologies through to our framework for analysis and presentation of findings. They are an attempt to model a more inclusive and balanced mindset, which we think is critical to informing the actions needed on the ground. These include:

- A mainstreamed gender perspective as part of our framework, research methods, review process, and writing.

- Discussing clean fuels and cooking solutions on a par with electricity access, and often putting the discussion about cooking first.
- A multi-stakeholder approach that champions the voices, priorities, and perspectives of energy-poor men and women living in a range of different contexts around the world.
- A holistic approach to energy access, focusing on the energy services people need at home, in their productive lives, and the community services they rely on.

Methodologies for a bottom-up perspective

A distinctive feature of the *PPEO* series is its data-rich and grounded analysis

A distinctive feature of the *PPEO* series is its data-rich and grounded analysis which puts the needs, priorities, and perspectives of energy-poor communities at the heart of the discussion. In the past three editions we used a range of methodologies offering new perspectives. If taken up more widely, elements of these methodologies could change the way interventions are planned and delivered, focusing attention on those too often left behind.

The methodologies are described in detail in each report, but here we provide a brief overview. Overall they demonstrate a bottom-up approach to data collection and analysis while informing national-scale planning, financing, and delivery.

Community plans as the cornerstone

The starting point and centrepiece of our analysis for the 2016 edition was new research in 12 off-grid rural communities in three very differing contexts: Togo, Kenya, and Bangladesh. The objective was to create demand profiles for cooking and electricity, considering energy needs for households, productive uses, and community services.

Gathering the necessary information required mapping the settlements and local energy resources. We researched the local availability and costs of a range of fuels, stoves, off-grid solutions, and their components. We carried out surveys of a representative sample of between 50 and 68 households. For enterprises and community services, we either interviewed all those present in a community, or a representative sample where numbers were high. In Bangladesh this meant an average of 46 enterprises per community and 12 community facilities, while in Togo it meant only 14 enterprises and 8 community facilities on average.

PPEO 2016 created 12 community demand profiles for both cooking and electricity

Of equal importance were a set of participatory exercises carried out with focus groups: some mixed and some for women only. These used a range of participatory methodologies such as seasonal calendars, daily schedules, and ranking exercises to facilitate a rich discussion about needs, priorities, and perceptions. In both the surveys and focus groups we introduced communities to a range of technically feasible energy options to gather their feedback.

The findings were analysed to create energy demand profiles, and our conclusions were fed back and validated by the communities. We created summary sheets of the information as a resource for each community. Through iterative modelling we produced options for the least cost means of meeting this demand. This accounted for varying levels of demand between households, for different types of productive uses and community services, and for varying cooking preferences. The modelling also allowed for different types of electricity provision depending on the location of households or type of enterprise.

Scaling findings to the national level: technology mix and costs

In the 2017 edition we used the community-level electricity and cooking demand profiles to generate national-scale estimates. For this, we identified a representative sample of 95 settlements per country. Using nationally available data sets, we identified the energy resources available and settlement patterns for each. We allocated each one of the community demand profiles at random, and used this to calculate the least-cost technology mix. From this sample of 95, adjusting for the presence of national electricity grid connections, we extrapolated our findings to the national level. Using our community-level cost estimates we were able to estimate the national cost of provision, and the gap between people's willingness to pay and those costs.

We were careful to engage with the perspectives of a wide range of national-level stakeholders through workshops and interviews. This allowed us to identify the major current sources of financing for energy access. It also allowed us to hear stakeholders' perspectives on the major barriers to increasing energy access finance and growing investment in off-grid and clean cooking technologies.

We believe our approach offers a unique perspective. In particular, our bottom-up demand profiles are nuanced: not being based on everyone having the same electricity usage or using the same fuels and technologies for cooking. We apply our Total Energy Access approach looking comprehensively across energy for households, productive uses, and community services. We are sensitive to the geographical spread of households, and allow for 'stacking' of stand-alone products alongside a grid connection.

At the same time, our approach is not designed to be fully comprehensive. It is meant to be a counterpoint to other global modelling exercises, illustrating the different results that might be expected when using a more bottom-up and nuanced starting point. In particular, we recognize the following limitations:

- We did not try to account for either the falling costs of technologies or the growing efficiency of appliances, which would decrease the level of finance required.
- Equally, we did not include estimates for growth in the rural population, which would increase costs over time.
- Our four demand profiles per country do not cover the *full* range of experiences and preferences across different communities in a given country.

Overall, however, the technology mix and financing requirements we modelled are realistic and well matched to the energy demands of the people and communities they are intended to serve.

Based on community-level demand profiles from *PPEO 2016*, the 2017 edition generated national-scale technology and cost estimates

Reviewing experiences from large-scale delivery programmes

For the 2018 edition, we looked beyond our three national cases from 2016 and 2017. We centred our analysis on six case studies of large-scale delivery programmes in the sub-sectors of clean cooking, off-grid, and grid extension. Our objective was to explore how to scale up those areas of delivery that will help achieve energy access more quickly and cost-effectively. Critically, we explored how to ensure these solutions reach those usually left behind by poverty, remoteness, or gender discrimination.

***PPEO 2018* explored how to scale up energy access delivery quickly and cost-effectively, while leaving no one behind**

For each case study we reviewed a range of data sources, including public data sets and those provided by national-level programme managers. We talked to groups of end users in at least two villages, supply-chain actors and financiers, and national decision-makers. We held village-, district- and national-level workshops to get a nuanced view of the programme's design and implementation and to assess aspects of inclusion, such as why particular project locations were selected, how the poorest were included, and how gender issues were identified and women empowered.

Our framework for analysis considered three aspects:

1. A before and after situation analysis of the national context for the programme.
2. Programme dimensions covering actions and successes in boosting demand, supply, access to finance, and a more supportive policy environment.
3. Programme results including the scale of delivery among the target population, and the inclusivity of results in terms of reaching the poorest and most remote, and in addressing gender inequalities.

Elements of methodology for uptake and replication

Some of the research methods we used helped us to explore the nuances of particular case studies. However, there are elements that, if adopted by national ministries of planning or energy, could make a significant difference to the direction and priorities for energy planning and programming:

- *Community-level energy demand profiles, technology preferences, and willingness to pay*. Taking the time to carry out this type of research using both quantitative and participatory methods in a small selection of communities would help to ground national programmes in the realities and perspectives of energy-poor communities. It would also be instrumental in ensuring the different needs of men and women are heard at national levels.
- *Indicators for inclusion*. Only by measuring inclusion, and ideally setting targets associated with it, will it be valued and pursued as much as simply the number of connections and people reached.

From village to nation

BOTTOM-UP METHODOLOGIES EXPLORING NATIONAL-SCALE ENERGY ACCESS

Attributes of the PPEO methodologies

- **Gender mainstreaming from beginning to end**
- **Listening to and amplifying stakeholder voices**
- **Assessing inclusion as a key measure of success**
- **Integrating energy options across on-grid, off-grid, and clean cooking**
- **Starting with community-level needs and priorities**
- **Holistic approach to energy for households, productive uses, and community services**

2016

Community led

Starting point
12 communities across Bangladesh, Kenya, and Togo.

Methods
Resource mapping, surveys, focus groups, estimating costs for a range of viable solutions.

Analysis
Energy demand profiles, preferences, and willingness-to-pay disaggregated by gender.

Adjust
Iterations applied to the model to create least-cost balance of networked (grid or mini-grid) versus stand-alone solutions.

Result
Community-level plans of least-cost, preferred technology options for electricity and clean cooking.

2017

Affordable service provision

Starting point
Representative sample of 95 settlements in Bangladesh, Kenya, and Togo.

Inputs
Community energy demand profiles from *PPEO 2016* + national maps of energy resources + satellite view of the settlement pattern = least-cost technology options for 95 settlements.

Adjust
Extrapolate and adjust least-cost technology options to the national scale.

Result
Estimates of the technology mix and total costs of universal energy access at the national level.

2018

For everyone, everywhere

Starting point
6 case study programmes (2 cooking, 2 off-grid electricity, 2 grid electricity) from across Asia, Latin America and sub-Saharan Africa.

Methods
Data, interviews, workshops from the community to the national level.

Analysis
Before and after situational analyses; assessment of programme elements including policy, finance, supply and demand, as well as outcomes for scale and inclusion.

Results
Scores for inclusivity and scale for each programme.

Total Energy Access Framework

1. **Recognize**
   Recognize energy needs at home, for earning a living and in the wider community.
2. **Measure**
   Measure energy services, not just supplies.
3. **Prioritize**
   Prioritize and finance decentralized electricity and clean cooking solutions.
4. **Acknowledge**
   Acknowledge the roles of government, private sector, and civil society as part of a multi-stakeholder approach.

THE ROAD TO 2030

In a world where 89 per cent of the population has easy access to affordable electricity, we sometimes forget how reliant we are on power for running businesses, agriculture, healthcare, education, and many other services. For the 840 million people currently without access to electricity, lack of power also means fewer economic and educational opportunities, as well as poorer healthcare.

At the same time, over a third of the world's population (IEA, 2017) continue to rely on dirty cooking fuels and technologies, which have significant detrimental health impacts. Each year, close to 4 million people die prematurely from illnesses attributable to household air pollution from inefficient cooking practices using solid fuels and kerosene (WHO, 2018). The large amount of time spent by women and children collecting firewood interferes with education and other activities. Furthermore, the use of firewood and charcoal production has caused deforestation in many areas and is a significant contributor to climate change.

Providing access to modern, reliable, and affordable energy services has been recognized as one of the key development priorities which, according to Sustainable Development Goal 7 (SDG7), should be achieved by 2030. Reaching this goal can at the same time facilitate the achievement of other SDGs, as energy access can transform lives. However, energy provision alone is no panacea and needs to be part of an effective development strategy.

As we simultaneously deal with the worsening climate emergency, it is important that energy access is mostly provided through low-carbon solutions to ensure there is no long-term lock-in into fossil fuels. Luckily, there are win-win solutions. Many cleaner cooking options cut emissions and black carbon, as well as reducing deforestation. Off-grid renewable energy solutions are now cost-competitive and rapidly scalable options (IRENA, 2019).

Since we started this set of three *Poor people's energy outlook* editions in 2016, there have been a number of positive developments in the energy access landscape, especially as regards access to off-grid electricity. However, as we discuss in the subsequent sections, the overall picture is somewhat mixed and, for now, universal energy access remains elusive.

Low-carbon solutions for energy access provision will help to protect against a lock-in into fossil fuels

Energy access: overall trends

According to the latest SDG7 tracking report (IEA et al., 2019), there has been progress towards SDG7 but not enough for the goal to be met by 2030 (Figure 2.1). Access to electricity has advanced most, with the number of people without access dropping from 1.2 billion in 2010 to around 840 million in 2017. Progress has been most pronounced in India, Bangladesh, and Kenya, while those without access are increasingly concentrated in sub-Saharan Africa. Progress on clean cooking has generally been less obvious, with only a small decrease (from 2.96 billion to 2.90 billion) in the number of people without access to clean cooking solutions across Asia and Africa.

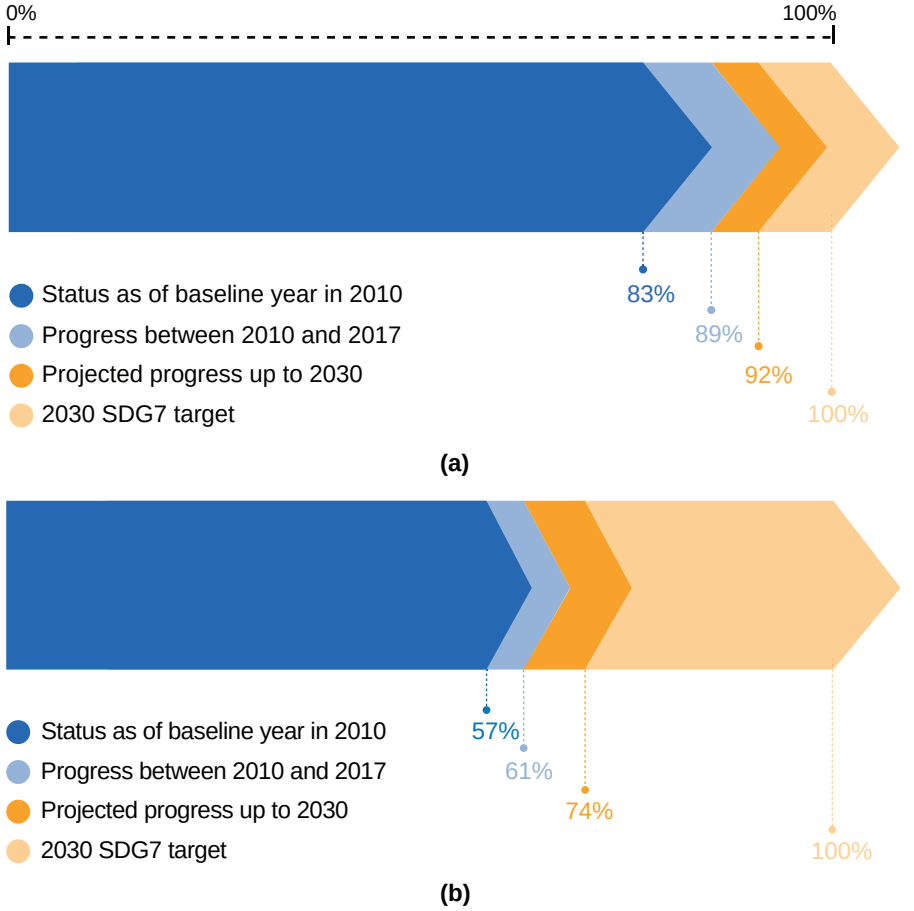


Figure 2.1 Percentage of population with access to (a) electricity and (b) clean cooking fuels and technologies, and SDG7 targets

Source: IEA et al., 2019

These high-level figures mask a more complex situation on the ground, as even where it has been stated that access has been provided, it is not necessarily reliable or affordable. The World Bank's Multi-Tier Framework (MTF) focuses on the actual service households receive. To date, MTF surveys have been released for Cambodia, Ethiopia, and Rwanda, with surveys in another 17 countries currently under way. They include a look at the gender dimension of energy access and have found significant variability in household access rates based on gender of head of household (IEA et al., 2019). A better understanding of the characteristics of energy access on the ground should allow donors and policy-makers to improve the effectiveness of their energy access approaches.

Public and private funding, particularly for clean cooking and off-grid solutions, remains a major problem

Funding for energy access, both public and private, remains a major problem, with particularly acute shortfalls for clean cooking and off-grid electricity solutions. With the energy access deficit generally being most severe in the least developed countries, in-country funding tends to be limited. Traditionally, there has been a reliance on donor funding, although recently some international private funding has been flowing into some countries, mostly in East Africa.

Clean cooking

Lack of progress in clean cooking remains a key obstacle to reaching universal energy access in 2030. While the share of the global population with access to clean fuels and technologies reached 61 per cent in 2017 (Figure 2.1), there are still around 3 billion people without access to clean cooking solutions, with population growth outpacing the numbers gaining access. By contrast, electricity access has recently managed to keep ahead of population growth (IEA et al., 2019).

China and India have the largest number of people without access to clean cooking: 45 per cent of the global total. However, both countries have made some good progress over the last decade, in particular by increasing the penetration of liquid petroleum gas (LPG) as a cooking fuel.

The access deficit remains most acute in sub-Saharan Africa, where it keeps increasing, mostly due to rapid population growth. Globally, the problem is mainly a rural one, with only 34 per cent of rural dwellers having access to clean fuels, while in urban areas it is 83 per cent. However, in high-deficit countries, urban charcoal use can be a significant problem.

Obstacles to clean cooking progress include a lack of investment, policies, awareness, and culturally acceptable solutions

There are multiple obstacles to achieving better progress in clean cooking. First, investment has long been lagging behind and has been described by SEforALL as 'abysmally low' (SEforALL, 2018). The SDG tracking report suggests that US$4 bn per year would be needed to achieve clean cooking access by 2030, yet in 2017 only $40 m were available (Clean Cooking Alliance, 2019). There is a shortage of both private and public funding, with, for example, the multilateral development banks committing only 1.6 per cent of their total energy finance into clean cooking solutions in 2017 (Oil Change International, 2018).

Other obstacles include the lack of policies, lack of awareness of the benefits of clean cooking options, and often also the lack of culturally acceptable solutions. Women play a particularly crucial role in the widespread adoption of clean cooking solutions, yet they often struggle with affordability, especially as they are on average poorer and less able to access finance. Enabling women (both as consumers and as entrepreneurs) needs to be a central focus of clean cooking programmes.

In terms of technical solutions, many clean cooking programmes focus on improved biomass cookstoves. These can have their own issues of affordability and acceptability and few meet stringent World Health

Organization standards on indoor air quality. However, some innovative business models have emerged (mostly in East Africa), for example through leasing of gasifier stoves linked to the sale of specific pellets. New distribution channels are being opened through solar home system companies and pay-as-you-go models are being explored (currently mostly for LPG stoves). As yet, the economic viability of these new models and approaches remains unproven (Clean Cooking Alliance, 2019).

Many countries are promoting LPG for cooking which, while a fossil fuel, has clear benefits in terms of indoor emissions. For example, Indonesia has increased the share of LPG in cooking from 11 per cent in 2007 to 72 per cent in 2016, supported through an expensive ongoing subsidy programme to support both the stoves and ongoing fuel purchases (SEforALL, 2018). Kenya has also seen an increase in LPG cooking, as well as some bioethanol and biogas (see Chapter 3). However, while kerosene remains the cheapest fuel in urban areas, it continues to dominate there, especially among the urban poor (Dalberg, 2018).

Biogas, based on animal, human, and food wastes, is a very clean option and can be economically attractive. While take-up has generally been slow, there are some examples of successful scale-up, as in the case of Kenya (see Chapter 3). Globally, an estimated 125 million people use biogas for cooking, of whom 111 million are in China (REN21, 2019). However, there are challenges around the affordability of biogas systems.

Electric cooking has also recently emerged as a potential contender for the scale-up of clean cooking solutions and is receiving some donor funding. A report for Hivos and the World Future Council (Couture and Jacobs, 2019) argued that electric cooking based on solar home systems or a mini-grid is now well within the range of cost-competitiveness of other cooking alternatives, to a large extent due to the falling costs of solar PV and batteries. Appliance efficiency is key as traditional electric hotplates are very power-hungry. With efficient slow cookers and pressure cookers, electric cooking can actually be cheaper than cooking with firewood or charcoal. However, at present electric cooking has very little penetration and is a long way from scale-up. Further cost reductions are needed, as well as behavioural changes.

Electricity access

The share of the global population with access to electricity reached 89 per cent in 2017, rising from 83 per cent in 2010 (Figure 2.1). 2015–17 saw what the tracking report calls 'a surge' of electrification, although progress remains uneven (IEA et al., 2019). Sub-Saharan Africa has the lowest access rate with 44 per cent, while Latin America, the Caribbean, and eastern and south-eastern Asia have now reached close to 100 per cent electricity access. Similar to cooking, lack of electricity access is a particular problem for rural populations, although many urban areas suffer from unreliable supplies.

