



Columbia World Projects Forum Report:
Expanding Access to Energy

May 14, 2018

Foreword

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Dear Reader:

The attached report is the first in a series to be issued by Columbia World Projects (CWP) on the results of fora held to identify possible solutions to important challenges facing humanity. Each forum will bring together distinguished leaders and experts from inside and outside the academy, with a view to identifying specific projects in which research and scholarship can be brought to bear on the challenge, and offer scalable solutions to the benefit of people whose lives are affected by it, while also enriching our understanding of how to effectively tackle such complex problems.

Given the critical role that energy access plays in enabling economic opportunity, health, gender equality, environmental sustainability, and other key measures of human development, as well as Columbia's longstanding leadership and deep knowledge in the fields of energy and climate change, we decided to set out as our first challenge expanding access to energy. On February 19 and 20, 2018, we convened a distinguished group of experts from a range of fields in government, the private sector, NGOs, multilateral organizations, the media, and the academy, with the aim not only of better understanding key aspects of this challenge, but also of identifying concrete, implementable solutions.

Virtually all of the Forum participants – a full list of whom can be found at the end of the report – have dedicated significant parts of their careers to addressing this challenge, and therefore were canny about its magnitude and complexity, and the lack of a quick, one-size-fits-all solution. But these experts were also rigorous and thoughtful when it came to homing in on the persistent obstacles to expanding energy access, and how approaching the problem in new ways – with distinct tools and unique partnerships – might be able to unlock meaningful progress. The following report is a product of their key insights and findings.

The structure of the report follows the sequence of the Forum itself: It begins by summarizing the main insights from an opening discussion on defining the challenge of energy access; then it moves to the discussions in the Forum's working groups, each of which was tasked with evaluating a handful of ideas for potential CWP projects; and it concludes with the findings of the Forum's closing plenary, in which participants expressed their views on the most promising ideas proposed at the meeting. Ultimately, four ideas received strong support from the participants, which – given the deep expertise and diverse backgrounds of those in attendance – we view as a strong signal that these projects may enable significant advances in expanding energy access, and merit further development. CWP will now do so, with the prospect of funding one or more of these projects in whole or in part.

The Forum was held under Chatham House rules, and as such the ideas and views expressed in the report are not attributed to individual participants. Yet the report does try, where possible, to specify the relative support for an idea or point of view, ranging from an individual observation to a consensus view.

While identifying project ideas to be developed by CWP and its partners is the primary objective of this and future fora, it is also our aim that these gatherings will deepen our understanding of complex global problems, inspire even the most advanced experts to see such vexing challenges in new ways, and encourage partnerships that might lead to breakthroughs that could improve countless lives. One of the main reasons we are issuing reports like this one is to share the innovative ideas and insights generated by participants, in the hopes that others will take them up, develop them, and test them in the field. We know that these challenges cannot be solved by any one institution alone, and that it will take many efforts like this one to make meaningful progress.



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I. Introduction

Energy access has been called the “golden thread” because of the critical role it plays in enabling economic opportunity and growth, health, gender, equality, food security, and environmental sustainability. Access to energy is fundamental to meeting the basic needs not only of individuals and households, but entire communities – making it possible to light classrooms, refrigerate vaccines, power machines in factories, and pump water to fields. As such, expanding access to energy holds the promise of unlocking enormous potential for development, which is why UN Member States made ensuring access to affordable, reliable, sustainable, and modern energy for all one of the UN Sustainable Development Goals adopted in 2015.¹

Just as access to energy underpins development, so can the lack of access to energy perpetuate and even exacerbate poverty, insecurity, and inequality. Household air pollution, mostly produced by smoky fuels and inefficient stoves, causes nearly four million premature deaths each year, mostly of women and children.² In sub-Saharan Africa, almost half of vaccines are lost and 70 percent of electrical medical devices fail as a result of an unreliable electricity supply.³ A weak power infrastructure is estimated to cost sub-Saharan Africa’s economies approximately 2 percent of their GDP annually.⁴ Households that rely on traditional biomass for cooking dedicate an average of 1.4 hours per day collecting firewood – work that is disproportionately carried out by women and children, preventing them from directing that time towards other opportunities.⁵

There is little question among experts regarding the importance of expanding energy access to human development. Yet despite some progress, the challenge is only becoming more difficult and important to solve. The International Energy Agency (IEA) reports that nearly 1.2 billion people have gained electricity access since 2000,⁶ 500 million of them in India alone.⁷ While there are challenges associated with the collection of accurate and comprehensive data, no one

¹ Resolution adopted by the United Nations General Assembly, *Transforming Our World: The 2030 Agenda for Sustainable Development*, A/RES/70/1 (September 25, 2015), <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication>. For an example of a potential link between energy access and other forms of development, a study of an electrification program targeting rural communities in South Africa found that providing electricity led to a nearly 10 percent rise in female employment. See Taryn Dinkelman, “The Effects of Rural Electrification on Employment: New Evidence from South Africa,” *The American Economic Review*, vol. 101, no. 7 (2011): 3080, www.jstor.org/stable/41408731.

² “Household Air Pollution and Health,” World Health Organization, last modified May 1, 2018, <http://www.who.int/en/news-room/fact-sheets/detail/household-air-pollution-and-health>.

³ *Atlas of Africa Energy Resources*, UNEP (United Nations Environment Programme), 2017, http://wedocs.unep.org/bitstream/handle/20.500.11822/20476/Atlas_Africa_Energy_Resources.pdf.

⁴ Thomas Barnebeck Andersen and Carl-Johan Dalgaard, “Power Outages and Economic Growth in Africa,” *Energy Economics* vol. 38, issue C (July 2013): 19-23.

⁵ *World Energy Outlook 2017: From Poverty to Prosperity*, International Energy Agency, October 19, 2017, https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf.

