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THE BOTTOM LINE

To reduce household air pollution, improve health outcomes, save nonrenewable biomass, and support local economic development, developing countries are seeking to increase the use of liquefied petroleum gas (LPG) as a clean cooking solution. In the absence of targeted subsidies, LPG will not be the solution for the world's poorest people. But many developing countries, especially in Sub-Saharan Africa, are recognizing it as key to increasing access to clean cooking energy and making progress on Sustainable Development Goal 7; they are adopting ambitious targets to scale up its use across the continent.

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Increasing the Use of Liquefied Petroleum Gas in Cooking in Developing Countries

Why is clean cooking a development priority?

Three billion of the world's people lack access to clean cooking solutions

About 40 percent of the world's population still uses solid fuels and kerosene, the burning of which has deleterious health, economic, and environmental consequences. Every year up to four million people die prematurely from the effects of household air pollution caused by cooking with solid fuels—almost all of them in low- and middle-income countries (WHO 2014a; Forouzanfar and others 2016). In addition, use of these fuels imposes massive economic costs: Household air pollution in low- and middle-income countries caused an estimated $1.52 trillion in economic losses and $94 billion in lost labor income in 2013 (World Bank 2016). Use of solid fuels for cooking can also cause forest loss and degradation where concentrated use of wood fuels is prevalent, typically in and around urban centers. The need to adopt clean cooking fuels and stoves is thus urgent.

In 2014, 3.04 billion people around the world lived without access to clean cooking, a slight increase since 2012 (World Bank 2017). The greatest absolute number of those people lived in South and Southwest Asia, but it is in Sub-Saharan Africa that one finds the highest deficit in access proportional to population: only 12 percent of Africans had access to clean cooking fuels and technologies in 2014. The increase since 2012 in the number of people living without access is also mainly driven by Africa, where each year the population expands by 25 million, while access to clean cooking increases by only 4 million (World Bank 2017). Achieving Sustainable Development Goal 7 (SDG7)—ensuring access to affordable, reliable, sustainable, and modern energy for all by 2030—will therefore require a massive scale-up in the deployment and adoption of clean and affordable clean cooking solutions (WHO 2016).

Would better biomass stoves help?

Yes, but more efficient biomass stoves may not be adequate to fully address this global challenge

The international development community continues to debate the optimal approach to supporting clean cooking. Indeed, only in 2014 did the World Health Organization (WHO) provide indoor air quality guidelines including the types of fuels and technologies that can help lower the byproducts of incomplete combustion to a level that would result in positive health outcomes for those exposed (WHO 2014b). These guidelines are being used to raise awareness of the health burden from cooking with solid fuels and to track progress toward increasing the proportion of the population relying primarily on clean fuels and technology—one of the SDG7 indicators. Among the key findings is that for several important health outcomes, exposure to the key pollutant—fine particulate matter, or PM2.5—needs to be brought down to very low levels to capture most of the health benefit. Most of the clean cooking interventions promoted in recent years have not come close enough to these levels.

Motivated in part by the desire to allow users to continue to use the cooking methods they are used to, some interventions are focusing on improving the performance of biomass stoves by increasing the efficiency of fuel wood use and reducing emissions. Today there are improved biomass models that are more efficient

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than earlier models and have lower emission profiles—but they may not reduce household air pollution enough to provide the health benefits needed to reach SDG7, as several studies have shown (Sambandam and others 2015; Balakrishnan and others 2015; Mortimer and others 2016). Laboratory testing for some of the newer advanced stoves is promising, but the results cannot be consistently replicated in the field (Berkeley Air Monitoring Group 2015), and the reliability of fuel supply for processed biomass presents another challenge (Thurber and others 2014). Where possible, the focus therefore needs to shift to "BLEN" fuels (biofuels, liquefied petroleum gas, electricity, and piped natural gas)—fuels that are truly clean at point of use.

Just how clean and affordable is LPG?

LPG's environmental footprint is negligible—and a global surplus exists

Liquefied petroleum gas (LPG)—known in some countries as propane, butane, bottled gas, or cooking gas—is a clean-burning and efficient cooking fuel used by almost three billion people. It has long been an aspirational fuel choice for many urban and rural poor.

Some in the development community dislike LPG because it is nonrenewable. But as it is an unavoidable byproduct of oil and natural gas production and oil refining, a global LPG surplus exists. Some of the surplus is vented or flared at oil and gas production sites, wasting this valuable fuel resource and spewing carbon back into the atmosphere. Using it for clean cooking makes sense.