Off-grid renewable energy systems are emerging as the least expensive and fastest option for providing energy access to many remote rural populations (REN21, 2019). According to IRENA estimates (IRENA, 2019), the number of people served by off-grid renewables globally reached 133 million people in 2016, a sixfold expansion during the previous five years. Solar lanterns (serving around 100 million people) are the most widespread technology, followed by solar home systems (24 million) and mini-grids (9 million).

Solar home systems (SHS), generally based on pay-as-you-go distribution models, have been one of the success stories in the energy access field, with impressive growth rates over recent years. According to the latest market

Lack of electricity access is a particular problem for rural populations, although many urban areas suffer from unreliable supplies

report (GOGLA et al., 2019), the second half of 2018 saw a 77 per cent increase in sales compared with the same period in 2017, and a 133 per cent increase compared with 2016. While many SHS only provide the most basic level of access, increasingly larger, more transformative SHS are being sold, and close to 5 million people now have access to enough energy each day to power a range of efficient appliances. However, for most SHS companies, profits remain elusive (Wood Mackenzie and Energy 4 Impact, 2019).

While SHS are the best solution for areas with low population density and low demand, in off-grid areas where population density and demand are higher (e.g. including power for agriculture and small business use, so-called 'productive uses') mini-grids can be a viable option. According to the World Bank's Energy Sector Management Assistance Program (ESMAP), at least 19,000 mini-grids have been installed in 134 countries and territories (ESMAP, 2019). While mini-grids based on diesel or micro-hydro have been around for a long time, most new mini-grid installations are based on solar PV. IRENA (2019) has recorded 328 MW of solar mini-grids globally, mostly installed since 2014. More than 7,500 new mini-grids are planned, mostly in Africa, connecting more than 27 million people for an investment cost of $12 bn (ESMAP, 2019). To meet SDG7, ESMAP estimates that more than 210,000 new mini-grids serving 490 million additional people are needed by 2030, requiring almost $220 bn in investment.

Mini-grid capital costs have been declining and are expected to fall even further in coming years

Mini-grid capital costs have been declining and are expected to continue to fall over the period to 2030. ESMAP (2019) suggests that the per-kWh cost of mini-grid electricity is on pace to decrease by two-thirds by 2030, mostly as a result of declining capital costs and increased load factor. Several large multinational energy companies have entered the mini-grid space and different business models are being tested, although viability remains a challenge. Scaling up renewable energy mini-grids also requires dedicated policies and regulations, which are being implemented in a growing number of countries (IRENA, 2018).

Grid expansion remains an important element of dealing with electricity access. From 2000 to 2016, nearly all those who gained access did so through new grid connections (IEA, 2017). However, reliability is not necessarily assured, even if there is a grid connection. In 2017, one-third of access-deficit countries faced more than one weekly disruption in electricity supply that lasted over four minutes (IEA et al., 2019). Furthermore, as unserved populations are increasingly those that are more distant from the nearest grid, off-grid is becoming the most obvious solution.

Funding remains a significant challenge for electrification. SEforALL (2018) reported a 56 per cent increase in overall electrification finance commitments in 20 high-impact countries, from $19.4 bn in 2013–14 to $30.2 bn in 2015–16 (the most recent data available). However, this amounts to only just over half of the $51 bn annual spending the SDG7 tracking report has estimated as necessary to meet the 2030 goal (IEA et al., 2019). Furthermore, SEforALL found that most of this funding is focused on expanding electricity supply to non-residential consumers. While this is important for supporting wider economic growth, it does not address the SDG goal of 'leaving no one behind'.

Furthermore, only 1.3 per cent of overall energy access finance went to off-grid solutions in 2015–16. International financial institution (IFI) funding scored little better, with only 2 per cent of all IFI energy finance committed to off-grid and decentralized energy solutions in 2017 (Oil Change International, 2018). On a more positive note, there are signs that more funding is beginning to flow into off-grid solutions; for example, the World Bank has approved the $224 m Regional Off-Grid Electrification Project (ROGEP) for West Africa and the Sahel in 2019.

Achieving universal access by 2030: what needs to change

With just over 10 years to go before the SDG7 target date, universal access remains elusive. Despite significant progress in electrification in recent years, the annual rate of improvement falls short of what is needed and current projections suggest that by 2030 there will still be 650 million people without access to electricity (Figure 2.1). Specifically, it will become increasingly difficult to reach the remaining unserved populations, often in very remote areas, where affordability will remain a barrier. For clean cooking, progress will continue at an even slower pace than for electricity and 2.2 billion people are likely to remain without clean cooking access in 2030.

According to IEA et al. (2019), decentralized renewables are the least-cost solution for more than half of the population that needs to be served to reach universal electricity access. In rural areas, the share would be higher at 77 per cent. For cooking, IEA modelling suggests a mixed picture, with improved biomass cookstoves, LPG and kerosene, and gas each accounting for between a quarter and a third of cooking fuels.

Scaling-up access is a major challenge, requiring a huge increase in investment but also new innovative business models, changes in policy frameworks, institutional capacity, increased awareness, and improved technical solutions. In subsequent chapters, we look in more detail at clean cooking and electrification. Through a number of case studies, we explore how inclusive energy access can be achieved at scale, with a focus on bottom-up planning and financing.

Scaling up energy access is a major challenge, requiring massive investment as well as new approaches, policies, and institutional priorities

CLEAN COOKSTOVES AND FUELS

Every day around the world, women wake early to set about the first daily tasks. For nearly 4 in 10 this will almost certainly involve lighting a fire to burn wood, charcoal, or kerosene to heat water for hot drinks or to cook breakfast. Throughout the day women spend time collecting fuel and are again found tending to the fire and cooking in the evening (Practical Action, 2010). These fundamental tasks have never been a political or development priority, despite contributing to nearly 4 million deaths a year (WHO, 2018) and having a significant impact on local and global environmental sustainability. In Chapter 2 we saw that progress on clean cooking is barely keeping up with global population growth (and failing to do so in sub-Saharan Africa). The scale of the challenge is huge and tackling it will require bold and coordinated action, and commitments of far more public and private sector resources.

This chapter brings together the highlights from *PPEOs 2016*, *2017*, and *2018* and our key recommendations. We cover bottom-up planning for clean cooking, what this means for the national technology mix,

and the costs of delivering this. We review lessons about the balance between working at scale and achieving inclusive results that leave no one behind. Bringing these insights on clean cooking together highlights the issues and challenges that are specific to this critical, but too often overlooked, area of energy access.

Bottom-up planning for clean cooking solutions

Our work on energy access planning was rooted first in understanding the context and perspectives in a selection of case study communities in Togo, Kenya, and Bangladesh. It was therefore grounded in meaningful interaction with end users. The chosen countries offered a range of resources, policies, cultures, and different stages of energy access progress. The four rural communities in each country were selected not as a representative sample, but to illustrate a diversity of situations. In each community we shared information about technically feasible cooking options and sought people's views, priorities, and preferences. Carrying out similar exercises would be valuable to inform any national planning process. In addition, for the 2018 edition, we explored specific cookstove and fuel markets in Ghana (improved charcoal stoves) and Kenya (rural domestic biogas).

Our work on energy access planning was rooted in understanding the context and perspectives of end users

National- and community-level stoves and fuel use 2015: starting points for action

The contexts for clean cooking in Kenya, Togo, and Bangladesh varied widely. This included variety in the size and maturity of stoves and fuels markets, and differences in the enabling environment in terms of policies, financing, and levels of public awareness, as well as differences in food and cooking practices. In turn, the case study communities where we collected data in 2015 used a variety of stoves and fuels. There was also variation in the extent to which households spent money on fuel or collected it for free, which is a critical factor in shaping opportunities for new stoves and fuel markets.

Bangladesh relied heavily on freely available biomass and poorly developed markets for stoves. In the four communities the vast majority used firewood as a primary fuel, with some use of crop residues, leaves, and animal dung. Only a few households reported buying fuel. All the households we surveyed used homemade stoves (Tier 0 of the Multi-Tier Framework) except for one owning a low-grade manufactured stove. Since our 2015 survey there has been an expansion of the market for improved stoves, with Infrastructure Development Company Limited (IDCOL)'s programme delivering 1.6 million new stoves between May 2013 and June 2018 (World Bank, 2018a). However, this still only reaches an estimated 3 to 5 per cent of households, and these stoves, while more fuel efficient, are far from 'clean', with no health benefits (GCF, 2018). The liquid petroleum gas (LPG) market has also grown fourfold from 2015 to 2018 (Rahman, 2018), replacing dwindling piped natural gas supplies. Where infrastructure exists for delivery and refilling, there is some LPG uptake among rural households, and some use of electric appliances (rice cookers and induction stoves) in line with expanded grid connections.

In the two northerly Togolese communities which were more remote and water-scarce, households relied entirely on, and sometimes paid for,

Across Bangladesh, Kenya, and Togo the fuel preferences, cooking practices, market sizes, and enabling environments varied widely

firewood. In the two other communities, LPG or charcoal was sometimes used (charcoal by a third of households in one community). Up-to-date national information is unavailable, but 2015 surveys found that 98 per cent of the rural population relies on biomass for cooking, of which 79 per cent use firewood and 17 per cent use charcoal as a primary fuel (MPDAT et al., 2015). Togo had the least developed market for improved cookstoves, with only a few NGO programmes promoting artisanal mud stoves.

In Kenya, on the other hand, while we found high proportions using firewood, there was a far greater use of charcoal than in Bangladesh or Togo. In two communities, 32 per cent and 47 per cent of households used charcoal as their primary fuel, partly due to a scarcity of firewood. It was common for households to buy fuel, particularly charcoal, to use alongside firewood. Ownership and use of more than one stove (stove stacking) was common.

Kenya has a large market for improved stoves, especially basic '*jiko*' charcoal stoves, and the market for higher quality stoves is growing. One of the most detailed surveys of its kind (EED Advisory, 2019) found that 86 per cent of rural households still cook primarily using firewood stoves. At the same time, 49 per cent of rural households use more than one cooking device. An estimated 4.2 million households now use a non-branded ceramic *jiko* (up from an estimated 2.25 million in 2012). The survey estimated that 390,000 households nationally use manufactured charcoal stoves, but only 54,000 use manufactured wood-burning stoves. This matches our case study findings of few branded manufactured stoves. Even in Kenya, therefore, despite positive conditions, growing the market for significantly improved stoves remains challenging.

Time spent collecting and preparing fuel and cooking

Fuel and stove choices have an impact on time spent collecting and preparing fuel and on cooking. In almost all communities it is primarily women who prepare fuel and cook, while collecting fuel is sometimes shared between men and women. As seen in Figure 3.1, on average, households spend 4 hours 44 mins per day on these tasks in Bangladesh, 5 hours 16 minutes in Kenya, and 5 hours 26 minutes in Togo. Focus group participants highlighted this time burden and their wish to free up time for other activities.

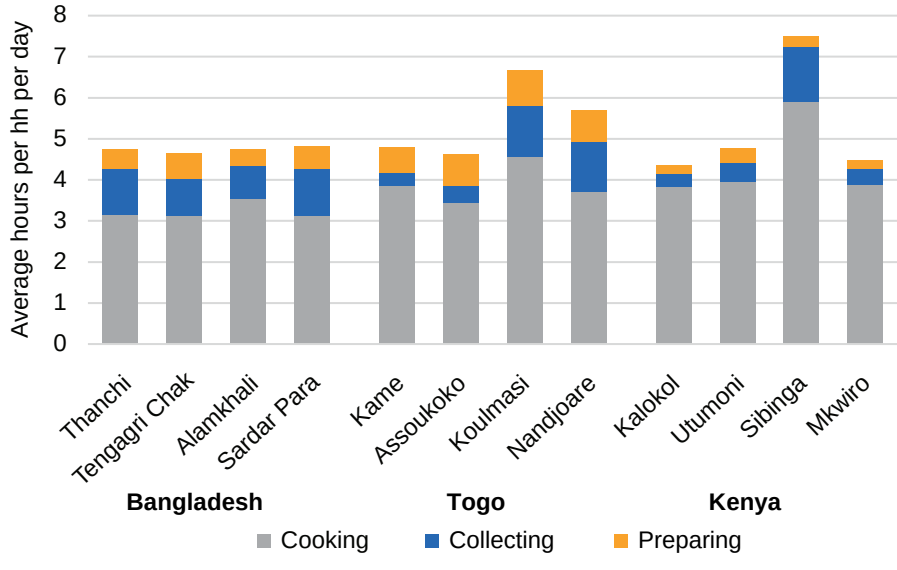


Figure 3.1 Average hours spent collecting and preparing fuel and cooking

Community preferences for improved cooking solutions and national implications

We asked communities about their energy access priorities. Improved energy for household use was prioritized first in all but one community; within this category cooking was among the top two or three priorities in Kenya and Togo. In Kenya, public awareness messages had spread with women talking about the importance of stoves that did not cause health problems. In Bangladesh, on the other hand, clean cooking only featured in the top four in one community. It was prioritized alongside other energy-enabled tasks such as pumping water, processing crops, or lighting the home. Women did not perceive any significant health risks from their current stoves and they (and their husbands) valued how smoke helps to keep insects away.

When discussing the important features of cooking solutions, fuel was a key concern in almost all communities. Fuel should be free, cheap, or easy to obtain. Cooks also often mentioned the speed and ease of lighting fires as important. Focus group participants had had negative experiences of improved wood stoves in Kenya and Bangladesh. In Kenya they were felt to be complicated, take too long to light, or only stay alight for a short time (as found by Ipsos and CCA, 2014). In Bangladesh, people disliked the time and effort required to chop wood into very small pieces for these stoves (also found by e.g. WASHPlus, 2014).

Fuel cost was a key concern in almost all communities surveyed

People were asked to rank a range of locally available solutions (including their current solution) in order of preference. For some, there was little appetite for change. In two Kenyan communities, 20 per cent and 50 per cent of households preferred their traditional three-stone fire. EED Advisory (2019) also found that 28 per cent of rural respondents listed their traditional three-stone fire as their preferred option, appreciating its flexibility and low cost. Similarly, in all four communities in Bangladesh between 19 per cent and 48 per cent of respondents preferred their existing stove. Contrastingly, in Togo there was widespread dissatisfaction with existing solutions, despite poor national activity on clean cooking. This could be due to the shortage of fuel wood. At the other end of the spectrum, significant proportions of households in all countries would prefer to leapfrog to an entirely clean solution: LPG, biogas, or electric cooking.[1]

For our national-level modelling, we used people's preferred choice for an MTF Tier 2 or higher solution even if they had elected their three stone fire. Where people chose electric cooking, we included this only where the cost would be within 10 per cent of LPG.

In all three countries, nearly half the population wanted to switch to entirely clean cooking solutions

In all three countries, nearly half the population wanted to switch to entirely clean cooking solutions. In our analysis at the time, the cheapest way of providing this was LPG, with electric cooking being feasible in some cases in Kenya. However, the range of clean fuel cooking solutions is expanding and relative costs are changing rapidly (explored below). The remaining half of the population would continue to rely on biomass-based solutions. These would need to be gradually improved over time to be deemed 'clean for health' and thus meet the threshold for SDG7 (MTF Tiers 4 and 5). However, compared with current solutions, they will be a significant improvement in terms of comfort, efficiency, and time savings, as seen in Table 3.1. In Togo and Kenya, reliance on wood and charcoal would be balanced.

This mix of technology choices would save significant amounts of time for women, and for men who shared some of the burden of fuel collection. The global debate has largely focused on the health benefits of switching to *clean* cooking, but our discussions with women at the community level highlighted the extent to which they value the reductions in burdens and time spent.

Note: these calculations are an adjustment from those published in *PPEO 2017* because we have now accounted for the fact that not all households regularly collect and/or prepare fuel. Time savings assume faster cooking times as well as reduced requirement to collect and prepare fuel.

Table 3.1 Current and future time savings by switching to preferred cooking options

	Average time spent currently per day	*Average time spent after switch to preferred option*
Bangladesh	4 hours 44 mins	2 hours 45 mins (↓42%)
Togo	5 hours 26 mins	3 hours 15 mins (↓40%)
Kenya	5 hours 16 mins	3 hours 18 mins (↓37%)

Financing the transition to improved cooking solutions

In modelling the financing required for people's preferred mix of technology, we considered affordability and willingness to pay, and extrapolated our findings to the national level.

Community-level affordability and willingness to pay for improved cooking solutions

To ensure we were using comparable figures, we calculated the full levelized cost of different cooking solutions per household per day, factoring in the price of fuel, or a cost to account for the time taken collecting and preparing fuel linked to daily labour rates. For all three countries, a shift to an improved biomass stove would represent a saving for households of between 55 and 80 per cent. In terms of clean fuel solutions (stove and fuel), in Bangladesh shifting to LPG was 1.4 times as expensive (at 2016 prices), and in Kenya it was 5 times as expensive as current solutions.[2] However, in Togo, biogas had good potential, being cheaper than current solutions in one community and only 40 per cent more in a second.

In the majority of communities, willingness to pay for improved cooking solutions was low

Currently, however, there is low willingness to invest at all. In 7 of the 12 communities, the majority of households were not willing to pay anything towards improved cooking solutions. Where they were willing to pay something, the *amounts* were low. In a few cases, people said they would be willing to pay the commercial cost of the cheapest improved biomass stoves, but for clean fuels a significant affordability gap existed. For LPG (usually the cheapest clean fuel solution), although people were willing to pay more than for biomass, the amounts would only cover around a quarter of the costs in Bangladesh and Kenya, or up to 45 per cent in Togo. In Togo, the cheapest clean fuel option (biogas) was within range of affordability for at least some in one of the communities. Interestingly, people were willing to pay more for cooking with electricity than with gas, but still significantly below the full cost.