⁶ “2017 Dataset,” Energy Access Database, International Energy Agency, last accessed May 8, 2018, <http://www.iea.org/energyaccess/database/>.

⁷ *World Energy Outlook 2017*, International Energy Agency, *supra* note 5.

disputes that a significant number of people who did not have access ten years ago have access today. Similarly, there is no question that the proportion of the population without access to electricity has decreased in every region of the world. Nevertheless, population growth has meant that the absolute numbers are not improving. Today, more people are without access to electricity than was the case in 2000.⁸ Moreover, with the coming increases in temperature associated with global warming and rapid urbanization, which leads to a growing concentration of people living and working in close proximity, the need for energy access and efficient cooling technologies is more critical than ever.

On February 19 and 20, 2018, Columbia World Projects (CWP) convened more than 30 energy experts from government, multilateral institutions, nongovernmental and philanthropic organizations, the private sector, and academia, among other fields, to discuss concrete ways in which research and scholarship can be brought to bear on expanding access to energy. This report summarizes the main findings of that Forum. Specifically, Section II summarizes the Forum's opening plenary discussion on the scope and nature of the problem, key cross-cutting issues, and different ways of approaching the challenge of expanding energy access. Section III reports on the discussions held by the Forum's five thematic working groups, in which a series of project proposals for how to bring research and scholarship to bear on expanding access to energy were evaluated. Section IV summarizes the closing plenary session, in which the projects developed in the working groups were discussed and participants ultimately weighed in on what they considered to be the top two or three ideas most worthy of further development. Section V sets out the next steps Columbia World Projects will undertake in developing the four ideas that received the most support from participants as potential CWP projects.

II. Understanding, Scoping, and Focusing in on Key Aspects of the Challenge

In order to provide a basis for a discussion of specific projects in which academic research and scholarship might be applied in partnership with non-academic entities to expand energy access, participants discussed the scope and nature of the challenge, including key areas of focus that might be especially productive. While various, and sometimes competing, views were expressed, certain common themes emerged, which were instructive and ultimately set the landscape for a discussion on project ideas within the working groups, described below.

Defining the Challenge

Participants noted that there are numerous ways of defining and measuring access, and that the working definitions of what it means to have “access to energy” are often imprecise. Participants pointed out that people frequently equate access with energy as access to electricity, even though there are obviously other forms, such as heat (thermal) energy and radiant energy to be considered. And even in the context of electricity, deciding what amount of electricity is sufficient to constitute energy access is complicated, and does not address other important factors relevant to meaningful access.

⁸ Ibid.

The IEA defines electricity access as a “household having an electricity supply connection, with a minimum level of consumption of 250 kilowatt-hours (kWh) per year for a rural household and 500 kWh for an urban household.”⁹ This would provide sufficient power for the basics – powering a phone charger, several light bulbs, a radio, and even a laptop – but it would not provide sufficient power for major appliances like a refrigerator. By this measure, approximately one billion people do not have access to electricity.¹⁰ And even if one accepts this minimal level as an appropriate measure of access, it does not capture whether the service received is reliable, affordable, safe, and of adequate quality. Most participants at the Forum, therefore, were of the view that it is important to take these additional issues into account and to think of access along a spectrum, distinguishing, for example, between basic access, which would allow a household to carry out certain rudimentary tasks (such as powering a lightbulb or a radio) and access that allows for essential services or productive uses (such as powering devices at a health clinic or a water pump used to irrigate fields). Of course, what constitutes basic access and productive access or services can differ depending on where you are in the world. Moreover, in assessing key uses of energy, such as cooking or heating, the challenge is not always about providing households with access to specific forms of energy, but instead about increasing the efficiency of the households’ energy consumption and mitigating the negative consequences of its use (such as pollution or harmful health effects). In sum, several participants suggested that it would be better to think about access in terms of the services and uses provided, while also considering the quality, reliability, affordability, availability, and safety of the access, rather than simply the form or amount of energy accessed.

Participants also noted the complexity not only of defining energy access, but also of measuring the impact of such access (or lack thereof) on individual households and communities. While it is now an axiom that energy access has a positive impact on key development factors such as health, economic opportunity, and education – and that the lack of access can constitute a significant hindrance to such development – efforts to quantify the impact of access have been limited and at times imprecise. Many participants were of the view that there is insufficient focus in the field of energy access on the quality and the relative impact of energy access. Additionally, participants noted that it is important to measure the impact of access not only on individual households, but also on communities, where an investment in greater, more reliable, and more affordable power can more effectively drive access forward and help advance other key development goals. In other words, access to an increased level of reliable, affordable power has the potential to contribute to a structural transformation of the economy, which increases productivity and provides new opportunities for productive activities, stimulating a higher level of demand. And that increased demand may, with time, make viable investments in additional energy access efforts that were not previously viable.

Putting aside these definitional issues for further discussion in the context of specific project proposals, participants considered different areas of focus that might have the greatest impact on the broader challenge.

⁹ Ibid.

¹⁰ “2017 Dataset,” Energy Access Database, International Energy Agency, *supra* note 6.