The environmental footprint of LPG is negligible compared with biomass and other fuels (Grieshop, Marshall, and Kandlika 2011), because of its very efficient and complete combustion and its sustained performance in field use over time (Smith, Rogers, and Cowlin 2005). LPG emits negligible amounts of black carbon and other short-lived pollutants that contribute to global warming (Grieshop, Marshall, and Kandlika 2011).

LPG has a clean emission profile and low sulfur content. In global burden of disease studies, cooking with LPG is taken as the feasible counterfactual level of pollution, because it is usually the first clean fuel consumers use when they move away from biomass. To explore the possible health benefits to pregnant women and their children, the U.S. National Institutes of Health, with support from the Bill and Melinda Gates Foundation, the Global LPG Partnership, and other partners, recently funded a $30 million, five-year randomized controlled trial of replacing biomass with LPG in cooking (NIH 2016).

Low-income countries in Africa are trying to learn from the large-scale adoption of LPG for clean cooking in Indonesia, India, and other parts of the world, and to demonstrate its affordability when the right supports are in place. The key barrier may be *accessibility*, with affordability only a secondary barrier that can be mitigated through cross-subsidization. LPG may not be more expensive than cooking with biomass, assuming consumers are paying for those fuels, especially when the ever increasing costs of charcoal are taken into account (Bruce, Aunan, and Rehfuess 2017).

The Global LPG Partnership (GLPGP) assisted Cameroon in developing that country's first national LPG master plan (box 1).

Box 1. Cameroon's master plan for increasing the use of LPG

Cameroon adopted its first national LPG master plan in 2016, partnering with the Global LPG Partnership to craft policies and reforms and define investments and interventions to increase the share of households cooking with LPG from about 12 percent in 2014 to 58 percent by 2030. Driving Cameroon to act was the significant deforestation it had experienced, caused in part by the widespread use of firewood and charcoal as cooking fuel.

To develop its master plan, Cameroon took a government-led, inter-ministerial, multi-stakeholder approach, drawing on international best practices and facilitated by GLPGP experts. Some €400 million in investments over the next 15 years—for cylinders, importation facilities, refilling plants, and distribution (including by small and medium-size enterprises)—will support this scale-up.

In February 2017, GLPGP, together with Cameroonian partners and the Department of Public Health and Policy at the University of Liverpool, launched a new microfinance pilot to expand the adoption of LPG for clean cooking to previously unserved communities. The pilot marks the first time that microfinance institutions in Cameroon have provided loans to support the purchase and initial refilling of LPG. It is also part of an international initiative on the part of GLPGP and other institutions, including the University of Liverpool, to evaluate what portion of households can be encouraged to switch to LPG for cooking if the barrier of upfront cost is lowered, by making the equipment more affordable and accessible.

Today there are improved biomass models that are more efficient than earlier models and have lower emission profiles—but they may not reduce household air pollution enough to provide the health benefits needed to reach SDG7.

Box 2. About the Global LPG Partnership

The Global LPG Partnership (GLPGP) was launched in 2012 at the Rio+20 conference as a public-private partnership (PPP) under the UN Sustainable Energy for All Initiative. Its goal is to help countries make the shift to LPG for clean cooking on a large scale, to enable the move of a billion people to clean LPG energy for household cooking by 2030.

GLPGP works at the invitation of host-country governments, partnering with other public and private sector stakeholders to create national plans for rapid, sustainable scale-up of LPG infrastructure, distribution, and demand. It then assists with financing and implementing key elements of the plan to help countries facilitate the transition to clean cooking for as many people as possible.

GLPGP was established on the premise that LPG is the preferred solution for the next 15–20 years, until a fully renewable solution for clean cooking can be found and made sustainable on a large scale. Such an energy source might eventually include bio-LPG, which is chemically identical to fossil fuel–derived LPG and would use the same supply infrastructure. Other innovative solutions are still under development or being researched.

GLPGP (box 2) is now working with Cameroon's government on the technical plans and financing structures required to deliver the projects defined in the master plan.

Is LPG catching on?

Many countries across Africa have already set goals for increased or exclusive LPG use

Members of the Economic Community of West African States (ECOWAS) have coordinated their LPG targets for clean cooking through the Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) (table 1). Cabo Verde has established goals for almost exclusive LPG use. Burkina Faso and Niger have set very high LPG targets for urban areas. Nigeria and Togo are seeking to have LPG represent 80 percent and 75 percent, respectively, of their cooking fuel mix by 2030.