National projections of the costs of a transition to clean cooking

Based on the national technology mix for improved cooking solutions (Figure 3.2), in Table 3.2 we estimated the costs of achieving this transition (Practical Action, 2017). While the IEA suggests the global cost of clean cooking is only 10 per cent that of electricity access, our estimates – according to people's *preferences* for cleaner solutions and fuel costs – were considerably higher. Between US$20 and $41 per person per year would be needed, compared with between $67 and $93 for electricity. Given the significant numbers lacking clean cooking, the total finance required by 2030 is greater

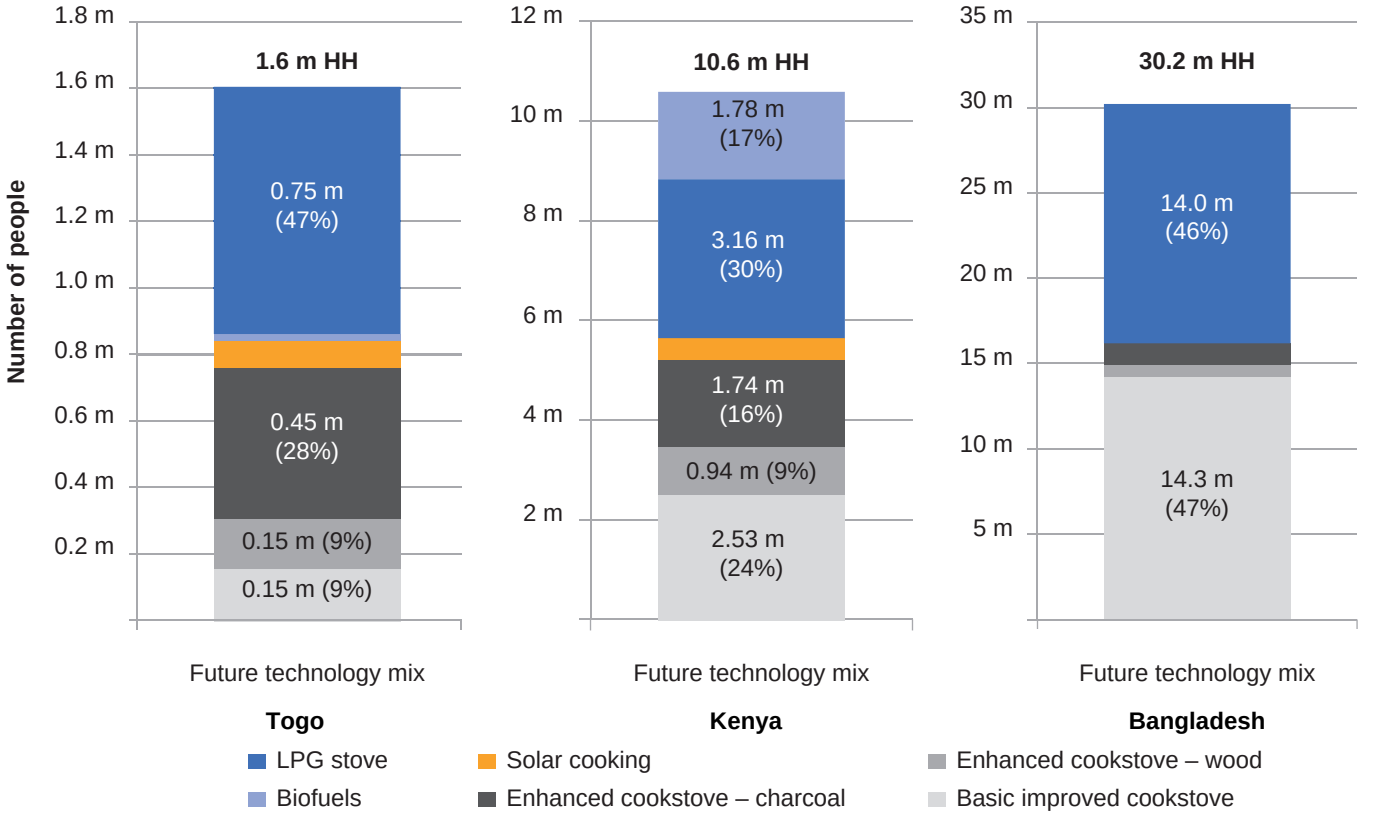


Figure 3.2 National technology mix for improved cooking solutions, user preferred choice

Table 3.2 Cumulative cost of provision of national clean cooking plans to 2030

	Finance required		*Average*	*Gap pp/yr*
	Total to 2030	*Per person/yr*	*WTP pp/yr*	
Togo	$2.1 bn	$20	$12	$8
Kenya	$27.1 bn	$41	$11	$31
Bangladesh	$57.3 bn	$24	$2	$22

Note: WTP: willingness to pay

for clean cooking than for electricity in Kenya and Bangladesh. These differences are because the IEA only includes the unit cost of a stove, not the costs of infrastructure, distribution, or fuel. They also assume a slightly higher 50–70 per cent of rural households relying on improved biomass stoves than in our models. In their cost modelling of future cooking scenarios for sub-Saharan Africa, Dagnachew et al. (2018) also model costs similar to ours with a starting point of $100 per household per year.

Across the different mix of technologies for each country, we found that willingness to pay was on average higher in Kenya and Togo than in Bangladesh. However, an affordability gap remains. We must continue to explore cost-effective, truly clean-fuel cooking options (biogas, bioethanol, or other technologies) to help reduce prices. This is unlikely to be achieved without public funding support.

Changes in relative costs for cooking solutions

Since completing the research for *PPEO 2017*, the costs of different cooking options have changed. Bangladesh's waiving of import duties for LPG has caused prices to fall, although the infrastructure for supply and refilling of cylinders has yet to reach all parts of the country. Similarly, in Kenya LPG prices reduced in 2016 thanks to the removal of 16 per cent VAT in the Finance Act of 2016; although by November 2018, prices

were back to previous levels (KNBS, 2018). Bioethanol is becoming cost-competitive with both LPG and charcoal in urban areas, and prices will fall further with the removal of VAT in the 2019 Finance Bill (Dalberg, 2018).

A 2019 update of relative costs of clean cooking options in sub-Saharan Africa (Couture and Jacobs, 2019) highlighted the effect of falling prices for solar panels (down by 82 per cent since 2010) and lithium-ion batteries (down by 76 per cent) on the potential for using off-grid electricity to power cooking. It concludes that, if paired with high-efficiency appliances such as electric pressure cookers, cooking with electricity can be cheaper than LPG, and cost-competitive with biomass at between $0.10 and $0.30 per household per day. It found that, where feasible, biogas remains cost-competitive at between $0.27 and $0.75 per household per day.

These trends mean that the cumulative costs of national clean cooking plans could potentially reduce. However, this will require significant efforts in building markets for clean fuels and efficient appliances. Without this, there is a risk that costs may increase, with increased reliance on charcoal where prices are rising.

Trends in financing for clean cooking

Investment committed to clean cooking is tiny compared to that for electricity, particularly grid expansion

We touched on the global trends in clean cooking finance in Chapter 2. In our three *PPEO 2017* case study countries, and in line with the global trends, we found that the amounts committed were tiny compared with electricity investments – in particular grid-expansion. East Africa is a hub for clean cooking finance, and we identified $60 m of planned investments, but this is still only 3 per cent of Kenya Power's budget for electricity grid extension. In both Bangladesh and Kenya it was positive to see basic improved cookstoves embedded as part of major programmes such as the Kenya Off-Grid Solar Access Project (KOSAP). In Bangladesh, $46 m of the $340 m Rural Electrification and Renewable Energy Development II (RERED II) programme budget is for improved cookstoves. In Togo, we identified only $250,000 of planned investments, just 0.03 per cent of all energy access plans.

Little has changed since our 2017 analysis. In Bangladesh, a new $82.2 m World Bank programme with co-financing from the Green Climate Fund over three-and-a-half years aims to further scale up IDCOL's work on basic improved cookstoves to reach a further 4 million households. No major new commitments were announced in Kenya or Togo.

Gender barriers in access to finance

Women continue to face additional, gendered barriers when accessing finance as consumers or entrepreneurs

Access to finance for clean cooking is constrained overall, and women entrepreneurs or consumers face even greater barriers (Figure 3.3). Women in developing countries are already less likely than men to have a bank account or access finance from formal institutions for a whole range of legal, cultural, and technological reasons (Dutta, 2018). In Kenya, for example, women own 48 per cent of small businesses, but access only 7 per cent of the available credit (AfDB, 2016). In Togo, women similarly faced problems, with their lack of collateral often being a significant barrier to accessing credit. In Kenya's cookstoves sector, more women are present at lower levels of the value chain and in smaller businesses. Finance providers view such enterprises as informal, disorganized, lacking sufficient accounting records, and therefore riskier, leading to high collateral requirements and interest rates (Hewitt et al., 2018).

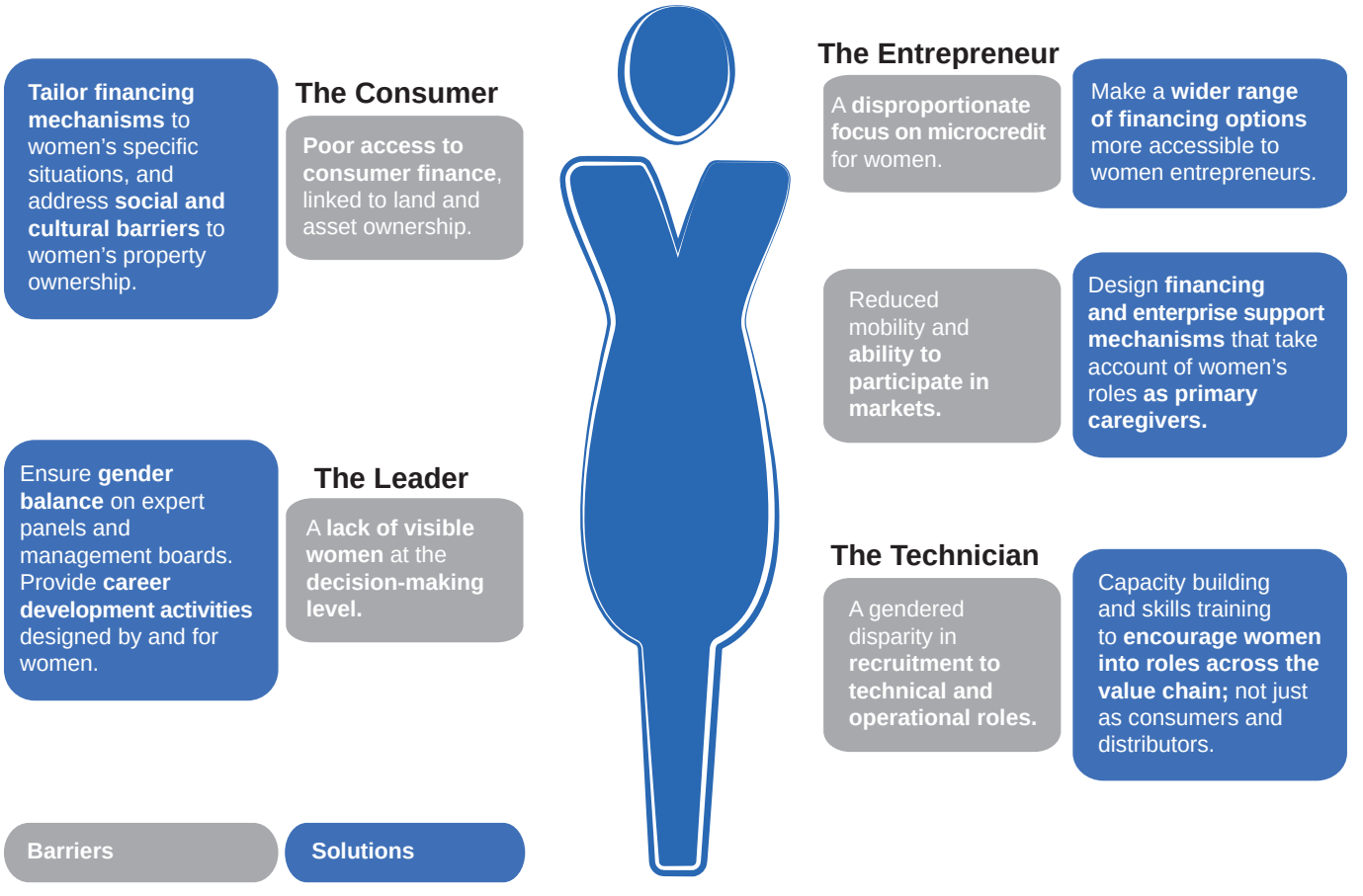


Figure 3.3 Barriers and solutions to women's participation in energy access markets

As consumers, women are generally more reliable in making repayments than men (D'Espallier et al., 2011). However, many microfinance institutions (MFIs) (in Togo, for example) are unwilling to grant stoves loans because they are not seen as 'directly productive'. Similarly, in Bangladesh, the majority of microfinance borrowers are women (Esty, 2014). However, most energy access products are sold through IDCOL partners in agreements with the 'household head' (mostly men).

At the same time, however, there is increasing evidence that involving women in energy value chains is good for women and good for business (Hart and Smith, 2013; ENERGIA, 2019; Johns Hopkins University et al., 2019). Women can be powerful sales agents because they are 'in the best position to help the buyer understand the benefits of ... improved cookstoves' (Wright, cited in Johns Hopkins University et al., 2019: 48). They can also 'leverage existing social networks, [and] form trusting relationships with potential customers' (ENERGIA, 2019: 13). The combination of access to finance and the right sort of training and mentoring is key to supporting women energy entrepreneurs (Duta, 2018). When provided with focused, personal agency-based empowerment training, women cookstove entrepreneurs in Kenya outsold men by three to one (Shankar et al., cited in Johns Hopkins University et al., 2019).

Recommendations for focus of financing to leverage change at national levels

Our country-specific financing recommendations varied according to the level of market development, as can be seen in Table 3.3. Togo, for example, was largely pre-commercial with a need to first develop clear national targets for clean cooking, and a supportive environment

Table 3.3 Financing recommendations per country

Togo	*Kenya*	*Bangladesh*
Focus on gender mainstreaming and women's empowerment	Focus on gender mainstreaming and women's empowerment	Focus on gender mainstreaming and women's empowerment
Include national targets for clean cooking	Encourage more flexible loan requirements for fuel and stove enterprises	Fund awareness campaign for clean cooking
Introduce targeted subsidies for the rural poor	Expand consumer finance/ pay as you go	Facilitate working capital finance for stove enterprises
Reform collateral requirements for enterprises and consumers	Facilitate carbon credits and alternative financing mechanisms	Encourage microfinance for clean cooking
Facilitate carbon credits and alternative financing mechanisms	Streamline accreditation for stove and fuel companies	

for companies to establish themselves. In Bangladesh, commercial companies needed support with access to working capital and in marketing and awareness raising. In Kenya, the sector is increasingly split between larger, more formal cookstove businesses and many smaller-scale companies producing artisanal products. It is the latter who are perceived as high risk and struggle most to access finance. A system for business accreditation could help.

Across countries, the need to focus on gender mainstreaming and empowerment was evident. This should include supporting women's greater involvement in roles higher up the energy value chain, as has been witnessed, for example, by BURN Manufacturing in Kenya (Practical Action, 2018). It must also ensure that consumer finance for clean cooking and fuels is tailored to women's needs and does not increase the barriers they face. For example, Inyenyeri's approach reduces initial affordability barriers by providing a stove and fuel pellets for free in return for regular delivery of wood fuel (Practical Action, 2018: 25).

Delivering clean cooking solutions at scale and inclusively

Gender blindness makes programmes less effective

Having considered planning and finance, we then considered whether it is possible to *deliver* both at scale and inclusively. Some would argue that scale is most important, given the huge numbers to be reached. However, gender blindness makes programmes less effective, and ignoring remoteness and poverty risks condemning large sections of the rural, wood-burning population to unsafe, unclean cooking for decades to come.

To address this issue of scale and inclusion, we reviewed a charcoal stoves programme in Ghana and a rural domestic biogas programme in Kenya. The clean cooking sector in each country is clearly broader than just charcoal stoves or biogas, but we chose to focus on these sub-sectors to allow a greater depth of analysis and lesson-learning.

We should note that the *Gyapa* charcoal stoves in Ghana, while reasonably efficient (International Workshop Agreement Tier 2), vary in quality and are relatively low performance for particulate emissions; thus, they have limited long-term health impacts. Access to these stoves

would not count towards SDG7, yet they have achieved significant scale, with benefits that are highly valued by their users and with useful lessons for others. More needs to be done to count and acknowledge these advances in global figures, as is recognized in the MTF.

Approaches to market creation and scale

The two programmes have faced different challenges and are at different stages in terms of market creation and scale. Ghana's reach of improved charcoal stoves has accelerated dramatically over time. The charcoal-using market has grown from 1.9 million households in 1999 to 4.1 million in 2017 and the sector has reached 37 per cent of the potential market (Figure 3.4), as much as 60–72 per cent of those who currently use charcoal as a primary fuel. Having begun as an NGO programme, a thriving market and at least two commercially independent companies have emerged. Supply chain actors (artisans, distributors, retailers) have also multiplied; from fewer than 10 in 2001 to 1,500 by 2017.

The programme worked systematically to address barriers that often impede cookstove markets by focusing on, among others, building capacity, smoothing financing challenges, and running an effective demand-creation programme. Gold Standard carbon credits have contributed to keeping the stoves affordable for a larger number of people.

In Kenya, the national biogas programme is at an earlier stage and did not take off as rapidly as Ghana's cookstoves market, although the market conditions for biogas have improved significantly. Just 2,400 biogas plants existed at the beginning of the programme, many of which were operating below capacity or had fallen into disuse. Rural communities did not trust the technology or see it as a worthwhile investment. By 2018, the programme had installed 17,134 plants, reaching around 10 per cent of the potential market. Biogas users reported a range of benefits including time savings, clean and convenient cooking, and bio-slurry to improve agricultural yields.

As well as driving installations, the programme aimed to create a market for biogas. Supply has improved with 577 masons trained, of whom 240 are still working, and 82 registered companies exist. The programme focused on improving quality to reduce system breakdowns (23 per cent of those built in Phase 1 were not operational by Phase 2). The increased popularity of prefabricated plants matches trends elsewhere (such as Sistema.bio in Central America), and could be a route to a more scalable business model.

Biogas demand was boosted through marketing hubs engaging with agricultural cooperatives in dairy, coffee, and tea. Affordability was addressed through a range of financing options to overcome the high installation costs of $500–$1,000, including accessing carbon credits, initially offering subsidies, and, in Phase 2, using results-based financing

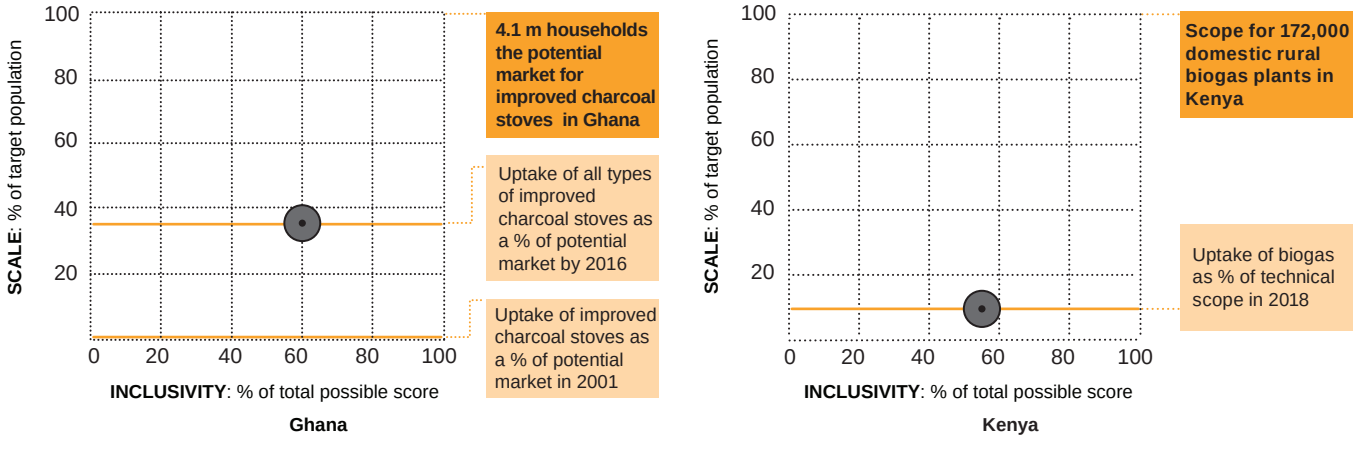


Figure 3.4 Scale and inclusivity results for the Ghana clean cookstoves programme and Kenya Biogas Program

to encourage local finance institutions to introduce new loan packages. It can be argued that subsidies are not needed for biogas because the systems eventually save farmers money. However, there is a strong case for subsidies as a way of kick-starting the market and targeting poor consumers, as with, for example, LPG in Indonesia. The programme focused more on boosting private investment, increasing the number of retailers, and engaging more women in the supply chain.