Potential Areas of Focus

When considering how to allocate limited resources for expanding energy access, one might decide to target populations or regions that are harder and more expensive to reach, rather than populations that are more accessible and cheaper to reach, even if doing so means reaching fewer people in absolute numbers. For example, reaching so-called last-mile populations – who are furthest removed from the grid, and who may not be able to pay for even rudimentary access – will almost certainly carry a higher cost for access per household than other investments and will be more difficult for commercial providers to do on an economically sustainable basis. To the extent governments have tried to provide access to these last-mile communities, they have often done so through state-owned utilities that rely on subsidies to make up for the target populations’ inability to pay the full cost. Yet any subsidy provided to last-mile populations may undercut a market-driven expansion in other areas.¹¹ Nevertheless, given the heightened challenges associated with providing access to these smaller, more marginalized populations, these may be precisely the people that governments, humanitarian agencies, and development groups should be focused on, when directing their resources – both because they are the least likely to gain access to this essential service, and because of the severity of their need. Similarly, while efforts to expand access to clean fuels and technologies for cooking have proven particularly difficult, the profoundly negative effects of the lack of access to clean cooking (for health, human development, economic opportunity, and the environment) make this a critically important area for further research. The harmful effects extend far beyond individual households and communities, as traditional cookstoves and fuels produce one-fifth of all black carbon emissions globally.¹² In addition to impacting climate change, black carbon disrupts weather patterns and accelerates the melting of snow and ice, which many people rely on for drinking water and farming.¹³ Thinking about targeted interventions in this way upends what has been the approach of some development agencies, which tend to focus on projects designed to reach as many people as possible at lower costs and that have a lower risk of failure than would likely be true for an intervention targeting an especially marginalized and needy population.

Another focus might be on a particular country or region where the concentration of need is the greatest. For example, in pursuing an expansion of access, one might focus on one of the six countries that together account for more than half of the global population without access to energy: India, Nigeria, the Democratic Republic of Congo, Ethiopia, Pakistan, and Bangladesh.¹⁴ Alternatively, one might focus on sub-Saharan Africa, given that of the 50 countries with the lowest rates of access, only five are outside of sub-Saharan Africa, where the electrification rate

¹¹ Jørund Buen, “The Danger of Subsidized Solar: How Government and Donors Unwittingly Hobbled Our Business,” *NextBillion* (blog), William Davidson Institute at the University of Michigan, January 8, 2018, <https://nextbillion.net/danger-subsidized-solar-government-donors-unwittingly-hobbled-business/>.

¹² “Clean Cookstove Research,” Science in Action, Environmental Protection Agency, December 2015, https://www.epa.gov/sites/production/files/2015-12/documents/cookstove_0.pdf.

¹³ *Ibid.*

¹⁴ *World Energy Outlook 2017*, International Energy Agency, *supra* note 5.

is still just 43 percent.¹⁵ By 2030, the IEA expects that 90 percent of people lacking energy access will be in sub-Saharan Africa.¹⁶ Among the advantages of focusing on an individual country or region, several participants noted, was that it may lend itself more to a comprehensive approach – involving a diverse range of interventions and actors – which is more likely to produce results. On the other hand, the problem of energy access is, of course, not restricted to the specific countries or region named; it is substantial in parts of Asia, and persists even in developed countries like the United States, where a combination of high costs, poverty, and chronic underdevelopment continues to leave a relatively small number of vulnerable communities without electricity and the basic services it allows.

Alternatively, efforts to expand energy access could focus on closing the gaps within countries and regions – perhaps most notably the urban-rural divide. The global urban electricity access rate was 96 percent in 2014, whereas the rural rate was 73 percent.¹⁷ In less developed countries, the disparity is even starker. As of 2014, nearly half of the approximately one billion people worldwide without access to electricity lived in rural parts of sub-Saharan Africa.¹⁸ In Malawi, Tanzania, Uganda, and Niger, 80 percent of the population lived in rural areas with electrification rates as low as 4 to 5 percent over the period 2012 to 2014.¹⁹ This divide is also reflected in the lack of access to clean fuel for cooking. In sub-Saharan Africa, a 2012 survey found that 62 percent of the urban population relied on solid fuels (primarily wood and charcoal) for cooking, compared to 95 percent of the rural population.²⁰ It is no coincidence that these rural areas are oftentimes “off the grid” – that is, they do not have access to a country’s main electricity network – as the cost of transmission and distribution of electricity to these areas is much higher. Nor is it a coincidence that populations with low incomes generally live in areas with lower electrification rates than those with higher incomes.²¹

Another way to maximize impact could be to seek interventions that target gaps in energy access which, if successful, could be scaled with far-reaching impact across sectors and borders. For example, a breakthrough in improving the provision and adoption of clean cooking energy could have a significant global impact, though some would argue that what works in one location is unlikely to be the solution in another. Alternatively, one might measure maximal impact not by absolute numbers of people affected, but rather by those for whom access is a critical determinant of extreme poverty. Or the focus might be on solutions for populations

¹⁵ Demetrios Mentis, et al., “Lighting the World: The First Application of an Open Source, Spatial Electrification Tool (OnSSET) on Sub-Saharan Africa,” *Environmental Research Letters* 12 (July 2017): 1.

¹⁶ *World Energy Outlook 2017*, International Energy Agency, *supra* note 5.

¹⁷ *Electrification: Ensure Universal Access to Modern Energy Services*, Sustainable Energy for All, 2017, <https://www.seforall.org/sites/default/files/Electrification.pdf>.

¹⁸ *Ibid.*

¹⁹ *Ibid.*

²⁰ Srilata Kammila, Jan Friedrich Kappen, Dana Rysankova, Besnik Hyseni, Venkata Ramana Putti, *Clean and Improved Cooking in Sub-Saharan Africa: A Landscape Report*, (Washington: World Bank Group, 2014), 36, <http://documents.worldbank.org/curated/en/164241468178757464/Clean-and-improved-cooking-in-Sub-Saharan-Africa-a-landscape-report>.

²¹ “Modern Energy for All,” International Energy Agency, last accessed May 5, 2018, <https://www.iea.org/energyaccess/modernenergyforall/>.

whose access to energy has been abruptly interrupted by natural or man-made disasters, such as displaced populations living in migrant or refugee camps or the hundreds of thousands of Puerto Ricans who were left without electricity for months after Hurricane Maria ravaged the island in September 2017. An argument in favor of this kind of approach could be that it is easier to prevent such populations from slipping into extreme poverty than it is to pull others out of such poverty. Participants additionally noted that another reason to focus on resilience mechanisms for such populations is the rising frequency and magnitude of natural disasters are rising as a consequence of climate change, and this trend will only continue to grow.