Table 1. LPG penetration targets of ECOWAS member countries

Country	2015 population (millions)	2015 GDP per capita (dollars)	Percent of population using solid fuels in 2013	LPG penetration target by 2030	Status of SE4All Action Agenda
Benin	10.8	762	94	Not reported, but LPG expansion to urban areas cited	Under development (ECREEE 2015a)
Burkina Faso	18.1	589	95	68% in urban areas	Under development (ECREEE 2015a)
Cabo Verde	0.5	3,080	31	90% or more	Released (República de Cabo Verde 2015)
Côte d'Ivoire	22.7	1,399	81	1,200 kT of LPG for household cooking by 2030	Under development (ECREEE 2015a)
Gambia, The	2.0	472	95	Not reported, but LPG expansion to urban and peri-urban areas cited	Released (The Gambia 2015)
Ghana	27.4	1,370	83	50% by 2020	Released (ECREEE 2015b)
Guinea	12.6	531	> 95	50% access to clean cooking by 2025	Under development (ECREEE 2015a)
Guinea-Bissau	1.8	573	> 95	20%	Under development (ECREEE 2015a)
Liberia	4.5	456	> 95	43% ("cooking plan" scenario)	Released (Sandikie 2015)
Mali	17.6	724	> 95	62.5%	Under development (ECREEE 2015a)
Niger	19.9	359	> 95	85% urban, 60% rural	Under development (ECREEE 2015a)
Nigeria	182.2	2,640	75	80% for all clean fuels	Released (Republic of Nigeria 2015)
Senegal	15.1	900	61	Not reported	Under development (ECREEE 2015a)
Sierra Leone	6.5	653	> 95	25% for all clean fuels	Under development (ECREEE 2015a)
Togo	7.3	560	95	75% for all clean fuels	Under development (ECREEE 2015a)

Sources: Per capita GDP statistics: World Bank (2015); percent of population using solid fuels: WHO (2013, survey-based data).

The environmental footprint of LPG is negligible compared with biomass and other fuels. Gabon and Angola are seeking to achieve universal LPG access by 2025.

Table 2. LPG penetration targets of selected Central and East African countries

Country	2015 population (millions)	2015 GDP per capita (dollars)	Percent of population using solid fuels in 2013	LPG penetration target by 2030	Status of SE4All Action Agenda
Angola	25.0	4,101	54	100% by 2025	Pending CEMAC/CEEAC (2014)
Cameroon	23.3	1,217	78	58%	Released (Republic of Cameroon, 2016)
Gabon	1.7	8,266	20	100% by 2025	Pending CEMAC/CEEAC (2014)
Kenya	46.1	1,377	84	36%	Released (Republic of Kenya 2016)
Rwanda	11.6	697	> 95	25% LPG penetration in urban areas	Released (Republic of Rwanda 2016)
Tanzania	53.5	879	> 95	> 75% access to modern cooking solutions	Released (United Republic of Tanzania 2015)
Uganda	39.0	705	> 95	1 million urban households	Released (Republic of Uganda 2015)

Sources: Population and per capita GDP statistics: World Bank (2015); percent of population using solid fuels: WHO (2013, survey-based data).

The Central African Economic and Monetary Community (CEMAC) and the Economic Community of Central African States (CEEAC/ECCAS) have set the target of quadrupling LPG penetration, from 16.5 percent in 2010 to 66 percent in 2030 in urban areas and from 6 percent to 25 percent in rural areas (CEEAC-CEMAC 2014). Both Gabon and Angola, which have relatively high levels of LPG usage (62 percent and 54 percent, respectively) are seeking to achieve universal LPG access by 2025 (table 2).

East African countries have also included LPG expansion targets. Kenya has adopted a goal of 36 percent penetration (from an initial level of just 5 percent). It plans to eliminate the use of kerosene for cooking. Uganda seeks to increase the use of LPG significantly in urban areas.

Results in countries that have already made the switch to LPG at large scale are promising.

In Indonesia, policy changes and a nationally planned LPG scale-up program financed by both the public and private sectors increased the number of LPG stove users from just three million in 2007 to 43.3 million by 2012. Every household across six provinces, including Jakarta, reportedly received a free initial package of a 3-kilogram LPG cylinder, a first LPG fill, a one-burner stove, a hose, and a regulator (Sovacool 2016).