To achieve scale, markets must be built holistically across demand, supply, policy, and finance

PPEO 2018 concludes that to achieve scale, markets must be built holistically across demand, supply, policy, and finance. This requires multi-stakeholder market activation bringing government, the private sector, civil society, and consumers together. Actions could include:

- *Supply.* Technical support to companies, assistance and mentoring on investor readiness with elements of women's empowerment, balanced with ongoing design and business model improvements.
- *Demand.* Public awareness campaigns for clean cooking, with targeted messaging for particular groups (CCA, n.d.).
- *Policy.* National targets, tax incentives, implementation and enforcement of quality standards, and a clear, stable regulatory environment tailored to particular fuels and technologies but flexible enough to allow for new innovations.
- *Finance.* Improved access to finance for consumers and companies, including addressing gender barriers. Greater long-term or 'patient' capital to help establish strong markets. Affordability gap subsidies where needed, which results-based finance can support (EnDev, 2017).

Approaches to inclusion

As Figure 3.4 demonstrates, in terms of inclusion, both programmes scored similarly and, of the three factors comprising the index, both scored lowest on remoteness. In Ghana, this relates to the urban niche filled by improved charcoal stoves. In Kenya, although meeting the needs of rural wood-burning consumers, biogas is only feasible where there are enough cattle and sufficient water. This overlaps with districts that are on average more populated and better connected to other infrastructure.

The Ghana programme scored reasonably well for gender inclusion (Figure 3.5), meeting the practical needs of the mainly female group

Figure 3.5 Inclusivity results for the Ghana clean cookstoves programme and Kenya Biogas Program

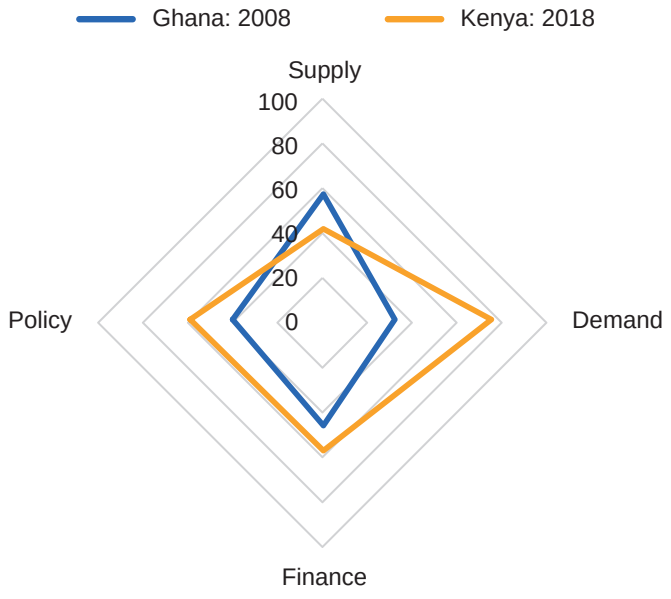


Figure 3.6 Enabling environment in Ghana and Kenya at the end of the programmes

of small retailers who were critical to achieving scale. In Kenya, the programme scored well for its deliberate attempts to address gender issues in a male-dominated sub-sector, with specialist inputs from ENERGIA. Similarly, both score reasonably well on their poverty focus. The Ghana programme worked to make the sales prices of stoves affordable, and in Kenya, despite the high up-front costs of biogas, financing schemes were making them affordable for many smallholder farming households.

Enabling environment for clean cooking in case study countries

A supportive enabling environment is important for achieving scale and inclusion. Our situation analysis covered the enabling environment for demand, supply, policy, and finance. As Figure 3.6 shows, at the end of the review period we found that Kenya was ahead of Ghana on indicators for finance and the policy environment, as we might expect given the long history of work on cooking in Kenya (Stevens et al., 2019). Ghana was ahead on 'supply' indicators, reflecting efforts taken to support market actors in the charcoal stoves sector.

If we compare our findings with the World Bank's Regulatory Indicators for Sustainable Energy (RISE) for cooking (Figure 3.7), we see that Kenya is marginally ahead of Ghana, having done more on standards, labelling, and providing incentives for consumers and suppliers. Ghana scores higher on embedding clean cooking in planning.

At a broader level, national energy policies and strategies are often driven by considerations of economic growth and energy security rather than access (Practical Action, 2016), with limited attention on clean cooking. This is despite the fact that biomass for cooking accounts for a huge amount of residential energy demand: 80 per cent in sub-Saharan Africa (IEA, 2014). Responsibilities are often distributed across multiple agencies, with clean cooking sometimes under renewable energy, agriculture, rural development, or even the ministry of petroleum in the case of LPG. This creates fragmentation and a lack of leadership. Given this, devising Action Plans and Investment Prospectuses under SEforALL helped to bring stakeholders and agencies together; however, momentum has sometimes stalled in follow-up planning and investments.

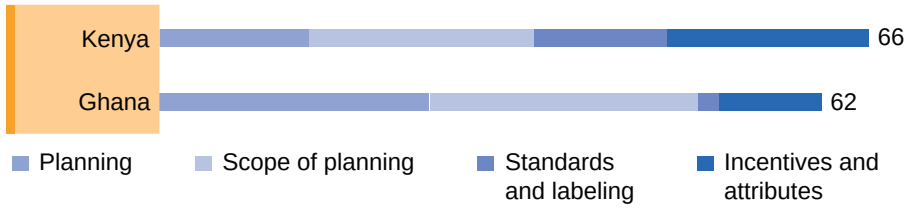


Figure 3.7 Comparison of Kenya and Ghana's regulatory environment for clean cooking

Source: World Bank http://rise.esmap.org/scores

Recommendations

By not comprehensively reporting on access to lower-tier clean cooking solutions, we miss much of what is happening in the sector

Clean cooking progress continues to lag behind that for electricity access. This is emphasized further by the lack of global progress monitoring at lower tiers than those considered 'clean for health'. Such monitoring is beginning to happen through the MTF, but we are far from this being reported annually for every country. Even if these lower tiers are not the ultimate goal, without reporting on them we miss much of what is happening in the sector.

Many of the recommendations for action we made in *PPEO 2016*, *2017*, and *2018* still stand, despite progress in some areas. Support to the sector as a whole, as well as to individual enterprises, is key. Some of our recommendations include:

- Set *ambitious national targets* for clean cooking and implement robust plans which put clean cooking on a par with electricity access and look for synergies between the two. They should consider higher tier fuels and stoves *and* incrementally improved biomass solutions.
- Establish *strong national leadership*, which brings relevant ministries and agencies together.
- Support *market activation*, promoting coordination through industry associations and engaging with civil society forums and consumers, particularly women.
- Fund *awareness campaigns* around improved cooking solutions.
- Work with *finance institutions* to improve awareness of the sector and of emerging business models, while addressing entrenched barriers to women's access to finance.
- Improve access to *consumer credit* for clean cooking solutions, including working with MFIs, addressing barriers faced by women and the poorest.
- Continue to challenge the sector to find ways to *serve the poorest, rural, wood-burning households* so they are not the last to be reached. Measure and value inclusion as much as numbers reached.

It is encouraging to see the greater focus in the sector on fuels, rather than just stoves, since 2016

It is encouraging to see the greater focus in the sector on fuels, rather than just stoves, since 2016. LPG has been subsidized and promoted by governments in a growing number of countries, although some donors avoid supporting it as a fossil fuel. The CCA Industry Snapshot (2019) highlights the potential for higher growth from fuel-based models, and new business models which integrate stoves and fuel sales. The range of clean fuels offering viable solutions is increasing with new developments in electric cooking and bioethanol, for example. New biomass-based options are also emerging with various types of briquettes and pellets (Dagnachew et al., 2018).

Examples of where small solar and clean cooking value chains are beginning to work together are emerging. Local distributors of small solar

products often carry a range of products including improved cookstoves, and a number of solar home system (SHS) companies such as EcoZoom and M-Kopa are starting to offer cookstoves (CCA, 2019). New alliances are also being formed between commercial distributors. In India, two large alliances (CLEAN and GOGLA) are working to bring data together on off-grid solar, solar pumps, mini/micro-grids, and improved cookstoves (GOGLA, 2018a). There is potential for integration through the development of electric cooking with batteries, stove, and appliance technologies. There has been less success where cooking elements are just add-ons to SHS programmes (as we found with the South African programme; see Chapter 4).

Debate remains about where support should be focused: on solutions that leapfrog to entirely clean cooking, or on incremental improvements in biomass-based solutions. Some argue the potential for growth, private sector investment, and larger-scale government support is in higher tier models, and supporting anything else will not achieve important benefits for those we seek to serve, nor will it attract the finance required. Others argue that the 'perfect should not be the enemy of the good' (Shafer, 2019). The spread of *Gyapa* stoves in Ghana and basic *jikos* in Kenya illustrates the scale that is achievable. Benefits brought by basic improved cookstoves are valued by women in reducing burdens and time spent, even if long-term health impacts are not realized.

The need to address the lack of clean cooking is urgent. While we wait for the next generation of business models to scale up, every day that passes sees women continue to suffer the physical and time burdens of using traditional fuels and fires. New and exciting opportunities are beginning to emerge, which need to be pursued boldly, while continuing to challenge the sector to reach those most likely to be left behind.

The need to address the lack of clean cooking is urgent

Routes to scale

CLEAN COOKING

Call to action

Plan

Raise levels of national ambition and commitment, mainstreaming gender, with strong leadership. Create an enabling environment. Monitor and report on scale and inclusion for all Tiers of access.

Finance

Ensure better, increased and gender-sensitive financing for consumers and entrepreneurs to build markets as well as address affordability. Incentivize reaching the 'last mile'.

Deliver

Activate markets with women as leaders. Take proactive steps to meet the needs of the rural, wood-burning majority.

5 HOURS

spent by women per day, approximately, to collect and prepare fuel and cook

51%

of people in our case study communities wanted to switch to an entirely clean solution

What she has

A choice of fuels which are cheap or free and easy to use, but also time-consuming and polluting.

What matters to her

To save time

To save money by using less fuel

Fuel that's easy to light

Barriers to inclusion

Affordability

The upfront cost of buying an improved stove and fuel may be high.

Social and cultural constraints

She may have poor access to consumer finance, linked to not owning assets or lacking a savings and credit history. She may be cautious to change traditional cooking methods.

Bargaining power

She may not have control over household decisions about the purchase of costly household items.

Lack of awareness

She may not be aware of the benefits to herself, her family, and the environment of cooking with improved stoves and clean fuels.

ELECTRIFICATION

When electricity first came to the village of Amaguaya in the Cordillera Real mountain range of Bolivia, a village leader said 'now we have a way, we have light, it is as if we are climbing the steps to a better and better life'. And beyond light, we hear from farmers about the difference solar-powered irrigation is making, from women about the time saved with grinding and threshing machines, and from school teachers and health workers about the improved services they can offer. Electricity has the power to transform lives. But despite global progress, millions are still left in the dark. And for others, electricity arrives but not in ways that can bring this wider, life-changing transformation. Our focus needs to be steadfast in finding ways to ensure the broad energy service needs of poor communities are met throughout the processes of planning, financing, and delivery.

In this chapter, we bring together the highlights from our research in *PPEO 2016*, *2017*, and *2018* and our key recommendations. We cover bottom-up planning for electrification, implications for the national technology mix, and the costs of delivering this. We review lessons about balancing delivery at scale with inclusion. We emphasize how planning needs to integrate grid and off-grid systems, while delivery calls for specialized skills and partners to bring benefits to all.

Bottom-up planning for electrification: meeting broad energy service needs

Our bottom-up approach starts with an in-depth understanding of 12 off-grid case study communities in Togo, Kenya, and Bangladesh, illustrating a diverse range of energy resources, livelihoods, and policy contexts. In line with our Total Energy Access framework (Practical Action, 2014) we looked at energy service needs and priorities for men and women in their households, livelihoods, and community services. We focused on communities beyond the reach of grid electricity. For the 2018 edition, we explored specific electrification programmes: solar home systems (SHS) in South Africa, mini-grids powered by micro-hydro in Nepal, and grid extension programmes at different scales and using different models in India and Peru.

Off-grid electricity access, 2015

The context for off-grid electricity access varied widely across our focal countries and the case study communities where we collected data in 2015.

Among households, the success of the IDCOL SHS programme was evident in Bangladesh, where in all but one community, two-thirds to three-quarters of households had a system, the most popular being a package with a 50 W panel. In Kenya, households owned a greater diversity of products. Solar lanterns were the most common, followed closely by small SHSs (see Figure 4.1). Togo had by far the lowest levels of electricity access with at most 9 or 10 per cent of households owning an SHS, and some using rechargeable batteries.

The different levels of access between communities in the same country is striking, and highlights the extent to which some are being left behind. The impact of geographic remoteness is evident. Sardar Para in Bangladesh, for example, is in the far northern tip of Bangladesh. In Kenya, those that were closer to larger market centres, or had access through family migrant labourers, had the highest ownership of off-grid systems. Income was also important. In Bangladesh, those without an SHS earned about half as much as those with a system, and in Togo those without were 30 per cent poorer. We found similar results in Kenya.

When it comes to electricity access, the impact of geographical remoteness is evident

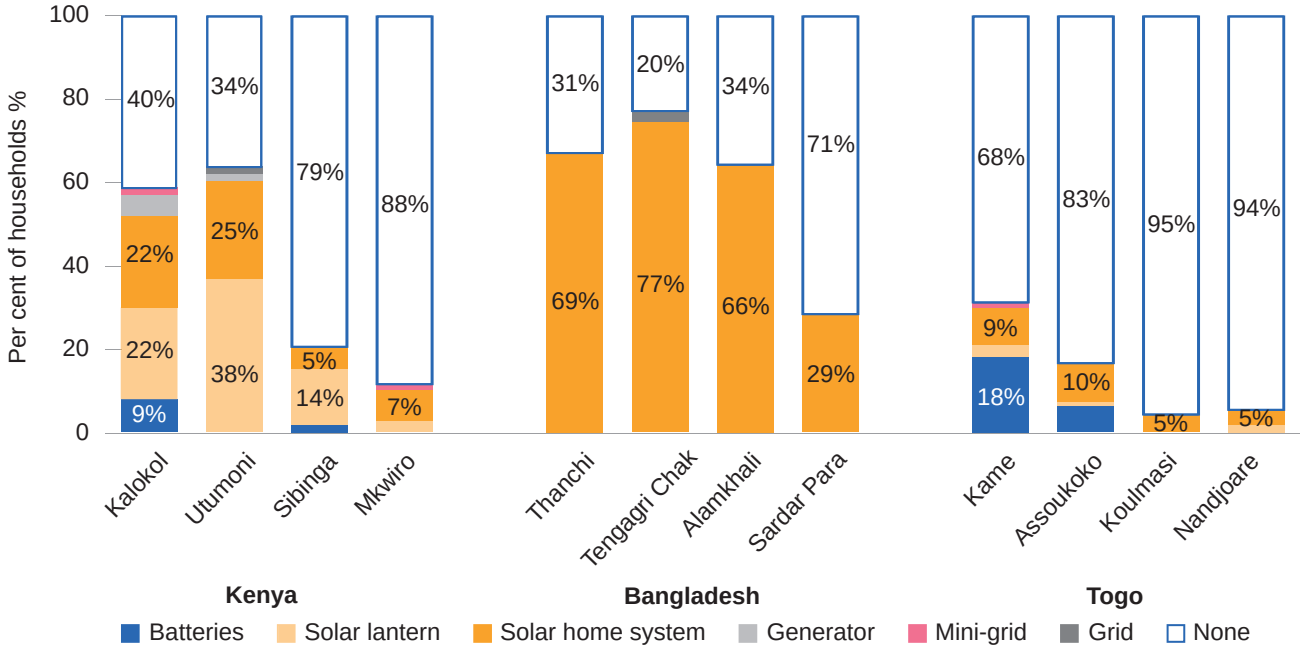


Figure 4.1 Primary source of household electricity in 2015

Having access to electricity gave households useful energy services. In Bangladesh, SHSs allowed phone charging and the use of fans (owned by 18–32 per cent of households) and televisions. Most of these SHSs were in Tier 1 of the World Bank's Multi-Tier Framework (MTF), with about three hours of reliable evening power. In Kenya and Togo, there was a wider range of system sizes, with some bigger systems allowing phone charging, radios, televisions, and a few fridges, and others being so limited they left households in Tier 0. These limitations mean a continuing use of kerosene for lighting. In all but two communities, two-thirds to three-quarters of households continued to use at least some kerosene or batteries for lighting alongside their solar devices.

Businesses require a range of energy services including lighting, ICTs, cooling, motive power, and heating

Businesses required a range of energy services including lighting, ICTs, cooling, motive power, and heating, and used a range of fuels to supply this. Bangladesh had the highest proportion using solar systems of the three countries (particularly in retail and service enterprises). Compared with households, more enterprises in all countries used higher powered systems (often diesel generators). These were expensive to run because of the costs of transporting fuel long distances.

Community facilities (schools, health centres, and religious buildings) also needed electricity. In Kenya and Bangladesh, health facilities were the most likely to have power (five out of six), usually at Tier 3 levels. In Togo, none of the villages had an electrified health centre. Religious buildings often had quite high-powered diesel generators for lighting and sound systems in Kenya and Togo. In Bangladesh, as for households and enterprises, solar power was commonly used by religious buildings for lighting. Schools were the least likely to be electrified (just 20 per cent in Kenya, 29 per cent in Bangladesh, and 15 per cent in Togo).

Since we collected these data in 2015, the market for off-grid solar has continued to grow rapidly in Kenya. GOGLA reports sales of 3.4 million products between January 2016 and December 2018 (GOGLA and Lighting Global, 2019), the vast majority of which support Tier 0 or Tier 1 lighting and mobile charging. Nearly 10 million Kenyans (21 per cent) now meet their basic electricity needs with quality-verified off-grid solar products (Dalberg Advisors and Lighting Global, 2018). In Bangladesh and Togo, there has been less progress. Sales of SHS through IDCOL are declining, while in Togo they are just beginning to pick up under the CIZO programme (Practical Action, 2018).

Community electricity priorities: building holistic plans from the bottom-up

Energy for households was the top priority in all but one community

We asked communities about their energy access priorities, covering both electricity and cooking, and realizing that it is not always the most power-demanding services that are the most important. Energy for households was the top priority in all but one community, and within that, *electric lighting* was the most important application in 10 out of 12 communities. In Togo, a focus group participant said: 'the lack of light is the source of many troubles: insecurity, isolation, and ignorance'. Another said: 'in the darkness, you are almost dead'. In all communities in Bangladesh the top reasons for needing lighting were working at home, helping children to study, and moving around easily and safely at night, including to use the toilet. In Kenya, women tended to prioritize lighting outside their homes instead of communal street lighting for improving security and using the toilet. These findings underline the value of off-grid lighting products for improving people's lives in very tangible ways.