Finally, participants identified certain cross-cutting challenges that, if addressed, could have a fundamental impact on expanding access to energy in more than one focus area. These challenges, which are summarized below, proved to be recurring themes when project ideas were discussed later on in the Forum's working groups:

Cross-Cutting Challenges

Data. Among the most persistent challenges raised by participants was the lack of sufficient and reliable data – particularly spatiotemporal data – on energy availability, access, and use, which is necessary on an ongoing basis to understand the current landscape, to identify challenges, and to inform effective interventions aimed at expanding access. Several participants pointed out critically important gaps in information or data on who has access to energy, on whether that access is reliable and affordable, and on consumers' evolving needs and demands. This includes data needed for monitoring programs, as well as for planning, operating, and financing energy expansion projects. Others noted the insufficient rigor and communication regarding how to “count” the data that are being collected, resulting in, for example, misleading information on the scope of the challenge, or in de-legitimizing certain solutions by only “counting” certain types of access. Finally, many participants underscored the need for interdisciplinary and rigorous analysis and modeling of the data being collected to more effectively drive energy access efforts in a wide range of areas and thereby reduce the inefficient allocation of resources.

Financing. Generating sufficient capital to expand access to energy is a massive and persistent challenge. Among the obstacles highlighted by participants is that investment in expanding energy access – which tends to be a capital-intensive venture – often comes through reinvestment of existing (and often weak) enterprise profits, as well as grant and equity financing. This is true not only for significant investments by big government utilities, which tend to rely on sovereign credit, transfers, and large-scale development loans, but also for domestic entrepreneurs who may be seeking much smaller amounts of financing for micro-grids and off-grid systems. A related challenge is the perception among potential funders that investments in expanding energy access are too risky, and that the returns are too small, given the relative poverty of targeted consumers and the unstable political and economic climates that exist in many of the countries where such investments are needed.

Public Authorities. Participants discussed the different challenges posed by national governments and sub-national entities in addressing energy access. Several participants noted that national governments of countries with the lowest rates of access tend to focus on reaching potential users almost exclusively through growing the country's electricity grid, while largely

ignoring alternatives such as micro-grids or off-grid technology, which might make for a more cost-effective and swift interventions and which may be better suited to a target population's initial energy needs. Such countries often do not have the technical infrastructure, the regulatory framework for integrated energy planning, or the personnel that would allow them to take advantage of a wide variety of options available for providing access, including decentralized renewable energy sources for electrification and solutions for clean cooking. Off-grid systems are often dismissed because they can only support a relatively limited range of services, yet sequencing access may be the most effective approach in building a marketplace for energy access. With time, as households and small businesses move up the energy ladder and their needs grow, governments could facilitate a phased approach in which off-grid use, for example, is eventually supplemented by connections to the country's main grid or micro-grids, as appropriate. Participants also highlighted institutional challenges that at times arise when working with public authorities, such as a lack of capacity, rigid bureaucracies, and political considerations influencing resource allocation decisions. Participants further noted that governments are not doing enough to facilitate the work of non-governmental actors to expand access to energy. Meanwhile, in some instances, governmental policies aimed at protecting domestic industries through tariffs or other mechanisms may create barriers to expanding energy access, such as by making it more expensive to import materials that are required for mini-grids and off-grid renewable systems through tariffs or other mechanisms.

Sustainability. Several participants pointed to the importance of developing and utilizing local expertise in order to expand energy access in a sustainable way. Building the capacity of local actors – from local entrepreneurs (such as start-ups that market off-grid systems), to domestic financial institutions (to fund these ventures), to local technical experts (who can build and maintain mini-grid and off-grid systems) – improves the chance of uptake, fosters a local constituency for growing energy access, and strengthens the durability of such efforts. Several participants noted that far too often, the solutions are devised from the top-down rather than from the bottom-up, resulting in interventions that are less responsive to community needs, and less likely to be adopted and implemented by local actors.

Unintended Negative Consequences. Participants additionally discussed the potential for unintended negative consequences – such as waste, market spoilage from providing products for free rather than at market prices, and public indebtedness – which must be better anticipated and taken into account when considering potential solutions. Perhaps most importantly, the discussion explored whether it is possible to seriously pursue universal energy access without undermining international climate change goals. Several participants underscored that while energy access and climate change objectives are frequently presented as competing goals, the trade-offs are often overstated and oversimplified. As a preliminary matter, the carbon footprint that would result from providing energy access to the vast majority of communities and households that currently do not have access – even when using conventional energy sources – is negligible compared to the carbon footprint of communities and households in developed countries. Where renewable energy sources are used in combination with energy efficiency measures, the small carbon footprint of providing such access would be reduced even further. In some instances, the provision of electricity or other forms of energy may actually reduce a household or community's carbon dioxide emissions. For example, a community that makes the

transition from biomass to liquefied petroleum gas (LPG) powered cookstoves could significantly cut the amount of carbon dioxide and black carbon it produces.

III. Working Group Discussions

While participants were mindful of the different ways of scoping and approaching the challenge of energy access, it was widely recognized that there are no “one-size-fits-all” solutions, and therefore that the “answer” to universal access almost assuredly lies in a series of different solutions that fit specific communities and circumstances. Consequently, the Forum’s discussion was not restricted to one particular approach or to addressing one key facet of the energy access problem, but rather considered a number of different and even competing ideas for projects. The Forum’s participants split up into five thematic working groups. The themes were intended solely to help organize the work of the Forum and allow smaller groups with relevant expertise to share and evaluate different proposals for how research and scholarship might be brought to bear on expanding energy access in significant ways, in partnership with actors outside of academia – and not to limit the discussion of the groups to any one theme or approach. Indeed, it was reflective of the nature of the energy access challenge and of the solutions required to effectively address it, that the projects discussed in each working group almost always touched on the themes of the other working groups.