Public financing for the program came from the termination of national kerosene subsidies, and in 13 provinces all subsidies were withdrawn. As part of the plan, the government created "8 new LPG terminals, 53 LPG cylinder factories, 31 stove factories, 14 regulator producers, and 22 filling stations," according to a report by the Asian Development Bank (Sovacool 2016). The program "generated $1.7 billion of investment across these types of facilities along with 28,000 new jobs." Government audits showed significant reductions in CO2 as a result of the switch from kerosene to LPG. Kenya is similarly now moving to replace kerosene for cooking with LPG.

What have we learned?

Five key lessons emerge from national efforts to date

Lesson 1

Adoption of LPG requires investment in infrastructure (import, bulk storage, transportation, and filling facilities and LPG cylinders) and expanded distribution and retailing networks to ensure reliable and affordable supply and safe delivery to end-users. If upstream supply issues are not addressed, LPG stove dissemination programs will not provide long-term benefits.

Experience has shown that, when made accessible, affordable, and available, LPG can be adopted by millions of rural poor as their primary cooking fuel.

Lesson 2

At the national government level, an inter-ministerial and multi-stakeholder approach is critical to ensure that planning addresses all relevant issues, including upstream investment and supply chain, health and environmental issues, and affordability. Policy makers must determine whether and how pricing regimes, taxes, and subsidies are tailored to enable poor people to adopt and use LPG on a sustained basis. Cameroon and India—which aims to expand national LPG use by providing free connections to an additional 50 million households within three years—are showing the way. To ensure safe adoption and ongoing usage, such approaches must be rolled out together with local awareness campaigns.

Lesson 3

The potential market for LPG for clean cooking is much larger than many people realize. Modeling by the International Energy Agency (2011) and experience in a number of countries have shown that, when made accessible, affordable, and available, LPG can be adopted by millions of rural poor as their primary cooking fuel. The experiences of Indonesia (Budya and Arofat 2011) and Brazil (Coelho and Goldemberg 2013), to a certain extent in Senegal, along with the emerging example of India, help to show what developing countries can achieve.

Lesson 4

The issue of partial versus full adoption and use of multiple cooking fuels, a practice known as "fuel stacking," remains important. As countries develop, their populations naturally shift from solid biomass fuels to clean ones. The shift to exclusive use of clean burning fuels can be accelerated, especially in areas where LPG is already used—just not exclusively. This requires education of consumers both in terms of health and environmental benefits, but also in the household economics of LPG, to help households understand how to compare the costs of LPG refills to, say, charcoal purchases. Also, if initial equipment purchases are not provided free of charge (in India they are now fully subsidized for below poverty line households), consumer financing mechanisms (such as microfinance, and, potentially "pay as you go" approaches) should be fully utilized to help consumers with initial equipment purchase. Additionally, because smoke from neighboring biomass-burning households or kerosene lamps could compromise the benefits of cooking with clean fuels, GLPGP and other environmental health experts recommend that all households within a community transition as fully to LPG as possible at the same time, to ensure that the maximum health benefits are achieved. Some Indian states such as Karnataka are adopting this approach, with designated "smokeless villages."

Lesson 5

Creating a strong enabling environment for LPG via a combination of national planning, policy reform and targeted investments across the supply chain is critical. Developing countries that have not done so remained stuck at levels of 2 kilograms per capita or less. In contrast, countries that have done so are maintaining high levels of LPG penetration, with or without long-lasting subsidies. By guiding investments throughout the LPG value chain, India and Senegal have raised LPG use to 10–15 kilograms per capita. Brazil, Indonesia, and Peru have reached at least 40 kilograms per capita.

These lessons are expressed in the form of "five principles" in box 3.

Box 3. Five principles for rapid and sustainable LPG market development

- Implement and rigorously enforce effective, self-consistent LPG market rules, with central emphasis on property rights protection in marketer-owned LPG cylinders and on public safety.
- Ensure stability and continuity of the LPG fuel supply in all regions to be served.
- Implement stable, market-sustaining and market-stimulating policies.
- Ensure high LPG retail density.
- Develop a consensus-based national master plan for coordinated LPG investments and interventions.

Source: Global LPG Partnership (2015).

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Live Wire 2014/7. "Understanding the Differences Between Cookstoves," by Koffi Ekouevi, Kate Kennedy, and Ruchi Soni.