After lighting, the ability to *charge mobile phones* and use other electronic items was important. In Bangladesh, *fans to cool* the living space were highlighted. Indoor temperatures were uncomfortably hot for 16–18 hours a day, for nearly half the year in all the communities. Women mentioned how vital fans were particularly in the months before and after giving birth when they are likely to spend the greatest amount of time in or near the home.

Energy for community services was the second highest priority after household energy. In Kenya, the greatest need was for *schools*, as it was in Togo. The other community services most frequently discussed are not usually included in the global discussion: *street lighting* and *energy for household water* (rather than irrigation). In Togo, street lighting was ranked second by all four communities, where women talked about how, together with household lighting, it was vital for improving security and deterring reptiles and snakes. In Bangladesh, street lighting was valued more by men who felt it might benefit their retail enterprises. In certain communities in Kenya and Bangladesh, and in all four in Togo, pumping and collecting water is a significant burden. Women from Sibinga, Kenya said: 'If we had a pump to draw water to our homes, this would reduce time and energy for going out to the river to fetch water. All this time can be diverted to other useful activities at home.'

Energy for productive uses was not rated as highly by the communities, and only featured in the top 3 in half of the 12 communities. Men tended to value energy for businesses and agriculture more highly than women, perhaps because as Pueyo (2019) reports, men own more businesses than women, and these businesses use more electricity than women-owned enterprises. In Bangladesh, the focus group discussions revealed a consistent demand for energy for *irrigating crops*. In Alamkhali, Bangladesh, focus group participants said: 'Electricity should be agriculture-use based and for the general poor people. Not for just one or two persons.'

In all three countries, there was a need for *energy for processing crops*, which is predominantly a task taken up by women. This was often regarded as a 'household' energy need by our survey participants. In Bangladesh, this involves threshing rice and/or grinding pulses. In Kenya, it involves threshing, milling, and hulling various grains. In Togo, there were an insufficient number of mills, which often break down or run out of fuel, leaving women to spend long hours grinding crops manually.

These expressed priorities beyond household lighting – water pumping, power in schools, or street lighting – ought to be at the forefront of cross-sectoral, cross-ministerial planning and policy debates. Too often planning is based on a 'gender-neutral' view focusing on household electricity connections alone.

Too often planning is based on a 'gender-neutral' view focusing on household electricity connections alone

Community energy demand profiles

To build community electricity demand profiles, we asked households, enterprises, and those running community facilities about the energy applications they would like to use. We based our calculations of power demand (kWh per day) on the energy efficiency of locally available products. We triangulated and added information from focus groups and factored in a 50 per cent increase in non-farming enterprise that could be stimulated by the arrival of wider electricity access.[1] This community-defined demand profile is thus at the upper end of what people are likely to use in the coming few years. Indeed, the MTF survey in Ethiopia found that three-quarters of grid-connected rural households only own very low-load appliances, corresponding to Tier 1 (Padam et al., 2018).

In terms of MTF tier levels, the majority of households wanted energy services at Tier 2 or 3 levels. Two of the communities in northern Togo were outliers, with 93 per cent and 68 per cent of households only requiring Tier 2 or below. The pattern of demand was noticeably different for enterprises and community facilities. Some did not need electrical power at all (9 per cent on average). For the majority (58 per cent on average), however, the services they wanted to use put their power requirements in Tier 3 or 4.

The amounts of power for each MTF tier level rise exponentially. There is a big jump between Tiers 2 and 3, and again between Tiers 3 and 4 (see Figure 4.2). This means that households using Tier 1 and 2 amounts of power represent a far lower draw on power than those using Tiers 3 or 4. In Tengagri Chak, Bangladesh, for example, while nearly half the households require power in Tier 2, this represents only 13 per cent of the daily power demand (see Figure 4.3). Similarly, when we plan in an integrated way across households, productive, and community uses, productive uses are likely to take a proportionally higher share of overall power demand (as seen in Figure 4.4). Catering for street lighting and power to community facilities only accounts for a small proportion of power demand.

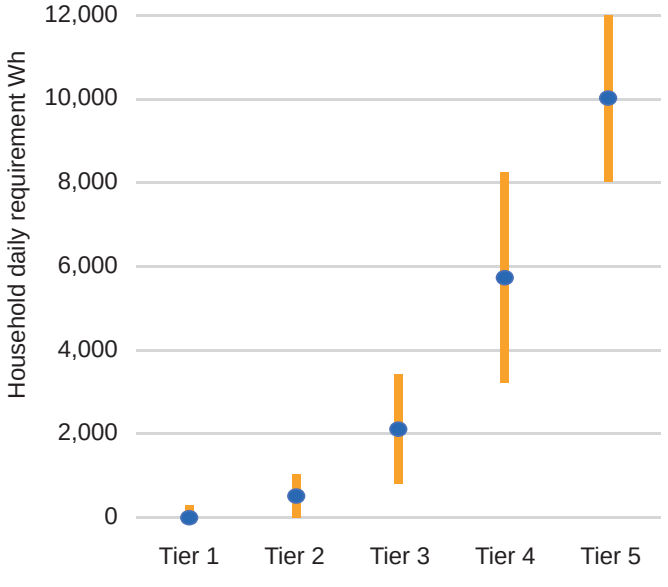


Figure 4.2 Power required for each tier of the Multi-Tier Framework

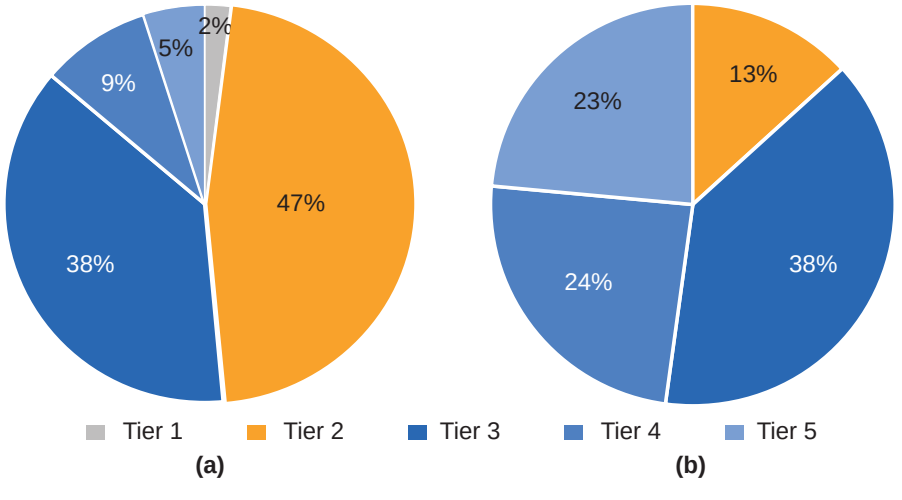


Figure 4.3 (a) Percentage of households per tier; (b) percentage of daily power demand per tier in Tengagri Chak, Bangladesh

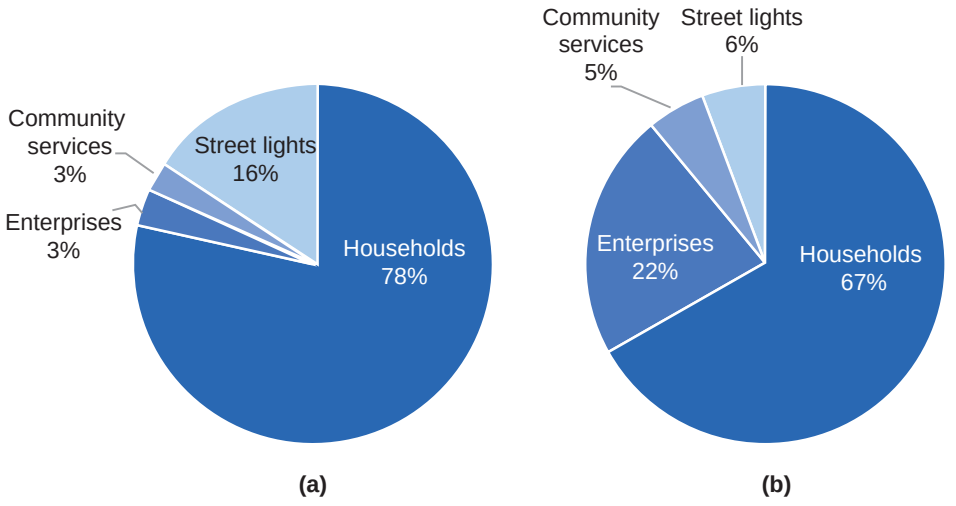


Figure 4.4 (a) Connections as a percentage of uses; (b) power demand (MWh/year) in Koulmasi, Togo

Least cost of provision

In establishing the least cost means of providing for these needs, we first worked out the balance between a distribution system (either grid connection or mini-grid) and stand-alone systems. Two factors were crucial. One was the geographical spread of the community. In Koulmasi and Nandjoare in Togo, scattered households meant households and enterprises were better served by stand-alone systems. In Utumoni in Kenya, households were spread across a hilly landscape. This meant that only a central cluster of households and enterprises would economically be served by a distribution system, and the rest with stand-alone systems.

A second factor is the level of power required. From Tier 3 and above, stand-alone systems are much more expensive per kWh than distribution systems. So, at these levels of demand it is usually better to supply everyone through a mini-grid or extension of the national grid. However, to achieve these levels of load requires a package of support to businesses in terms of financing, building capacities, and accessing markets.

Where fairly densely settled communities were located relatively close to the existing grid (four communities), the least-cost means of delivery would (unsurprisingly) be through grid extension. In five communities, mini-grids were the least-cost option, and in another three mini-grids were cost-competitive with grid extension. Figure 4.5 also shows the important role played by stand-alone systems (alongside mini-grids) in half the communities in delivering access for all.

To power the mini-grids, in one case (Assoukoko in Togo) a hydro-powered mini-grid was feasible. In all other cases, the cheapest power source was diesel. However, hybrid systems[2] that use primarily solar power with some diesel can reduce costs by 12–16 per cent (ARE, 2011; Frankfurt School-UNEP, 2015). Purely solar-powered mini-grids were significantly more expensive in our model due to high capital costs of the generation capacity and batteries needed to cover peak loads.

For our national-level modelling, we used the four community demand profiles and applied them to 95 representative communities nationwide. Some of these communities are already grid-connected. We removed those, focusing on those still unconnected as of 2016. We mapped the least-cost solutions to illustrate how particular parts of the country are the most likely to be best served by national grid connections, mini-grids, and/or stand-alone solutions.

Our comparisons are based on a cost of grid extension estimated by pricing the additional generation and distribution infrastructure required.

For our national-level modelling, we used the four community demand profiles and applied them to 95 representative communities nationwide

Note: * = where a mini-grid is within 15–18 per cent of costs of grid extension per kWh.

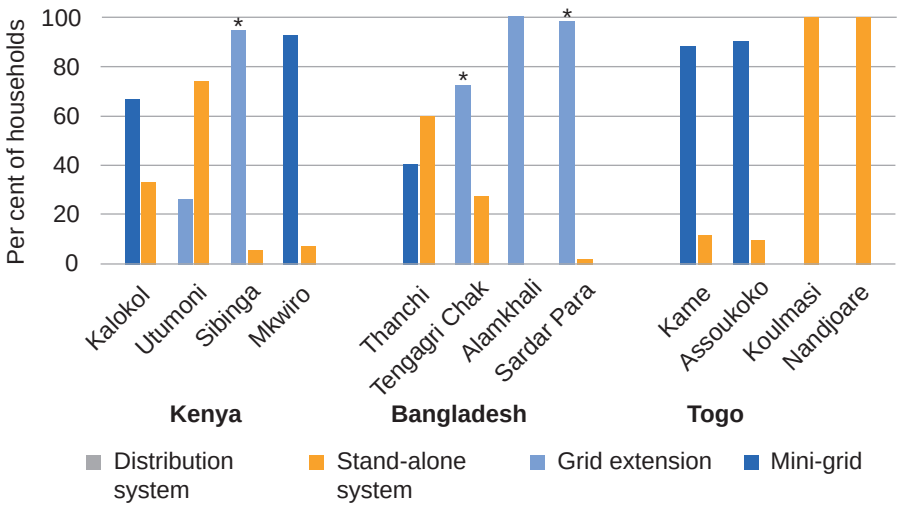


Figure 4.5 Balance of distribution systems and stand-alone systems

We used this method to create a fair comparison of costs to the national economy. However, in all three countries, the actual prices charged by electricity utilities per connection are significantly below cost-recovery (see Table 4.1). The lowest prices are in Bangladesh as noted, for example, in SREP (2015). Although some schemes are in place to reduce the sale price of off-grid systems (such as through IDCOL in Bangladesh) they do not offer anything like the level of subsidy enjoyed by the grid system.

Table 4.1 Consumer cost for Tier 2 grid electricity access versus the estimated 'real' cost, per day

	Cost to consumer for Tier 2 use[1] of national grid electricity: US$ per day in 2017	*Estimated 'real' cost of grid extension: US$ per day for Tier 2 use[2]*	*Difference*
Bangladesh	0.015	0.09–0.14	6 to 9 times below
Kenya	0.058	0.13–0.33	2.2 to 5.8 times below
Togo	0.137	0.17–>0.44[3]	1.2 to >3.2 times below

Notes: [1] We used a figure of 317 Wh per day, based on use of a range of Tier 2 appliances (lighting, fans, TV, phone charging). Tier 2 is defined as using between 200 and 1,000 Wh per day per household.
[2] Costs of use of grid electricity exclude connection fees and house wiring costs, which can be substantial.
[3] For Togo the real cost of grid extension in two of the communities would be more than the cost of an SHS (which is the highest figure shown here).

Our modelling suggests that off-grid systems (a mix of mini-grids and stand-alone systems) would be the least-cost solution for the majority of unconnected people: 66 per cent in Bangladesh, 68 per cent in Kenya, and nearly 100 per cent in Togo. Within that, stand-alone systems will play a larger role than mini-grids. Kenya is the most suitable of the three for mini-grids where they could meet 39 per cent of remaining needs (Figure 4.6).

Extension of the national grid makes sense for a third of the remaining unconnected households in Bangladesh and 27 per cent in Kenya. In Bangladesh, even where the grid has reached the main town in a district, some of the more scattered households would still be best served with off-grid solutions. In Togo, the most economical way of providing electricity for all those in unconnected districts is through off-grid solutions. Our surveys showed ongoing demand for solar lanterns in addition to connections to a distribution system as a back-up for power outages.

The results of our modelling exercise are broadly in line with others, such as outputs of the UN-DESA 'electrification paths' model. The SDG Tracking Report suggests that 54 per cent of new capacity should be in decentralized systems (IEA et al., 2019). Our models include a higher proportion of mini-grid and stand-alone systems for a similar level of

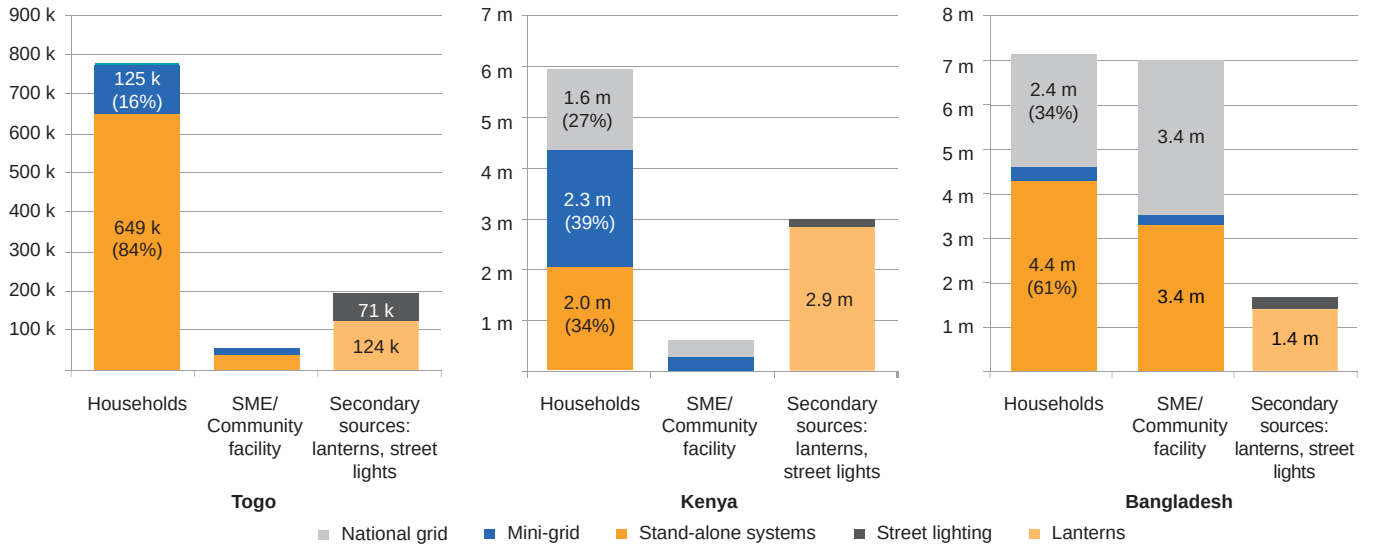


Figure 4.6 National technology mix for electricity, for those currently unelectrified

electricity service. This illustrates the value of paying detailed attention to the profiles of electricity demand, and the geographic distribution of households affecting the viability of distribution grids.

This technology mix is based on cost factors alone, but other considerations are also important including the time taken to deploy different solutions, which is far faster for decentralized solutions (Power for All, 2016). Every year, remaining without energy access is a wasted opportunity and comes at a price in terms of the potential savings in money, time, hours of study by children, and CO_2 emissions (SEforALL, 2017b). There is also growing evidence of the extent to which renewable energy can create jobs in the economy (GOGLA, 2018a; Power for All, 2019b).

Financing the stretch to electricity access for all

In modelling the financing required for meeting people's electricity service needs, we considered affordability and willingness to pay, and extrapolated our findings to the national level.

Community-level affordability and willingness to pay for electricity access

In 10 of the 12 communities, the majority were willing to pay something for an electricity service. In Bangladesh, focus group participants said: 'Everybody wants to use electronic goods. A man can be poor, but his willingness to use electronic products crosses the boundary of being poor.' Despite the important benefits that households recognized from accessing electricity, some said they were unwilling (or perhaps unable) to pay anything at all to use it. This was the case with the poorest community in Kenya, for example. Where they were willing to pay something, the *amounts* varied depending on the offering, with households generally willing to pay more for higher-tier systems. There was also some preference for mini-grids over SHSs in Kenya and Togo.