The working groups were asked to consider a number of questions when evaluating potential projects:

1. What are the project’s chances of achieving its objectives? What are its weaknesses? What role would research and/or scholarship play?
2. What obstacles might make the project difficult to achieve (e.g., lack of political will, high cost, lack of local support, financial investment)?
3. What key challenges are likely to arise in implementing the project? What would the obstacles be in the field?
4. How might the project be strengthened to address the risks, weaknesses, concerns that have been identified?
5. If successful, what magnitude of impact would the project likely have on access to energy?
6. Is anyone else already implementing this project or something similar?
7. Will this project happen anyway, regardless of whether it is taken up by CWP?
8. To what degree is research and/or scholarship important to the success of the project, and for how long?
9. Where might the project be implemented, and who would the key partners be in pursuing it?
10. What are possible unintended consequences and second-order effects?
11. What is the role of data and how would you measure the impact of the project?

Additionally, certain issues were highlighted for consideration with respect to each project proposal, including (i) customer and end-user factors that might influence implementation; (ii) country, government, and local conditions that might affect the likelihood of the project’s success; (iii) likely market impact; (iv) potential health implications; (v) potential environmental

impact, including the implications for climate change, pollution, and clean water; (vi) gender implications; (vii) specific regional perspectives, if any, that should be taken into account; and (viii) any geopolitical implications.

What follows is a breakdown of the work covered in each group and a summary of certain key ideas that emerged:

1. **Finance: Innovative financing mechanisms for affordable and reliable energy access.**

The Finance group examined ways of facilitating investments in expanding energy access, as such investments are often deterred by a combination of high risks, uncertain returns, and significant up-front costs. The group looked at steps that might be taken to enhance the viability of investments in such places. This group also examined what incentives might be put in place to encourage such investments. The group focused initially on questions and suggestions that cut across two potential projects discussed, which related to mobilizing financing for solar energy systems in Uganda and measuring the ability of people to pay for off-grid power in sub-Saharan Africa.

The first proposed project was focused on Uganda, where the national electrification level is 20 percent and the rural electrification level is around 10 percent.²² The basic concept was to develop a model for increasing private investment in local companies to deploy pay-as-you-go (PAYG) solar models that would provide basic energy access to households and ultimately help these companies scale up to meet the market demand. In support of mobilizing capital, the group considered blended capital models to de-risk investments, providing direct financial incentives, and promoting greater involvement on the part of domestic banks. At the same time, the group also discussed the need to help make local PAYG companies more competitive and investment-ready, along with ideas for how to help those companies reach the right market. Participants pointed out that if this were successful, the approach might be adapted and applied in other developing countries.

The second project was not unrelated, in that it focused on helping to identify and understand the potential market for electricity where populations are currently without access. Specifically, as the proposal noted, while more than 600 million people in sub-Saharan Africa are currently off the grid, it is not clear what proportion of this population lives in households that would be capable of purchasing off-grid energy, were it to be available. The aim of this project would be to help identify where the households are that can pay for electricity and roughly how much they can pay, which in turn would facilitate an intelligent and sustainable expansion of access. The group discussed two models for identifying those with the capacity to pay for electricity: 1) an asset-based approach, which uses household surveys on the ownership of electrical appliances (such as cell phones and radios) as a predictor of households' ability to pay; and 2) a spending-based approach, which uses households' current spending on kerosene, charcoal, and other energy sources as a means of predicting ability to pay. The impact of the project would be to provide a template for how governments, companies, and others can identify potential customers

²² "Uganda Country Commercial Guide: Energy," International Trade Administration, United States Department of Commerce, last modified August 3, 2017, <https://www.export.gov/article?id=Uganda-Energy>.

at a subnational level, and target their investments in providing electricity, thus making them more likely to invest in expanding access, and making their investments more likely to succeed.

The group discussed the metrics that could be used to help predict the ability and willingness of households to pay, including whether it would be possible to build a credit history of households, in order to produce a risk matrix for potential investors. Several participants agreed that identifying and segmenting different types of customers, such as those seeking basic household access versus those seeking commercial utility, would be critical, as it would allow for tailoring solutions to the distinct needs of different populations. And any financial investment that could distinguish between the different kinds of access being sought, along with their respective returns as people move up the energy ladder, would be more likely to succeed.

Participants also discussed which subsidies or grants might be used to lower the risk profile and thus make companies more likely to invest, in the context of a blended capital model, while recognizing that such subsidies and grants are insufficient on their own as a way of promoting adequate investment. Participants noted that local companies may do a better job of identifying populations who can pay, but often have difficulty attracting debt financing because they are unable to establish a deep equity base to start – a catch-22 in that often prevents local funding.

Finally, participants recognized that it would be important to consider, as companies expand into new areas that are commercially viable, how to avoid overlooking those regions or populations that are viewed as too risky by international companies and investors to target. A related and critically important question posed by the group was how to find ways to reach those “last-mile” recipients – some of whom are unable to pay for even the most rudimentary access – without undermining the market in areas where households can pay.

In the course of its discussion, the group came up with a new proposal – drawing in part on the two concept papers – for how to use data to provide utilities with information that could be used to lower the risk of investments and provide concessional capital at lower interest rates, attracting more financing, and informing better decisions around meeting the energy access demands of their customers, when expanding the grid or developing off-grid systems. The first phase of the project would consist of giving utilities tools to collect better information on certain customers or potential customers – including those who have the ability to pay for energy access, but who lack access to the grid. The second phase would involve analyzing the data, with the purpose of helping utilities make commercially viable decisions regarding expanding access and, by extension, allowing the market to more accurately assess and mitigate the risk of concessional capital and securitization. This in turn would maximize the capital of utilities to make improvements in existing services, and align their decisions more accurately with customer needs. This proposal overlaps with one looked at by the infrastructure working group, which is discussed below.