Live Wire 2014/8. "Tracking Access to Nonsolid Fuel for Cooking," by Sudeshna Ghosh Banerjee, Elisa Portale, Heather Adair-Rohani, and Sophie Bonjour.

Live Wire 2014/28 "Tracking Progress Toward Providing Sustainable Energy for All in East Asia and the Pacific," by Elisa Portale and Joeri de Wit.

Live Wire 2015/46. "Results-Based Financing to Promote Clean Stoves: Initial Lessons from Pilots in China and Indonesia," by Yabei Zhang and Norma Adams.

Live Wire 2015/63. "Toward Universal Access to Clean Cooking and Heating: Early Lessons from the East Asia and Pacific Clean Stove Initiative, by Yabei Zhang and Norma Adams.

(CONTINUED)

References

Balakrishnan K., S. Sambandam, S. Ghosh, K. Mukhopadhyay, M. Vaswani, N. K. Arora, D. Jack, A. Pillariseti, M. N. Bates, and K. R. Smith. 2015. "Household Air Pollution Exposures of Pregnant Women Receiving Advanced Combustion Cookstoves in India: Implications for Intervention." *Annals of Global Health* 81 (3): 375-85.

Berkeley Air Monitoring Group. 2015. *Field Performance of a Modified Philips Stove in Gisenyi, Rwanda.* Berkeley, CA.

Bruce, Nigel G., Kristin Aunan, and Eva A. Rehfuess. 2017. "Liquefied Petroleum Gas as a Clean Cooking Fuel for Developing Countries: Implications for Climate, Forests, and Affordability." Materials on Development Financing no. 7, KfW Development Bank, Frankfurt. https://drive.google.com/file/d/0B_799OzSu-p8WTB3YW1wZll4SXM/view.

Budya, Hanung, and Muhammad Yasi Arofat. 2011. "Providing Cleaner Energy Access in Indonesia through the Megaproject of Kerosene Conversion to LPG." *Energy Policy* 39 (12): 7575–86.

Coelho, Suani T., and José Goldemberg. 2013. "Energy Access: Lessons Learned in Brazil and Perspectives for Replication in Other Developing Countries." *Energy Policy* 61 (1): 1088–96.

Forouzanfar, M. H., and many others. 2016. "Global, Regional, and National Comparative Risk Assessment of 79 Behavioral, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990–2015: A Systematic Analysis for the Global Burden of Disease Study 2015." *The Lancet* 388 (1): 659–724.

Grieshop, Andrew P., Julian D. Marshall, and Milind Kandlika. 2011. "Health and Climate Benefits of Cookstove Replacement Options." *Energy Policy* 12 (12): 7530–42.

CEEAC-CEMAC (Communauté Economique des Etats de l'Afrique Centrale and Communauté Economique et Monetaire de l'Afrique Centrale). 2014. *Livre blanc de la CEEAC et de la CEMAC: Politiques régionale pour un accès universel aux services énérgetiques modernes et le dévelopment économique et social 2014–2030*. https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/News___Partners_Docs/ECCAS_CEMAC_livre_blanc_energie_2014.pdf.

ECREEE (ECOWAS Center for Renewable Energy and Energy Efficiency). 2015a. ECOWAS Sustainable Energy Policy & Investment High Level Forum Presentations. http://www.ecreee.org/node/85076.

———. 2015b. *Sustainable Energy for All (SE4ALL) Action Agenda for Ghana.* http://www.ecreee.org/sites/default/files/events/sustainable_energy_action_plan_ghana.pdf.

Global LPG Partnership. 2015. "Five Essential Principles for Rapid and Sustainable LPG Market Development." New York. www.glpgp.org/publications.

The Gambia, Ministry of Energy. 2015. SE4ALL *Action Agenda*. http://www.se4all.org/sites/default/files/Gambia_AA_EN_Released.pdf.

IEA (International Energy Agency) and OECD (Organisation for Economic Co-operation and Development). 2011. *World Energy Outlook 2011*. Paris. https://www.iea.org/media/weowebsite/energymodel/Poverty_Methodology.pdf.

Mortimer, K., and many others 2016. "A Cleaner Burning Biomass-Fuelled Cookstove Intervention to Prevent Pneumonia in Children under 5 Years Old in Rural Malawi (the Cooking and Pneumonia Study): A Cluster Randomised Controlled Trial." *The Lancet* 389 (10065): 167–75.