In 10 of the 12 communities, the majority were willing to pay something for an electricity service

The narrowest gap between willingness to pay and the (unsubsidized) costs of the systems was for Tier 2 mini-grids. In 8 of 12 communities, the average willingness to pay (among those who would pay something) exceeded the cost. However, when we factored people's willingness to pay into our models, we found that distribution systems (grid or mini-grid)

An affordability gap prevents communities benefiting from systems that would meet their needs at the least cost

were *not* economically viable in all but one community. Because some are not willing to pay at the level of costs we calculated, numbers connecting go down and costs per kWh for those remaining go up. In turn this means fewer people willing to pay. Eventually only richer households could afford to be connected.

Overall this emphasizes the affordability gap which prevents communities from benefiting from the systems that would meet their needs at the least cost. Where public funding is not invested, the effect is to increase the costs of electrification for the nation as a whole, because the most cost-effective options are not viable. Energy-poor, remote communities end up paying the most, or not being connected at all.

National projections of the costs of electricity access for all

Based on the least-cost technology mix for achieving energy access (Figure 4.6), we calculated the total cost of the transition (Practical Action, 2017, Table 4.2). This varies according to the population to be served, with the largest budget required in Bangladesh. Costs per person per year are also highest in Bangladesh because of demand for higher levels of productive power (mainly irrigation pumps). Despite varying levels of poverty, the average willingness to pay for electricity is very similar across all three countries. However, this is less than half the cost of provision.

Central to our modelling of the technology mix and financing required has been the integration of energy needs from household, productive uses, and community services. In all countries, energy for street lighting and community services were high priorities, while not adding significantly to costs. Providing stand-alone solar street lighting represents 0.5 per cent of the electrification cost in Bangladesh and Kenya, and 7 per cent in Togo. Increasing rural incomes from powering agricultural livelihoods would help fund electricity provision. This underlines the need for a range of responsible ministries such as agriculture, education, health, and water to plan for energy access.

The costs, efficiency, and availability of electricity access solutions are constantly changing

Changes in costs of electricity access solutions

Since completing the research for *PPEO 2017* there have been continuing changes in the costs of electricity access solutions. The manufacturing cost of pico solar devices fell by 27 per cent between 2012 and 2016. Predictions are that prices are likely to stabilize by 2022 after a further 7 per cent fall between 2016 and 2022. Declines in battery prices are likely to have a bigger impact on SHSs, whose manufacturing

Table 4.2 Cumulative cost of provision of national electricity access plans to 2030

	Finance required		*Average WTP pp/yr*	*Finance gap pp/yr*
	Total to 2030	*Per person/yr*		
Togo	$4.9 bn	$93	$23.80	$70
Kenya	$26 bn	$72	$23.40	$49
Bangladesh	$75.2 bn[1]	$134	$23.30	$111
Bangladesh (households only)	$37.7 bn	$67	$23.30	$44

Note: WTP: willingness to pay.
[1] A large proportion of this figure ($37.5 bn) is for energy for productive uses.

costs are predicted to fall by 39 per cent between 2016 and 2022 (Lighting Global, 2018).

Costs for mini-grids vary greatly depending on the power source. Costs per kWh for a micro-hydro system, for example, have traditionally been much lower than for solar PV. However, the gap is closing with the use of hybrid systems. The World Bank estimates that solar-diesel hybrid system costs are likely to fall from an average of $0.55 per kWh today to $0.22 by 2030 (ESMAP, 2019). Over the past decade capital costs for solar-only mini-grids have also decreased by 62–85 per cent. Costs of grid electricity may also fall over time, as grid-connected renewables could deliver more cheaply than fossil fuels. However, this is only a small proportion of the costs for delivering grid-based power, so the overall effect is likely to be small. Overall, mini-grids are estimated to be the cheapest option for 490 million of the 1.2 billion to be electrified by 2030 (ESMAP, 2019).

Other factors driving costs include policy choices. The costs of SHS in Bangladesh, for example, have been reduced by aggregating demand through the IDCOL programme. Changes in VAT regulations have affected prices across East Africa. The cost, efficiency, and availability of appliances compatible with decentralized solutions is also increasingly important. Our models were based on the energy *services* that people wanted to use. As these services become more possible with a reduced energy demand, costs will fall.

Overall, therefore, if we were to repeat our modelling and financing exercise with today's prices, we would probably find an even greater share of the technology mix for decentralized renewables as they become even more cost-competitive with the grid. This would translate into reducing costs at the national level.

Trends in financing for electricity access

Our reviews of the national financing picture for electricity access in *PPEO 2017* found that commitments for grid versus distributed systems remain widely out of sync with our findings and calls by other experts. In Kenya, despite new commitments, only 15 per cent of funding was going towards distributed energy, and in Togo only 5 per cent. In Bangladesh, investments in stand-alone systems were a quarter of total energy funding. Compare this with our estimates that, for districts still unconnected, funding for distributed electricity should account for approximately 83 per cent of future electricity finance in Kenya, 82 per cent in Bangladesh, and 100 per cent in Togo.[3]

Commitments for grid versus distributed systems remain widely out of sync with our findings and calls by other experts

Some of the biggest changes have been in Togo where the government has now completed an off-grid plan, which is integrated into the national electrification plan (GOGLA, 2019a), with support provided under the CIZO programme. This includes an import duty waiver for companies licenced under the programme, with two licences issued so far. Concessional financing is likely to be made available through the World Bank's West Africa Regional Off-Grid Energy Programme (ROGEP) and the African Development Bank.

Kenya continues to be a hotspot for global investments, with 58 per cent of the global $511 m raised by the distributed renewable energy (DRE) sector being concentrated in East Africa (Wood Mackenzie and Energy 4 Impact, 2019). In Bangladesh, a new SREP financing (loans and grant) of $185 m will scale up grid-connected renewables and rooftop solar for companies. A further $55 m has been approved by the World Bank for the Rural Electrification and Renewable Energy Development (RERED) II project to support the installation of 1,000 solar irrigation pumps and 30 solar mini-grids.

These are welcome investments and maintain the pace of previous years. However, they still fall short of the $52–55 bn needed per year for energy access (World Bank, 2018b), with 79 per cent needed for off-grid solutions (IEA, 2017).

Recommendations for financing to leverage change at national levels

Our financing recommendations for each country drew on multi-stakeholder consultations for *PPEO 2017* (Table 4.3). In Togo in 2017, markets for off-grid electricity products were nascent. Microfinance institutions were well represented in the country, but few were involved in loans for energy access and the local banking sector was not familiar with energy access businesses. The CIZO has helped to kick-start markets (GOGLA, 2019a). Lighting Global (IFC, 2018) recommends that more could still be done on boosting affordability, controlling quality, and raising awareness.

Kenya, by contrast, is recognized as a 'global front-runner in terms of the depth and dynamism of its off-grid solar market' (GOGLA, 2019b). This market growth has been supported by an enabling policy environment, as well as the widespread use of mobile banking and microfinance. Despite this, stakeholders identified barriers similar to those found elsewhere, including: the affordability gap, high perceptions of financial risk, and a local financial system that could do much more for energy access companies and the communities they serve. Some of the tariff changes called for by our stakeholders were introduced across the East Africa region in 2016, although later amendments meant import tariffs and VAT increased again (GOGLA, n.d.). Further reforms were called for, in particular for mini-grids, to streamline licensing and contracting processes, and to revise the feed-in tariff policy to incorporate mini-grids.

In Bangladesh, as elsewhere, financing and regulations for stand-alone systems are easier than for mini-grids. The SHS industry has faced major challenges with the massive grid expansion programme and some giveaways of systems through the *Kabikha* programme. It is trying to re-focus on new markets such as solar irrigation. There were calls for greater certainty for potential mini-grid developers in identifying areas that will not be reached by the grid, and to develop closer links with the agriculture sector, which has happened to a degree through plans for the RERED II programme.

Table 4.3 Financing recommendations per country

Togo	*Kenya*	*Bangladesh*
Focus on gender mainstreaming and women's empowerment	Support project development	Reform financing system for mini-grids
Reduce taxes and charges for DRE products	Reform tariff policies for DRE products	Focus on gender mainstreaming and women's empowerment
Encourage more flexible loan requirements for DRE enterprises	Focus on gender mainstreaming and women's empowerment	Integrate energy and agriculture financing
Promote pay as you go	Reduce taxes and charges for DRE products	Devise a clearer grid extension plan
Facilitate bundling of projects	Facilitate bundling of projects	Reduce policy conflicts on energy-for-work
	Standardize project requirements	Increase government loan guarantees

Gender barriers in access to finance

A common need in all countries was to overcome gender barriers in access to finance (Figure 3.3). As ENERGIA's five year research programme shows (ENERGIA, 2019), when women are involved in energy supply chains as entrepreneurs or employees, particularly in non-traditional roles, there are advantages for them, the business as a whole, and their customers. In terms of finance, this needs specific and tailored measures to address gendered issues around affordability by enabling flexible payments and reducing payment sizes, and changes in the enabling environment to support financial inclusion.

When women are enabled to meaningfully participate in energy supply chains they, their businesses, and customers all benefit

In Togo, with its nascent energy access market, there is very limited research on gender and energy finance or value chain engagement. In Kenya, as in many countries, women as consumers and entrepreneurs face numerous problems accessing finance, including a lack of credit history and collateral. A number of programmes are working to address this, such as the wPOWER Hub (2013–18), the Women in Energy Enterprises in Kenya (WEEK) programme, and efforts to mainstream gender considerations in, for example, the Green Mini-Grids programme. Kenya Power (KPLC) has also made progress in gender mainstreaming. It remains important to ensure a consistent voice for women in energy decision-making, including in the design of financial instruments.

In Bangladesh, while the huge microfinance sector focuses on women (Esty, 2014), who constitute the majority of borrowers, SHS loan agreements through IDCOL are made with household heads, who are mostly men. While this does remove an element of control from women, using an SHS also reduces household expenditure on other items such as kerosene (Khandker et al., 2014), potentially leaving women with additional disposable income. More needs to be done to push for gender mainstreaming in policy and financing, for example through donors setting stronger preconditions, or championing these issues as part of programme design.

Delivering electricity access at scale and inclusively

We looked at delivery programmes to address whether it is possible to deliver both at scale and inclusively, in line with the growing concern that the poorest and most remote will be the last to be reached.

We reviewed in detail the experience of off-grid programmes in Nepal (micro-hydro mini-grids), South Africa (SHS), and grid extension programmes in Peru and India.

Approaches to scale and market creation

The ambitions of each programme for achieving scale were significantly different. India's national drive for electrification has been enormous, with every household claimed to be grid-connected by January 2019 (Saubhagya, 2019). In Nepal, there is a similar significant drive for universal access, and the SDG7 Tracking Report suggests 96 per cent nationally now have access either to grid or off-grid supply.[4] In Nepal, off-grid electricity was pursued with as much drive as grid extension. In South Africa, by contrast, the SHS programme was always seen as 'temporary' and a second best to national grid extension. In Peru, electrification rates were already high and the remaining rural households are challenging to reach. The programme we considered focused on testing new models for reaching the 'last mile'.

In terms of results (see Figure 4.7), the programme in India connected huge numbers of households. In Odisha state alone, 2.86 million households

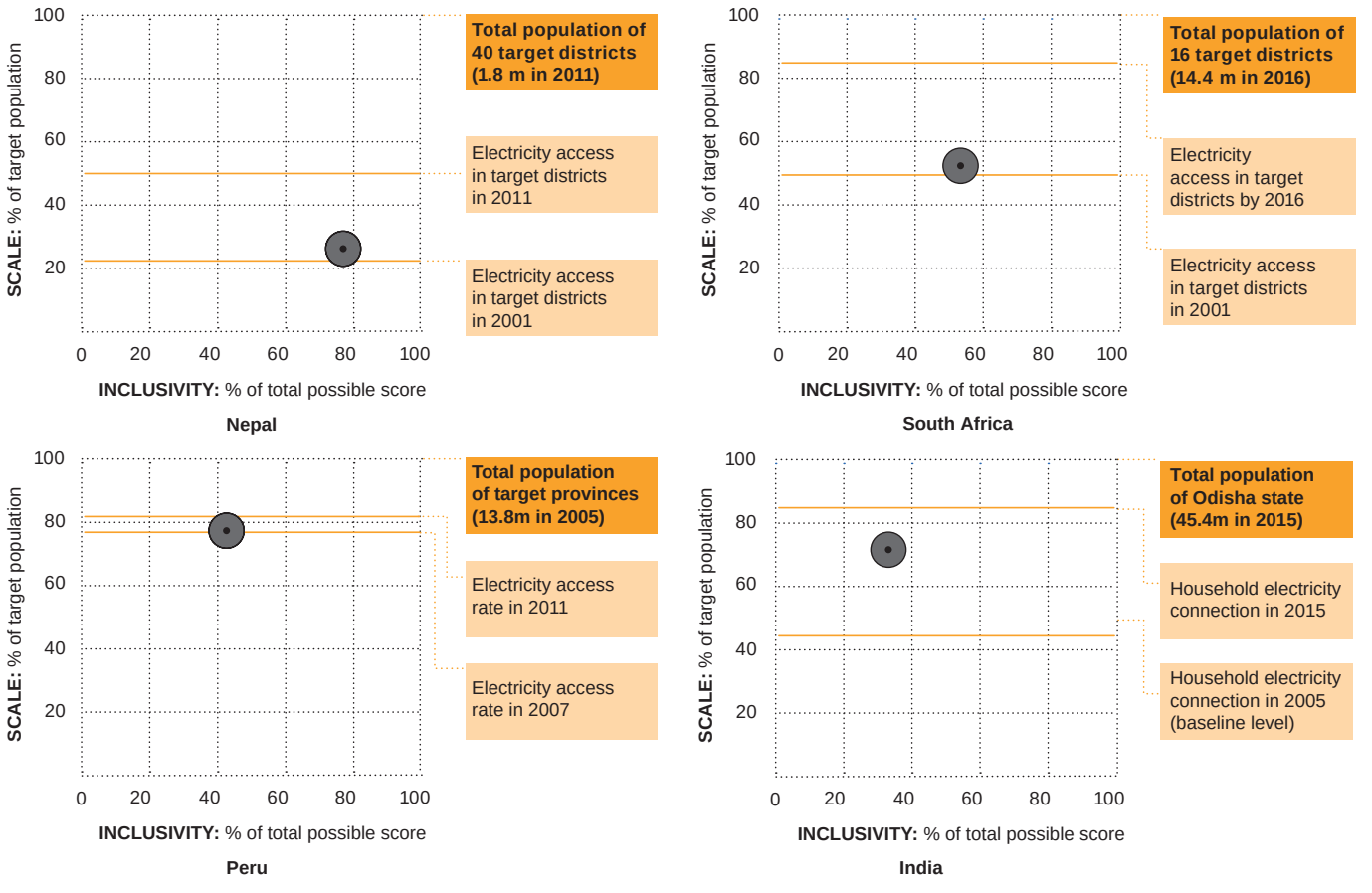


Figure 4.7 Scale and inclusion results from *PPEO 2018* case study programmes

(or 53 per cent of those unelectrified) were connected over 10 years. Electrification rates rose in the state from 45 per cent in 2005–6 to 85 per cent in 2015–16 (according to the Demographic and Health Survey results). The pace of connections has continued under the *Saubhagya* programme. Although all households are said to be connected, this is in fact just those who *applied* to be connected (Urpelainen, 2019). The Council on Energy, Environment and Water's representative survey in 2018 found that only 86 per cent of rural households in Odisha were connected (Jain et al., 2018). In Nepal, the Rural Energy Development Programme installed 454 micro-hydro systems reaching 600,000 people and bringing electricity to 5 per cent of unelectrified households. While these numbers seem small, they are substantial for a mini-grid programme. Nationally, off-grid systems (solar and micro-hydro) in Nepal now serve 18 per cent of the population (USAID, 2018).

By contrast, in South Africa, only 150,000 SHS had been installed by April 2017 and perhaps only 60,000 were still operational, benefiting at most 500,000 people. Just 1.5 per cent of households in the target districts were using SHS by 2016. In Peru, the Rural Electrification Project was part of a wider rural electrification drive. The programme brought electricity to 105,000 households, or 13 per cent of those unelectrified in its target provinces. In combination with other programmes, electrification rates in these provinces rose from 75 per cent in 2005 to 80 per cent in 2011.

Ambitions for market creation that considered demand, supply, policy, and finance varied widely across the programmes

Ambitions for market creation, working on aspects across demand, supply, policy, and finance, also varied between the programmes. They all included some actions to sustain and support the new connections, although with varying degrees of resourcing, commitment, and success. In India, the overwhelming focus was on supply and systems were stretched to keep up with such rapidly increasing customer numbers. The idea was to contract franchisees (local companies, NGOs, or individuals) to help manage meter reading, billing, collecting payments, and basic maintenance, but the programme struggled to

recruit or help franchisees make this a viable business. The programme has also struggled with accurate billing and maintenance, such as replacing faulty meters and transformers. The component aimed at boosting productive uses had to be cancelled because the quality of electricity supply was too poor to support such use.

The South African SHS programme was also not primarily designed to build a market, but to deliver access to off-grid households, making systems affordable by heavily subsidizing end user costs. As a result, and due to prescriptive regulations about the types of system that could be installed, the programme failed to take advantage of technology advances happening elsewhere in the world. There was also a lack of planning about how to allow households to use the systems alongside the grid as that began to reach new areas.

By contrast, the programmes in Nepal and Peru were more interested in market building. In Peru, the grid extension programme aimed to build the capacity of distribution companies to extend supplies to new communities. It included a component for promoting productive uses, which resulted in 21,111 enterprises and families adopting electricity-powered equipment. Businesses more than quadrupled electricity use, and beneficiary households tripled electricity use. This significantly helped to boost the viability of the programme for the distribution companies as well as improving the incomes of households. The programme was supported greatly by the 2006 Electrification Act, which made the provision that household connection costs should be borne by the distribution company, not the household, and that tariffs should cross-subsidize between higher and lower consuming customers.

In Nepal, a comprehensive approach was taken to market building. Part of the intention of the programme was not only to ensure the mini-grids were sustainable (with productive uses components and community capacity building components), but also to build the market for micro-hydro suppliers. Rural Energy Service Centres were created to source components, install systems, and provide maintenance services. The programme built the capacity of private companies to run these centres. The Alternative Energy Promotion Centre also developed standards and provided training, and certified companies to undertake work. This was matched with community mobilization to support the smooth operation of the systems locally.

Our analysis suggests that a broad-based package of actions covering not only supply but also demand, policy, and finance is needed even in large grid extension programmes. Without this, there are risks to the programme's viability, and costs at the national level will be high. The programme also risks delivering electricity poles and wires, but not the transformational opportunities this can and should bring.

Approaches to inclusion

Each programme was rated for inclusion against three factors: gender, remoteness, and poverty. They achieved very different results, from a low score of 36 in India to 79 in Nepal (see Figure 4.8). Overall, the public sector-led grid extension programmes performed less well on inclusivity.