2. *Efficiency: Accelerating access by promoting efficient end-use and thereby making energy services more affordable.*

The Efficiency group reviewed different ways in which advances in the efficiency, quality, and standards of end-use items might play a role in expanding energy access by lowering the amount

of electricity needed to provide the same service, by reducing the costs to consumers, by improving the likelihood of uptake, or by making the energy generated by renewable sources sufficient to meet users' demand where the grid cannot reach.

The group discussed a series of potential projects that cover a broad range of efficiency applications relevant to expanding access. Specifically, the group looked at (i) developing more efficient medical devices for off-grid health clinics in Africa, which would run off solar units and have a significant impact on maternal and neonatal health around labor and delivery; (ii) promoting and evaluating the development of additional minimum quality standards for products that are used with off-grid solar systems, such as the Lighting Global Standard, in an effort to foster a more sustainable market for off-grid energy systems and their products; (iii) improving access to, and the use of, clean cooking in India through electric induction ovens; (iv) developing more efficient appliances for household use with micro-grids in India, in an effort to improve the reach and quality of micro-grid access; and (v) improving cooling technology for populations with limited access to electricity – an increasingly urgent need given rising temperatures caused by greenhouse gas emissions. The group also discussed the possibility of creating an open platform for energy access data that could be used by researchers, practitioners, and investors to enable a better understanding of the challenge and better planning and implementation of interventions to improve access.

In many cases, the project ideas discussed were ones that were underway by various non-academics, yet the proposal was made to engage research and scholarship to improve the effectiveness of the overall effort, or perhaps even to transform the approach being taken over time. A recurring question across the projects was why more efficient energy services and products had not already been developed. For instance, in the case of developing advanced medical devices for use with off-grid renewable systems, participants asked whether the chief obstacle was technological or market-driven (or some combination of the two). In other words: Is the reason such devices do not exist because they are difficult to engineer for off-grid systems, or because those with the capacity to develop such devices see little economic benefit in doing so? Participants also made the point that access to more efficient, reliable, and affordable products does not always translate into adoption. To give one example, when reviewing a proposed project to incentivize the expanded use of electric induction ovens in India, the group noted that while electric cookstoves have already been shown to be more efficient and less damaging to health, the vast majority of Indian households have chosen to stick with traditional biomass cookstoves (even among those who could easily afford an electric cookstove).

This observation related to a common gap identified by the group: very little is known about consumer preferences about energy efficiency, or how such preferences might be shaped. Indeed, the central focus of one of the projects proposed to measure exactly that question – namely, whether it matters to households that a given product is efficient and reliable, and if so, whether introducing such standards in more places could help grow the market for quality-assured, efficient off-grid energy systems. Several participants noted that such a study could yield negative unintended consequences, were it to determine that quality assurance or efficiency standards matter little to consumers, which could in turn discourage the development of such products. But the group concluded that the collection and analysis of data like this, without

which interventions are poorly informed and have a lower chance of success, is essential to drive the expansion of energy access.

3. *Infrastructure: Structural solutions to deliver universal energy access.*

The Infrastructure group considered whether there were structural solutions that could promote expanded access by helping to encourage the deliberate and effective growth of a country's electricity grid, micro-grids, and off-grid systems in an integrated way. Specifically, the group considered (i) conducting a study regarding the privatization of, and challenges faced by, electricity distribution companies (often referred to as “discos”) in Nigeria, in an effort to determine what lessons might be learned and applied elsewhere, making it possible to provide access to electricity in rural areas in a commercially viable way; (ii) developing a data platform for key countries in concert with local institutions (such as universities), which would allow for an improved geospatial assessment of the current and emerging energy demands of households who are being served by a utility and those who are not; (iii) piloting a project in which basic off-grid access is subsidized to key populations with PAYG technology that would capture key data regarding the use and payment history of the population and draw on that data to drive the growth of the grid in a commercially viable way; (iv) investigating the feasibility of leveraging natural gas finds in Mozambique and Tanzania to create local infrastructure and markets for use, while exporting some gas across East Africa to generate revenue (which can be used for clean cooking and cleaner transportation, and to meet needs for power, fertilizer, and industry, among other uses); and (v) studying the business models around micro-grids and identifying the most viable models.

Participants spoke to the endemic problems with discos, and challenges in working with them, including the lack of an imperative to earn a profit, the dearth of accountability for their inefficiencies and failures, bureaucratic impediments, and their general slowness when it comes to incorporating new ways of providing energy to the populations they serve, beyond simply extending the grid. While it was noted that such problems may make discos more difficult to work with and hamper efforts to expand energy access, participants agreed that these utilities are central players and must be improved. Participants suggested the value of studying the instances where efforts to modernize or privatize discos had come up short, and where – to the extent positive examples exist – utilities have effectively modernized, whether by incorporating micro-grids and off-grid systems in their expansion, improving their data collection, or working with non-traditional partners, such as entrepreneurs or local funders. Such examples may provide insights into how to effectively work with discos, or reveal common pitfalls to avoid.

Aside from the institutional challenges faced by discos, the working group agreed that a fundamental concern was that discos were not making effective decisions regarding how to grow the grid in commercially viable ways, in part because they lacked sufficient information regarding potential customers and the capability to model and analyze such information. While it is common sense that information about customer use, need, and demand should inform decisions about infrastructure (such as when and where to invest in expanding the grid), the group spoke at length about the dearth of reliable data that discos and other key actors possess on these crucial metrics. The group recognized that governments and discos need help not just in collecting and analyzing this data, but also in determining what kind of data they should be

collecting and analyzing. Such data would be valuable, participants noted, and may even help to subsidize the provision of basic access to potential customers who are not yet connected to the grid. The data could also be used to attract investments from the makers of appliances, who have a powerful incentive to identify customers in new markets, and who may be more inclined to focus on underserved populations when they know there is sufficient demand.