NIH (U.S. National Institutes of Health). 2016. "NIH-Funded Trial to Assess Benefits of Clean Cookstoves." *Global Health Matters* (Fogarty International Center, National Institutes of Health, U.S. Department of Health and Human Services): November/December: 3. http://bit.ly/LPGInterventionTrial.

Republic of Nigeria. 2015. *Sustainable Energy for All Action Agenda (SE4ALL-AA).* http://www.se4all.org/sites/default/files/NIGERIA_SE4ALL_ACTION_AGENDA_FINAL.pdf.

Republic of Kenya, Ministry of Energy and Petroleum. 2016. *Sustainable Energy for All (SE4All) Kenya Action Agenda.* http://www.se4all.org/sites/default/files/Kenya_AA_EN_Released.pdf.

Republic of Rwanda, Ministry of Infrastructure. 2016. *Sustainable Energy for All Action Agenda 2016 Update—Draft.* https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/RWANDA_Action_Agenda.pdf.

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(CONTINUED)

Live Wire 2015/63. "The Lao Cookstove Experience: Redefining Health through Cleaner Energy Solutions," by Rutu Dave and Rema N. Balasundaram.

Live Wire 2016/64. Contextual Design and Promotion of Clean Biomass Stoves: The Case of the Indonesia Clean Stove Initiative, by Laurent Durix, Helene Carlsson Rex, and Veronica Mendizabal.

Republic of Uganda, Ministry of Energy and Mineral Development. 2015. *Uganda's Sustainable Energy for All (Se4all) Initiative Action Agenda.* http://www.se4all.org/sites/default/files/Uganda_AA_EN_Released.pdf.

República de Cabo Verde. 2015. *Action Agenda for the Sustainable Energy for All Cape Verde.* http://www.se4all.org/sites/default/files/Cape_Verde__AA_EN_Released.pdf.

Sambandam, S., K. Balakrishnan, S. Ghosh, A. Sadasivam, S. Madhav, R. Ramasamy, M. Samanta, K. Mukhopadhyay, H. Rehman, and V. Ramanathan. 2015. "Can Currently Available Advanced Combustion Biomass Cook-Stoves Provide Health Relevant Exposure Reductions? Results from Initial Assessment of Select Commercial Models in India." *EcoHealth* 12 (1): 25–41.

Sandikie, Jacob S. 2015. *Liberia Sustainable Energy for All (SE4ALL) Action Agenda Report 2015.* http://www.se4all.org/sites/default/files/LIBERIA_AA_EN_Released_0.pdf.

Smith, K. R., J. Rogers, and S. C. Cowlin. 2005. *Household Fuels and Ill-Health in Developing Countries: What Improvements Can Be Brought by LP Gas?* Paris: World LP Gas Association.

Sovacool, Benjamin K. 2016. *Cobenefits and Trade-Offs of Green and Clean Energy: Evidence from the Academic Literature and Asian Case Studies.* Manila: Asian Development Bank. https://www.adb.org/sites/default/files/publication/217001/ewp-502.pdf.

Thurber, Marc C., Himani Phadke, Sriniketh Nagavarapu, Gireesh Shrimali, and Hisham Zerriffi. 2014. "'Oorja' in India: Assessing a Large-Scale Commercial Distribution of Advanced Biomass Stoves to Households." *Energy for Sustainable Development* 19: 138–50.

United Republic of Tanzania, Ministry of Energy and Minerals. 2015. *Tanzania's SE4All Action Agenda.* http://www.se4all.org/sites/default/files/TANZANIA_AA-Final.pdf.

WHO (World Health Organization).

———. 2013. *Population Using Solid Fuels.* http://apps.who.int/gho/data/view.main.1671?lang-en.

———. 2014a. *Burden of Disease from Household Air Pollution for 2012.* Geneva: World Health Organization.

———. 2014b. *Indoor Air Quality: Household Fuel Combustion.* Geneva: World Health Organization.

———. 2016. *Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children.* Geneva: World Health Organization.

World Bank. 2015. *Progress toward Sustainable Energy. Global Tracking Framework 2015, Summary Report.* Washington, DC: World Bank.

———. 2016. *The Cost of Air Pollution: Strengthening the Economic Case for Action.* Washington, DC: World Bank. http://documents.worldbank.org/curated/en/781521473177013155/The-cost-of-air-pollution-strengthening-the-economic-case-for-action.

———. 2017. *Progress toward Sustainable Energy. Global Tracking Framework 2017, Summary Report*. Washington, DC: World Bank.

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