The public sector-led grid extension programmes performed less well on inclusivity

Approaches to gender seemed to be a weak spot in three of the four (all except Nepal). Neither of the grid extension programmes nor the SHS programme in South Africa recognized that women might have difficulties in accessing or benefiting from the programme, or sought to empower women. In India and South Africa, programme evaluations did not address gender, and gender-disaggregated data was not collected. By contrast, in Nepal community mobilizers sought to ensure that women were empowered to play an active role in management and oversight

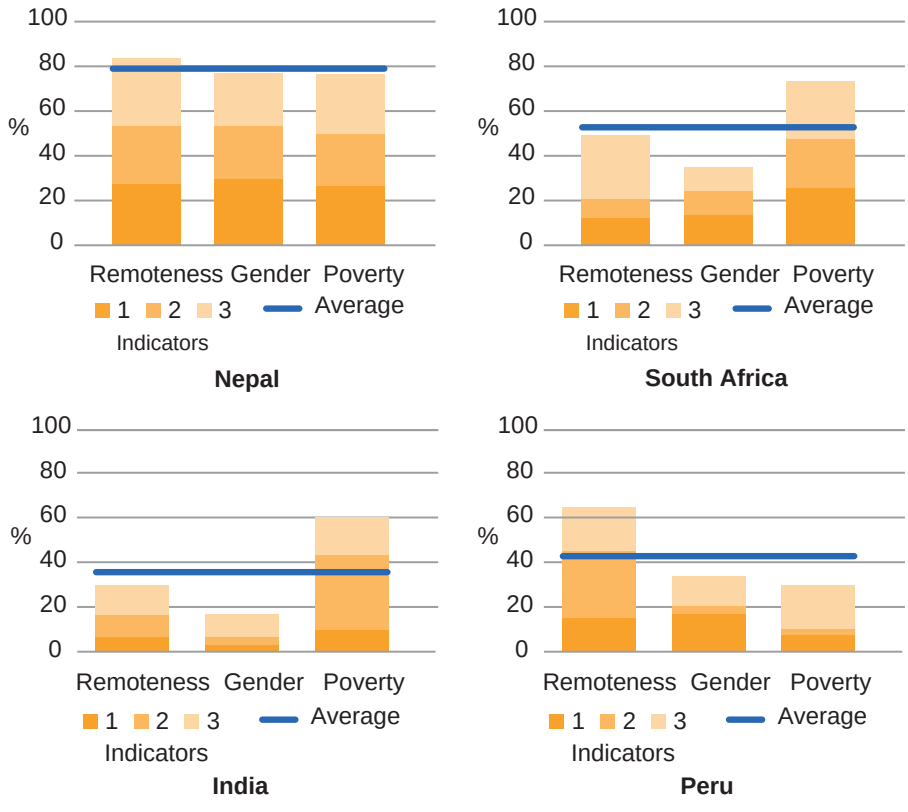


Figure 4.8 Inclusivity results for grid and off-grid electricity access programmes

through women-only groups and equal representation on micro-hydro functional groups. Although not by design, in Peru half the beneficiaries of the productive uses component in the rural highlands were women.

Research carried out by ENERGIA has looked at women's empowerment and electricity access (University of Oslo et al., 2019). This included examples from Nepal, India, and Kenya with cases of both grid extension and off-grid access. It concludes, as we found, that 'gender blind interventions, together with local norms and practices, hinder women's empowerment in that the provision of access is tacitly designed to become a realm largely dominated and controlled by men'. So, for example, in India, it was found that 'the immediate effect of using electricity primarily enhanced women's performance of their traditional roles as caregivers'.

Two of our case study programmes (Nepal and Peru) scored well on remoteness. Despite challenging terrain, both programmes were well targeted to reach isolated districts and communities with low population densities. Despite this, in Peru and also South Africa, the programmes still needed to find areas where enough potential customers were congregated to make delivery viable. In both India and Peru, off-grid components were planned as part of the programmes, but were poorly designed and ultimately unsuccessful, leaving the most remote areas unserved.

There are emerging examples of how remoteness can be addressed through financing, such as the Kenya Off-grid Solar Access Project in Kenya. Similarly, in the Lake Zone of Tanzania, a successful results-based financing programme led to sales of 38,000 SHSs, and 8 out of 10 participating companies remain active in the zone even after the programme closed in 2014 (Hankins, 2017).

A supportive enabling environment is important for achieving scale and inclusion

The programmes all scored better in their efforts to reach the poorest. All four included some element of government subsidy to help them achieve this. The South Africa and India examples used existing official citizen registers to target beneficiaries. While a high proportion of poor

households was reached, there were difficulties. Lists were inaccurate, with some of the most deserving left out. The approach also created a 'cliff edge' between those qualifying and those not. In Nepal and Peru, poor households were charged lower tariffs. In Nepal, these were fixed by local committees. In Peru, it was through cross-subsidies with richer households. However, in both cases, evaluations showed that higher income households benefited most since they were in the best position to capitalize on electricity to boost incomes.

If national electrification strategies are to reach the 'last mile' they will need to increasingly find ways to address inclusivity from the outset. That includes effectively integrating off-grid components. Including measures of inclusion and monitoring them through key performance indicators could ensure factors other than simply a connection point in a household are considered as a measure of success.

For national electrification strategies to reach the 'last mile', they must address inclusivity from the outset

Enabling environment for electricity access in case study countries

A supportive enabling environment is important for achieving scale and inclusion. Our situation analysis covered issues of demand, supply, policy, and finance (see Figure 4.9). At the end of the review period, the four countries were at a similar point in terms of policy and finance, with scope for improvement. Peru was ahead in terms of supply due to its well-developed supply systems and many competent ecosystem actors. The programme worked to further boost the capacity of distribution companies. The high score for demand in South Africa is based on customers being prepared to spend a high proportion of their income on energy (including on candles and kerosene in the absence of electricity).

The World Bank's Regulatory Indicators for Sustainable Energy (RISE) show a more differentiated picture for India, Nepal, and South Africa (Figure 4.10) and some results which seem at odds with our findings. For example, South Africa scores well for its 'framework for stand-alone systems', despite how problematic this has been in its implementation. In 2017, Nepal did not have an 'officially approved electrification plan' in the terms of these indicators but has managed to coordinate its efforts effectively at the national level (SEforALL, 2019a).

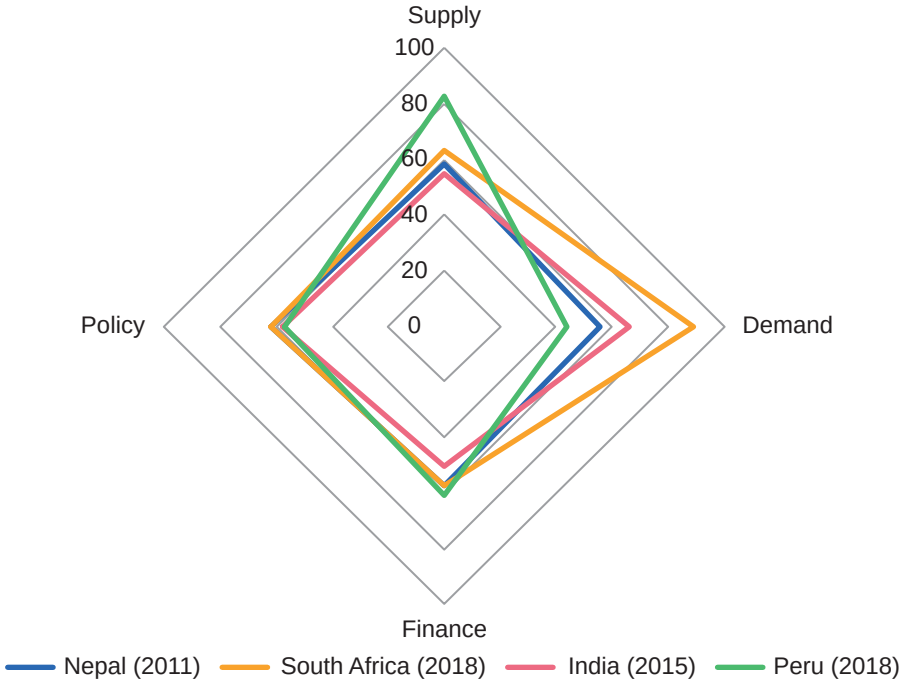


Figure 4.9 Enabling environment in Nepal, India, South Africa, and Peru at the end of the programmes

Note: no scores were available for Peru.

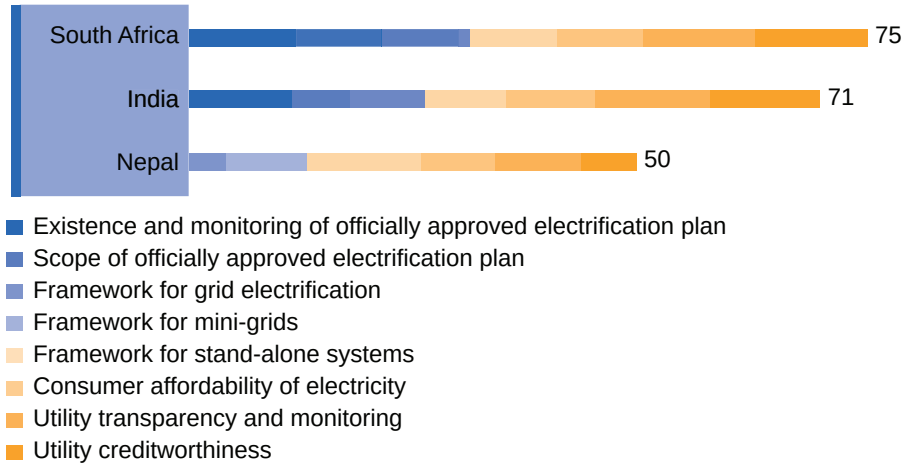


Figure 4.10 RISE electricity access scores
Source: World Bank http://rise.esmap.org/scores

While RISE considers important factors and allows comparison between countries, it fails to highlight some aspects that are increasingly important for energy access. Indicators related to gender mainstreaming are limited and embedded in the overall indicator for the 'scope of the national electrification plan'. Currently it is hard to pick out issues relating to 'inclusion'. As our examples have shown, while it is important to have a framework and policies in place, these indicators do not differentiate effectively in terms of the quality of implementation and enforcement. Critical elements of bottom-up planning and reaching the 'last mile' need to be embedded in national plans and RISE could be revised to highlight this more effectively.

Recommendations

Ignoring inclusion will continue to serve men better than women, and fail to reach the poorest and remotest communities

There has been important progress in electricity access in some places, but this continues to be driven by grid extension. Our analysis has shown how delivery at scale without adequate plans for inclusion will continue to serve men better than women, and fail to reach the poorest and those in remote communities. Some have assumed that simply promoting off-grid solutions will, by their very nature, mean more inclusivity. Our case studies show this is not guaranteed, and inclusivity has to be actively pursued in all sectors: grid, off-grid, and clean cooking.

The delivery of energy access through off-grid solutions, both mini-grids and stand-alone systems, continues to grow, but still faces systemic barriers. Some countries are setting exciting policy frameworks and targets, or are developing interventions for particular regions of their countries. If nations are to benefit from the faster, lower costs that these solutions offer, there still needs to be a mind-shift from many planners, financiers, and implementers. There is a great deal of inertia in business-as-usual approaches, which will see us move towards 2030 without the transformational progress that is needed.

Many of the recommendations for action we made in *PPEO 2016*, *2017*, and *2018* still stand, despite the dynamic context over the last three years. Some of our recommendations include the need to:

- *Set national targets* for gradual achievement of the levels of energy service that people want to use, starting with Tier 1 and moving to Tiers 2 and 3.
- *Measure and value inclusion* as much as numbers reached.
- Promote *gender mainstreaming* in planning to ensure that the issues women prioritize are addressed, such as domestic water pumping, labour-saving appliances in productive uses, and access to electricity in schools and health centres.

- Recognize the potential for *decentralized electricity access* and develop plans that integrate mini-grids, stand-alone systems, and grid extension.
- *Integrate planning* across ministries to meet needs in productive and community uses of energy, and to ensure energy access achieves its transformational potential.
- Find *innovative ways to subsidize* electrification across grid, mini-grid, and off-grid delivery to ensure inclusivity and affordability while minimizing market distortion. Investors, for example, are calling for more results-based finance for mini-grids (Power for All, 2019a).
- Support *market activation*, promoting coordination through industry associations and engaging with civil society forums and consumers, particularly women.

These recommendations are echoed, for example, in SEforALL's (2019b) guide *Integrated Electrification Pathways for Universal Access to Electricity*, which references our 2014, 2016, and 2018 reports. If they are taken up and rapidly deployed the development benefits for some of the world's poorest people could be transformational. Without them, we risk failing to achieve not only SDG7 but many of the other SDGs to which energy access is connected. The solutions are available and improving year by year, if only we can be bold in changing the systems needed to deliver them.

Routes to scale

ELECTRICITY

Call to action

Plan

Recognize the potential for decentralized electricity access and plan for a balanced, integrated approach across grid extension, mini-grids, and stand-alone systems for households, community services, and enterprises, taking into account women's specific needs.

Finance

Find innovative ways to subsidize electrification across grid, mini-grid, and off-grid delivery, to ensure inclusivity and affordability while minimizing market distortion.

Deliver

Deliver in ways which equally prioritize metrics for inclusion as well as scale from the very beginning, in order to ramp-up action that ensures no one is left behind.

The majority of households had Tier 0 or 1 electricity access, but aspire for

TIER 2 OR TIER 3

Household electric lighting was the top priority in

10 OF 12 COMMUNITIES

Energy for powering schools, pumping water, processing crops, and for household lighting is

PRIORITIZED BY WOMEN

Of the costs of actual provision nationally, average willingness to pay is

<50%

Barriers to inclusion

Gender blindness

'Gender-neutral' approaches to programme design, delivery, and financing reinforce patterns of discrimination that prevent women from benefiting from electricity equally to men.

Cross-sectoral efforts

Unless they are linked to agriculture, water, education, and other initiatives, energy interventions miss opportunities to save time and money and to create transformational change.

Enabling environment

Without a balanced consideration of not just supply but also elements of demand generation, policy, and finance, the transformational potential of electricity access for men and women will not be realized.

Affordability

Without pro-active efforts, energy access will remain beyond the financial means of the poorest, and remote areas will not be reached.

PEOPLE-FOCUSED DELIVERY

When we embarked on this series of the *PPEOs* in 2016, the UN Sustainable Development Goals had just been adopted. For the very first time, the provision of access to affordable and clean energy was being recognized as a global development imperative. However, tracking under the UN SEforALL initiative had already shown how challenging it would be to achieve universal energy access by 2030; in 2015, SEforALL found that new finance and business models were desperately needed, as were transformational strategies and policies (SEforALL, 2015). In 2019, this assessment still stands, and the *PPEO* focal areas of energy access planning, finance, and delivery remain as relevant and urgent as ever.

In this chapter, we bring together the findings from the three *PPEOs* (2016–18), across the clean cooking and electricity sectors, to provide insights for decision-makers on how to tackle planning, finance, and delivery to accelerate progress on energy access. While solutions to energy access are often context- and location-specific, our selection of case studies provides a wide and rich range of contexts, allowing us to draw

valuable lessons that are more widely applicable. Our goal is not to provide a blueprint for success, but to support decision-makers to identify, adapt, and replicate the most appropriate mix of actions.

Reaching the unserved billions

Considering how far off track the global community is from reaching the 2030 SDG7 target, finding ways to scale up and sustain delivery is of key importance. However, as SDG7 also aims to leave no one behind, a particular challenge is to strike the balance between scale and inclusivity. Reaching the 'last mile' – those who are unlikely to be reached by business-as-usual approaches due to their remoteness, income levels, or social discrimination – can be incredibly difficult but should not be left till last. In *PPEO 2018*, we therefore looked at a number of programmes to ascertain whether scale and inclusivity can go hand in hand. None of them had fully achieved this, but there were lessons from each.

Inclusivity has to be proactively and deliberately pursued in the off-grid and clean cooking sectors, just as it does on-grid

The two case studies that achieved the greatest scale were very different: India, with a public sector-led programme, focused on grid extension, and Ghana, with market-based cookstove sales, achieved beyond the initial phase of the project. Every case study we looked at had at least some inclusivity objectives, with varying outcomes. Overall, the public sector-led grid extension programmes performed less well on inclusivity and needed greater focus on remote areas, improved action to address gender issues, and carefully designed mechanisms to target lower income groups.

As *PPEO 2016* and *PPEO 2017* had already outlined, to achieve scale and reach the 'last mile', there is a need to accelerate the transition from grid-centric approaches towards integrated plans combining grid, mini-grid, off-grid, and clean cooking solutions. By redirecting subsidies from grid extension into other solutions, governments can accelerate energy access progress, leverage higher levels of private investment, and reach more people at lower cost. There is increased recognition of the value of off-grid approaches and many more countries now have integrated electrification plans with both on-grid and off-grid elements.

However, our case studies have also shown that simply promoting off-grid solutions will not automatically mean more inclusivity. In reality, inclusivity has to be proactively and deliberately pursued in the off-grid and clean cooking sectors, just as it does on-grid. Adding pro-poor 'bolt-ons' to existing programmes is not the answer. A concentrated focus, sufficient, and often innovative, finance experienced staffing, and tailored processes are needed to achieve inclusive outcomes. For example, we found that decentralizing key elements of decision-making to local levels (as in Peru and Nepal) can encourage inclusivity, raising considerations beyond purely cost, about which communities would benefit and the selection of local-level implementing partners.

Of course, we recognize that given finite resources, governments face trade-offs. Looking at costs alone, reaching the poorest or remotest constituents is more expensive than serving higher income, less remote areas. This needs to be balanced with a recognition of the economic benefits from electricity access that can accrue in these areas, and with the explicit SDG7 aim to leave no one behind. There is a clear need for governments and donors to work together with the private sector and civil society to develop strategies to reach the 'last mile'.

Addressing gender issues, if done well, can boost sales and profits

It is also increasingly apparent that addressing gender issues, if done well, can boost sales and profits. That includes reaching women as customers, and empowering women throughout energy value chains. It requires addressing deep-seated inequalities and social norms. Programmes must be designed with components that address barriers to women's participation. There are a number of examples of successful programmes that have fostered

Emphasizing supply over demand can lead to problems of sustainability down the line

women entrepreneurs, especially in the solar lighting and cookstove sectors (as detailed in Chapters 3 and 4).

All our case studies focused heavily on the extension of energy supply, but ideally a more balanced approach is needed to achieve scale and ensure the long-term viability of the interventions. Focusing too much on supply can lead to future problems with sustainability, as exemplified by the case with low electricity consumption in many grid extension programmes.

In Kenya, for example, KPLC has continued to add new residential electricity customers at a rapid pace, reaching a total of 6.76 million customers in June 2018, up from 4.6 million in June 2016. However, its basic revenue grew by only 3 per cent, and in December 2018 it reported KSh2.8 bn (US$27 m) in bad debts because 'more than 880,000 households that were supplied with electricity and had prepaid meters fitted did not consume the power, and did not pay for it' (Alushula, 2018). By contrast, the Nepal and Peru programmes have been pioneering in addressing demand and affordability through promoting productive uses.