4. **Renewables: Governance and policy frameworks for energy access.**

The Renewables group looked at ways to maximize the efficacy of renewable energy sources, including off-grid and micro-grid systems to reach isolated rural populations, particularly in sub-Saharan Africa, where renewables account for 70 percent of new access since 2012.²³ Specifically, the group considered a proposal to work with The Nature Conservancy to help certain middle-income and lower-income countries plan for a transition to a sustainable energy infrastructure on a national scale in an integrated, comprehensive way.

The group also considered a project drawing on mechanisms that exist in international agreements such as the Paris Climate Agreement that allow countries or companies to meet their targets for reducing greenhouse gas emissions by paying for emission-reducing projects in other countries, companies, or sectors. The project envisioned, among other things, devising monitoring and accounting protocols to quantify the added emissions reductions that would be achieved by particular projects geared toward energy access — and perhaps finding ways to bundle the projects so that countries can participate in the carbon offset programs while keeping transaction costs at a minimum.

Lastly, the group considered a project where Columbia University would identify promising entrepreneurs in the field of energy access, and connect them with venture capital funds and corporations, to foster greater investment. The project also proposed the creation of an investment portfolio focused on seed funding for energy access projects in developing countries, in which it was proposed that the University be a key investor.

A crosscutting theme of the working group discussion was the need to do a better job of anticipating and preempting the unintended negative consequences of such efforts. Participants said that projects aimed at expanding access through renewables were often assumed to represent an unalloyed good, yet practice has demonstrated otherwise. One participant highlighted the example of Indonesia, where the swift expansion of massive solar power installations has led to widespread deforestation and a significant loss of biodiversity. Similarly, under the offset mechanism in the Kyoto Protocol, some standards have had the perverse effect of actually incentivizing the production of dangerous gases, so that they can be traded for highly profitable credits. Participants said that while there will always be some unintended consequences, thinking through the possible social, economic, and political implications of such efforts can help mitigate such negative effects.

5. **Targeted Interventions: Clean cooking, displaced populations, and disasters.**

²³ Simon Evans, “Renewables Will Give More People Access to Electricity than Coal, Says IEA,” *CarbonBrief*, October 19, 2017, <https://www.carbonbrief.org/renewables-will-help-more-people-access-electricity-than-coal-ia>.

The group on targeted interventions looked at a series of specific interventions that might be focused on either particularly intractable problems with the potential for high impact, such as clean cooking initiatives, or places where it might be possible to focus in on specific marginalized populations. Specifically, the group considered (i) a plan to help Ghana accelerate access to clean cooking services at the community level; (ii) enabling a transition in Tanzania to clean cooking using an LPG Pay-as-You-Cook model, which would enable smaller payments by low-income households made by mobile phone, and which could be scalable in other areas; (iii) mechanisms for working with humanitarian organizations and host countries to improve energy access for the growing number of refugees worldwide, only 10 percent of whom have access to energy, and who are frequently in areas where a limited energy supply is inefficient, costly, and polluting; and (iv) using solar energy to provide electricity, enhance education, and promote development on Native American reservations, where in some areas and among certain tribes, nearly 40 percent of households lack access to electricity.²⁴

Participants agreed on the importance of seeking solutions that treat the lack of access to electricity and of clean cooking as interconnected problems with integrated solutions. Too often, the group agreed, efforts to address energy poverty are pursued in silos, when comprehensive interventions would be more efficient and more effective. The group spoke to using PAYG technology and accounts to allow households to pay in small increments for both renewable electricity and energy for clean cooking. One participant made the point that while we stack energy sources in developed countries (where, in a single household, we might cook with a natural gas or LPG stove, an electric microwave, and an oven), we unreasonably expect households in developing countries to use just one energy source for cooking.

The group discussed the power of creating bright spots – positive examples that show effective interventions can be achieved, whether in cities, regions, or entire countries. Indeed, in three of the proposed projects, the theory of change was that if an intervention could demonstrate that energy poverty could be mitigated – and that doing so had positive corollary effects for the affected population – governments, humanitarian agencies, donors, and others would be more inclined to pursue similar projects. For example, if a project proved that a comprehensive approach in Ghana could rapidly expand the uptake of clean cooking and improve health, girls’ education, and other forms of human development, it could encourage other governments and funders to invest in similar efforts.

One of the key themes discussed by the group was the tension between the desire to scale effective solutions and the need to tailor them to local context. Participants noted that the one-size-fits-all approach for energy solutions has too often resulted in the presumption that what works in one place will work in another. As such, for each of the projects discussed, participants noted the ways solutions might need to be adapted, be it to the distinct governance structures of different Native American tribes, or to different refugee communities (such as those living in protracted refugee situations versus those recently displaced).

²⁴ “Native Energy: Rural Electrification on Tribal Lands,” *RMI Outlet* (blog), Rocky Mountain Institute, June 24, 2014, https://www.rmi.org/news/blog_2014_06_24_native_energy_rural_electrification_on_tribal_lands/.

IV. Conclusions and Project Selection

When participants reconvened in a plenary session, working group chairs reported out on the various project ideas discussed in their respective groups, describing the potential impact on energy access that each might have, whether the project met key criteria, and providing an assessment of the its likelihood of success. Each participant was then asked to identify the two or three projects that they thought were especially promising and which they thought CWP should develop further. The four projects listed below received the most support, with the first proposal gaining virtually universal support.

Project #1 – Using Data to Expand Energy Access

The first idea pulls together into one project a series of ways in which data might be gathered and analyzed to drive more effective, sustainable decisions relevant to expanding energy access by partners on the ground. The concept would involve collecting key information in partnership with local institutions – including governments, the private sector, and NGOs – and constructing a data platform that scholars and practitioners could use to inform decisions that would expand access to energy.