In recent years, we have seen increasing private sector participation in energy access. Such market-driven approaches have brought dynamism and sustained growth, for example in clean cooking in Ghana and in off-grid electricity in eastern Africa through solar home systems (SHS). Market activation programmes, which bring stakeholders together, improve coordination and collaboration, and target required policy actions, can galvanize action and ramp-up progress. However, it is clear that private sector companies will seek the most profitable market segments first and will not deliver where it is unprofitable, which means that government and donor intervention will continue to be needed. The 'last mile' cannot be reached without some level of public funding. In the developed world, rural electrification was funded through public subsidies and it is not realistic to expect the poorest to be reached through market forces alone.

Box 5.1 Recommendations for achieving scale and inclusion in tandem

To achieve both scale and inclusivity in delivery we must aim for a balanced approach that holistically considers the barriers, not only in supply, but also addressing blockages in finance, weak demand, and policy shortcomings. This needs to include an understanding of the energy services that rural, 'last mile' communities actually require at home, in their livelihoods, and for community services. This will require:

- A multi-stakeholder approach, which deliberately seeks to engage and empower women.
- Proactive and deliberate actions with sufficient finance, experienced and empowered staff, and tailored processes.
- Working with those agencies that are currently reaching 'last mile' communities, including civil society organizations and private sector distributors (for example through the Global Distributors' Collective[1]).
- Measuring and setting targets for inclusion, to ensure it is valued alongside scale in terms of numbers of connections.

Unlocking the necessary funding

To reach scale in energy access, sufficient finance – both public and private – is a key ingredient. As discussed in Chapter 2, significant overall funding gaps for energy access have been identified at the global level, with the greatest shortfalls for clean cooking and off-grid electricity solutions. In *PPEO 2017*,

we explored the barriers to increasing financing for energy access. We looked at this not only in terms of the absolute amount of finance, but also how it is targeted, and whether it is reaching the places where it is needed most.

Increasing public and private funding

Our analysis of the three case study countries confirmed the need for rebalancing financial flows to put far greater emphasis on off-grid and clean cooking solutions. While there has been increasing recognition at global and national levels of the role of off-grid solutions, energy finance has still not shifted accordingly. One of the key problems is the lack of prioritization of off-grid by governments and donors, while at the same time public funding is widely put into grid extensions. In *PPEO 2017*, we pointed out that in countries like the USA, rural electrification only took off once subsidies were made available. Recently, this has been echoed by a group of 12 leading mini-grid investors who have argued that rural electrification has always required subsidy because it serves remote, dispersed customers with higher costs to connect, as well as lower incomes (Power for All, 2019a).

Additionally, our case studies found that even where there was global level financing for decentralized energy, it was not reaching businesses (large or small) at national levels in the forms they need or at affordable costs. Acumen, for example, highlights the need for long-term capital, and particularly early-stage equity, to close the 'pioneer gap' for companies too big for seed capital and too small for commercial capital (SEforALL, 2017a; Acumen, 2018). Women face even greater barriers in accessing this finance.

Finance must be appropriately structured and affordable for national-level companies

We proposed in *PPEO 2017* that more needs to be done to unlock local lending. In particular, the pico solar, SHS, and clean cooking sectors have high demands for local currency. However, accessing this is not straightforward as lenders lack experience with and trust in distributed energy companies. In 2017, SunFunder began to make local currency loans available and, similarly, CDC (the UK's development finance institution) recently emphasized its commitment to local currency debt financing (CDC, 2018). Initiatives such as the Climate Finance Lab continue to work towards innovative mechanisms and instruments for helping the right kinds of finance to flow to off-grid businesses.

There is also a need to provide funding to build up the skills of small energy entrepreneurs, including supporting and empowering women. For example, Practical Action is currently working on a project in Kenya funded by SIDA and ENERGIA helping women to set up clean energy businesses. The programme provides training in business skills and planning and access to market information, networks, and finance to develop profitable businesses manufacturing and selling cookstoves, briquettes, and solar products.

National power utility companies also have a role to play. However, they need to avoid seeing off-grid solutions as being in competition with their own plans for grid extension. A clear plan that identifies those areas open for off-grid service providers, for example, would increase transparency and reduce risk for off-grid energy developers. Increasingly, they also need to make clear provisions for how mini-grids and stand-alone systems can work alongside and complement the national grid. This has been challenging to date, and many mini-grids end up being abandoned when the grid arrives. However, viable examples exist and experiences from, for example, Sri Lanka and Indonesia should be built on (Clean Energy Solutions Center, 2018).

The financing gap for clean cooking solutions is far larger than for access to electricity, and yet the majority of the focus in discussions of energy access finance has been on electricity. Since we published *PPEO 2017*, new

carbon finance has been committed into clean cooking programmes, with the Green Climate Fund co-financing improved cookstove programmes in Bangladesh ($82.3 m), and in Kenya and Senegal (joint budget of $26.7 m). In the clean cooking sector, perhaps even more so than for electricity, a range of interventions are required including new technical innovations, awareness raising, and improvements to the enabling environment. Increasing financing flows is just one part of that picture. However, our research has shown that businesses are prevented from growing due to a lack of working capital, and the price points of many improved stoves are below that which consumer finance will lend for, and yet they are beyond the affordability of cash purchases.

Making energy access affordable

In *PPEO 2017*, we identified a significant gap between energy delivery costs in rural areas and communities' ability to use enough electricity and then afford the level of tariffs needed for mini-grid viability. For electricity access, subsidizing off-grid solutions, as discussed above, remains crucial for improving affordability and expanding access.

Finance to support productive uses of energy and community energy services will improve the viability and affordability of off-grid solutions

In addition, funding needs to be available to support the development of productive end uses and community energy services which will improve viability and affordability of off-grid solutions, especially mini-grids. This should include greater cross-sectoral sharing and embedding of expertise on, for example, supporting local energy-enabled agriculture in multilateral financing institutions and local banks.

In clean cooking, one of the challenges is the low willingness to pay for improved solutions found in our *PPEO 2017* case studies. Strategies for helping to subsidize clean cookstoves include results-based financing mechanisms, which allow subsidizing the costs of stoves to consumers. Social impact investments could be channelled in this way, and there could be greater links to social protection schemes. Innovative ideas for increasing consumer finance are being tried out in the sector, such as distributing stoves as an additional product line that can be offered by solar home system companies (e.g. M-Kopa in Kenya). Others are finding success in models where the cost of the stove is covered as part of regular fuel payments, as is the case with Inyenyeri.

In all of this, there is a need to be cognizant of the additional barriers that women face in terms of accessing finance. Gender-neutral or gender-blind financing schemes have been shown to be less accessible for women. Given the opportunities of accelerating access to energy when women are empowered as consumers and also within energy value chains, funders and investors need to track and be better aware of the gendered impacts of their lending.

Planning and policy that meets people's needs

Greater funding also needs to be made available for the creation of the right enabling frameworks for energy access. In *PPEO 2016* we focused on energy planning and policy-making processes that put people and their needs first. Like *PPEO 2017*, this used case studies of Bangladesh, Kenya, and Togo, where we worked with a number of rural communities to produce community-driven energy access plans. From these, we drew implications for national planning.

We used a Total Energy Access approach (Practical Action, 2014) which encompasses all forms of energy uses in households, as well as energy needed for productive and community uses. It considers all feasible means of energy provision: grid-connected, mini-grid, and stand-alone. This process

Box 5.2 Recommendations for building energy access markets

In *PPEO 2017*, we made a set of broad recommendations, highlighting some of the fundamental shifts that would help to move us towards building energy access markets. These included:

- Rebalancing expectations of national governments, concessional lenders, and donors to see decentralized energy investments not in terms of short-term commercial profits, but as long-term economic development opportunities.
- Shifting development financier evaluation and reward metrics to reflect development impacts in addition to, or rather than, deal size.
- Continuing to build the skills and experience of energy SMEs, including supporting and empowering women, and promoting investments in productive end uses of energy.
- Resourcing national market activation campaigns and partnerships in energy-poor countries to build demand, collaboration, positive peer pressure, and the policy and regulatory foundation for distributed energy markets to thrive.

produces very different results from the traditional, top-down national energy planning process in terms of technologies (smaller), timelines (faster), and economics (different financial support, more rural economic opportunity, more energy sector jobs).

As a result of top-down, national planning efforts, key findings showed that existing national energy plans are often out of touch with end user needs and aspirations. A lack of meaningful efforts to include the voices of energy-poor end users in planning impedes efforts to ensure energy solutions are adequate. As noted in Chapter 4, since *PPEO 2016* we have seen an increasing number of countries adopting detailed geospatial planning approaches, which allow greater understanding of the opportunities to include decentralized solutions, but there is still some way to go.

A lack of meaningful efforts to include the voices of energy-poor end users in planning impedes efforts

Furthermore, national electrification plans are often too supply-focused and fail to put much emphasis on the demand side, and in particular on boosting productive uses of energy and addressing the burdens on women's time. To address this, energy ministries and donors must ensure better integration of electricity planning with other ministries, such as health, education, water, and agriculture, which currently operate without much meaningful engagement with traditional energy players.

Clean cooking rarely receives much attention in national energy planning and policy. We found in our community surveys that people also attach less priority to clean cooking than other aspects of energy access. Reasons for this are complex but include a lack of awareness about the health impacts of traditional cooking solutions and less value being attached to women's work and time in tasks such as collecting and preparing firewood and cooking. Considering the enormous health, climate, and financial benefits of clean cooking solutions, there is a need for change at national and community levels. Policy-makers need to see the contradiction for their national goals between the push for national economic development and the majority of their citizens continuing to cook with traditional fuels. Clean cooking needs to be accorded a much higher priority in the overall narrative of national development.

Clean cooking needs to be accorded a much higher priority in the overall narrative of national development

In *PPEO 2016*, we argued that there was a fundamental lack of understanding and acceptance among many global and national decision-makers of the technologies and approaches we evidence as best suited to achieving universal energy access. In 2019, there are some signs that this is

slowly changing. There has been more consistent and louder championing of the need for greater attention to clean cooking solutions in the SDG7 tracking report and from organizations like SEforALL. MFIs are putting more emphasis on off-grid solutions in their strategies and this is slowly feeding through to actual financing. However, it is still rare that the voice of the energy-poor feeds through to energy planning at the national level.

Box 5.3 Recommendations for energy access planning

Good national plans and strategies, which can also adapt to new opportunities and respond to the changing dynamics of the sector, are a fundamental building block for achieving energy access. Our key recommendations are for the following:

- Integrated planning that addresses grid, off-grid, and clean cooking and increasingly looks for the synergies and interconnections between them.
- Holistic planning that considers the energy services that people need and prioritize and works with other ministries and sectors of the economy to deliver that (including agriculture, health, education, water, and gender).
- Use of geospatial tools to map the potential for grid and off-grid energy, but blending this with the lived experiences and perspectives of energy-poor communities.

Reaching the 'last mile' through better planning, finance, and delivery

Tackling the energy access challenge requires a sustained effort across finance, policy, planning and delivery

Tackling the energy access challenge, and ensuring it meets the needs of energy-poor communities, will require a sustained effort across finance, policy, planning, and delivery. Whether for cooking or electricity, our research demonstrates that if provision were to be based solely on ability to pay, energy access would be highly restricted across energy-poor communities. Even in relatively well-developed markets, there are still hard-to-reach villages and people unable to afford even the smallest solar lanterns. Finance, planning, and policies need to focus much more on reaching the 'last mile'. In our concluding chapter, we identify what that means for specific groups of decision-makers.

The road to 2030

CHALLENGING CONVENTION TO REACH UNIVERSAL ENERGY ACCESS

What's already happening

133 MILLION
people were served by off-grid renewables in 2016, a six-fold expansion over five years.[1]

19,000
mini-grids have been installed in 134 countries and territories.[3]

$40 MILLION
was invested in clean cooking companies in 2017.[4]

$30.2 BILLION
of electrification finance was dedicated to 20 high-impact countries in 2015-16.[5]

Remaining challenges to reach SDG7

ANOTHER 612 MILLION
people should be best reached by off-grid renewables by 2030.[2]

ANOTHER 210,000
mini-grids are needed, serving 490 million people by 2030.[3]

$4.4 BILLION
is required to achieve universal access to clean cooking by 2030.[2]

ONLY 1.3%
went to off-grid solutions. Almost all finance went to electrify non-residential consumers.[5]

Call to action

Plan

- Include the voices of the energy-poor to guide priorities for national planning.
- Focus on the energy services people need, going beyond household supply to include requirements for threshing and grinding crops, water pumping, street lighting, and energy for businesses, schools, and clinics.
- Produce integrated plans for grid and off-grid, and for clean cooking.

Finance

- Invest more public money in off-grid and clean cooking, developing institutional structures, expertise, and incentives to spend this money more effectively.
- Provide capital that meets the needs of small-scale energy entrepreneurs, especially women.
- Focus on making energy access affordable, linking this with agriculture and enterprise support.

Deliver

- Expand off-grid renewable energy solutions, which are generally cheaper and quicker to scale up, with a focus not just on supply, but also demand, finance, and enabling policies.
- Empower women as consumers and entrepreneurs and pursue inclusion proactively in all programmes.
- Develop and enforce supportive government policies as well as public funding to encourage the private sector to reach the energy-poor.

1 IRENA (2019) *Off-Grid Renewable Energy Solutions To Expand Electricity Access: An Opportunity Not To Be Missed*, Abu Dhabi: International Renewable Energy Agency
2 IEA, IRENA, UNSD, WB, and WHO (2019) *Tracking SDG 7: The Energy Progress Report 2019*, Washington, DC: World Bank
3 ESMAP (2019) *Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers*, ESMAP Technical Report 014/19, Washington, DC: World Bank
4 Clean Cooking Alliance (CCA) (2019) *2019 Clean Cooking Industry Snapshot* Washington, DC: CCA
5 SEforALL (2018) *Energizing Finance: Understanding the Landscape 2018*, Vienna and Washington, DC: SEforALL

CONCLUSIONS AND RECOMMENDATIONS

As we conclude this series of the *PPEO*, the provision of universal access remains a formidable task. Here, we have synthesized 3 years' worth of evidence and analysis on which energy access approaches best reach and meet the needs of the energy-poor, based on a range of case studies from around the world. We have updated our analysis with some of the latest evidence. While we have seen some progress in recent years, it is clear that there are still multiple barriers preventing the step change needed to achieve SDG7 by 2030.

Of most concern, the least progress is being made with reaching the 'last mile': those who will not be reached by business-as-usual approaches because of their income, remoteness, or social discrimination. Dealing with this particular challenge will require concerted action by all stakeholders, including international donors, national governments, private investors, and developers, as well as civil society. In these concluding sections, we present our top three recommendations for different stakeholder groups, drawing from our findings on planning, financing, and delivery.

For international donors and international financial institutions:

- Commit to allocating rising shares of funding to off-grid solutions and clean cooking, including for the provision of well-targeted subsidies.
- Shift financier evaluation and reward metrics to reflect inclusivity and development impacts in addition to, or rather than, deal size.
- Design programmes that proactively focus on reaching the 'last mile', ensuring these have sufficient resourcing and skilled staff.

For national governments:

- Develop energy plans that address grid, off-grid, and clean cooking together and look for the synergies and interconnections between them.
- Practice holistic planning that listens to the priorities of the energy-poor and works across ministries and sectors of the economy to deliver the energy services people need.
- Adopt gender mainstreaming in planning and delivery mechanisms to ensure that the issues women prioritize and the barriers to their engagement are addressed.

For private sector companies and investors:

- Partner with development organizations to jointly develop demand-side approaches and gender mainstreaming.
- Invest in building the skills and experience of energy SMEs and future leaders, including supporting and empowering women.
- Provide funding for market activation campaigns and partnerships in energy-poor countries.

For civil society organizations:

- Partner with governments and the private sector to ensure energy access programmes focus on pro-poor development outcomes.
- Continue to engage with energy-poor communities and enable the meaningful inclusion of their voices in national and international energy access debates.
- Maintain pressure on donors and MFIs to scale up financing for off-grid and clean cooking solutions.

With just over a decade to go to 2030, we cannot afford to lose any time. The *PPEO* has contributed to the growing evidence base of the most effective energy access approaches. For electricity, it has become increasingly clear that off-grid solutions need to provide the bulk of new connections but this cannot be done without some level of public subsidy. For clean cooking, public funding to support and steer the sector is also essential, bringing many wider benefits in terms of public health, the burden of women's work, and the environment. We know from many examples that empowering women works. There are now numerous successful business models for off-grid energy businesses.

Hence, at least in terms of evidence, we know where to start in accelerating progress towards SDG7. However, as technologies and their costs evolve, financing models change, and people's needs grow, we will continue to evaluate different approaches, ensuring lessons are learned and knowledge is shared widely. In a fast-changing sector, the *PPEO* continues to champion the needs and aspirations of energy-poor communities.

NOTES

Chapter 3

1. We considered other options such as ethanol stoves, or forced draft gasifier stoves using pellets. However, the stoves or a ready supply of fuel were not available in our case study communities at the time.
2. Affordability has been improved recently through the introduction of pay-as-you-go models to help overcome the hurdle of upfront costs. However, these figures reflect the levelized costs per household per day taking into account fuel and stoves, as we found them in 2017.

Chapter 4

1. These assumptions were our best estimates. Often, the number of enterprises and their current power demand was relatively small, so a 50 per cent increase did not represent a huge amount of additional power. We recognize also that the efficiency of appliances is improving all the time, as well as (gradually) their availability on the ground. Our purpose was to create a best estimate for modelling of future needs. If a mini-grid developer were carrying out a similar exercise, they would want to focus more on immediate needs and the pathway to households and businesses being able to pay for the power and appliances they would eventually like to use.
2. We did not model these hybrid systems because of the complexity of calculating the balance between solar and diesel components for each case. However, if detailed business modelling were to be done for each case study community, hybrid systems should be considered.
3. In Togo, there is a need for grid densification in places that are already grid-connected, which is recognized by the current national government strategy.
4. The accuracy of these numbers has been questioned by some, for example Adhikari (2018).

Chapter 5

1. The Global Distributors Collective (GDC) is a collective of 'last mile' distributors around the world who sell life-changing products such as solar lights, clean cookstoves, water filters, and nutrition products to 'last mile' households. The GDC supports and represents these 'last mile' distribution companies (LMDs) to help them reach underserved customers with these products, while also working to raise the profile of the 'last mile' distribution sector among national and global stakeholders.

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Poor people's energy outlook 2019

PPEO 2019 is the culmination of five years' research, exploring what it takes to realise the kinds of energy services that enable people living in energy poverty to thrive. The report compiles and updates key messages and recommendations on energy access planning (*PPEO 2016*), financing (*PPEO 2017*) and delivering at scale, while also leaving no one behind (*PPEO 2018*). It draws on primary research from community consultations in Bangladesh, Kenya and Togo, as well as analysis of energy access programmes across Latin America, South Asia and sub-Saharan Africa; considering how to ramp up energy access from small-scale interventions to national and global levels, to ensure that the transformational power of energy is universally enjoyed.

This is because, with just a decade to go until the deadline for the 2030 Global Goals, universal energy access remains elusive. Scaling-up access will require a huge increase and re-balance of investment, innovative business models, changes in policy frameworks and institutional capacity, increased awareness, and improved technical solutions. *PPEO 2019* explores progress achieved across these elements to date and considers what remains to be done, to ensure that we truly leave no one behind in our pursuit of SDG7.

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