During the final plenary discussion of the Forum, three proposals were surfaced where data analysis could significantly impact efforts to expand energy access:

1. The Infrastructure and the Finance working groups’ overlapping proposal for collecting and analyzing data in an effort to help governments and utilities make more financially sustainable decisions regarding the expansion of the national grid and the development of off-grid systems. Using PAYG and other technologies, the project would capture data regarding the location, use, and payment history of targeted populations, which could then be analyzed to decide where and how to grow the country’s grid and off-grid systems in a commercially viable way, perhaps focusing on Nigeria initially;²⁵
2. The Finance working group’s proposal overlaps with the first proposal, but is focused on lowering the risk of investment in local enterprises. In brief, data would be aggregated and models developed to more effectively analyze the ability and willingness of households to pay for energy access, including possibly building a risk matrix for potential investors, with the purpose of identifying commercially viable opportunities for local companies and organizations that are working to expand access, with an initial focus on Uganda in partnership with the UN Capital Development Fund; and
3. The Efficiency working group’s proposal to evaluate and guide the development and deployment of additional quality standards and testing for products that are used with off-grid solar systems, with the objective of fostering a more sustainable market for off-grid energy systems and their products. The project would initially focus on gathering and evaluating data – and lessons learned – from the deployment of quality-assured lighting

²⁵ While the Infrastructure and Finance working groups did not discuss the types of off-grid systems that should be looked at in the context of this project, one participant noted that both off-grid electrical and cooking fuel systems should be considered.

products, which could then be applied in the context of quality standards and testing for other appliances that are used with off-grid solar systems.

While the creation of a data platform received nearly universal support, participants identified a number of challenges, such as obtaining quality data, presenting the data appropriately, and making it broadly available. For example, it was noted that obtaining accurate data – with sufficient information regarding its provenance to establish credibility – is extremely challenging and important given the overall lack of reliable data in this area, particularly where it is needed most to drive decisions. Additionally, many individuals and entities may be unwilling to share key data sets, while others who may be more inclined to share such information with a university for purposes of expanding energy access could be concerned about the public disclosure of such information. Several participants noted the importance of establishing guidelines for the platform and a governing council that might help to bring together the right data sets and deal with issues regarding these challenges, as well as others that arise. Furthermore, while the three proposals identified above might be an initial focus of such a platform, these were not the only data-focused proposals surfaced in the discussion, and still other ideas for how to use the data to drive decisions intended to expand access might develop over time.

Project #2 – Advancing Clean Cooking in Ghana: 50 Percent by 2020

The second idea that received a majority of participants' support came from the Targeted Interventions working group and was related to clean cooking. Ghana has committed to giving 50 percent of their households access to clean cooking fuels by 2020, but the consensus view of experts on the matter is that – in spite of genuine efforts – Ghana is not on pace to meet this target. Nevertheless, there is genuine political will to achieve this goal, and an openness on the part of the government to working with outside partners. The project discussed would build on existing collaborations with the Ghanaian Ministries of Health and Energy and the University of Ghana, public and private sector partners, and philanthropies to accelerate progress on Ghana's goal, with a focus on encouraging the adoption of clean cooking by entire communities, rather than individual households. The aim of focusing on community-wide adoption is two-fold: first, to prevent the cross-contamination (and potentially negative health effects) of the households that adopt clean cooking fuels by neighboring households that rely on smoky fuels and inefficient stoves; and second, to identify community-wide levers and incentives to promote the adoption of clean cooking to complement those targeting individual households. This project would bring together new and diverse academic and practitioner expertise from inside and outside of Ghana to identify the obstacles to the adoption of clean cooking, and then evaluate and optimize – based on field research – a comprehensive set of interventions to overcome these obstacles (as opposed to an overly narrow approach focused on technological or financial fixes). If successful in Ghana, this approach might be applied elsewhere.

Project #3 – Offsetting Carbon Emissions through Renewable Energy Projects: A Framework for the Paris Agreement

The third idea that received significant support came from the Renewables working group and is focused on finding ways to facilitate the financing of energy access projects through offset mechanisms that are emerging from agreements such as the Paris Climate Agreement and the

Carbon Offsetting and Reduction Scheme for International Aviation, which allow countries or companies to satisfy their commitments to reduce greenhouse gas emissions by paying for emission-reducing projects in other countries, companies, or sectors. These emerging offset mechanisms create tremendous opportunities to furnish financing and thus the proposal was to, among other things, identify energy access ventures that have the potential to produce significant carbon credits, devise monitoring and accounting protocols to quantify the added emissions reductions that would be achieved by such ventures, and find ways to bundle and create a streamlined process for approving them, so that developing countries can participate in the carbon offset programs while keeping transaction costs at a minimum.²⁶

Project #4 – Reducing Maternal and Neonatal Mortality through Solar Suitcase Compatible Medical Devices

The fourth idea that received significant support came from the Efficiency working group and proposes developing a suite of high-efficiency medical devices that could be run from a Solar Suitcase made by We Care Solar (or other small-scale off-grid power systems), which has been distributed to a substantial number of health clinics in Africa that do not have reliable access to electricity. Specifically, the devices will need to be designed to require less power to operate and to run on direct, rather than alternating, current. A recent study of 11 major sub-Saharan African countries found that approximately one in four health facilities had no access to electricity, and only one in three hospitals had reliable electricity access.²⁷ This dearth of electricity is a major cause of maternal and neonatal mortality. Of the more than 300,000 women and girls who die each year from complications of pregnancy and childbirth, two-thirds of them are in sub-Saharan Africa. And for every maternal death, approximately 20 other women and girls suffer serious injuries, infections, or disabilities.²⁸ Meanwhile, of the ten countries with the highest rates of neonatal mortality, eight are in sub-Saharan Africa.²⁹ This is in a world where, every year, 2.6 million babies die before turning one month old, and another 2.6 million are stillborn.³⁰ The overarching aim of the proposed project would be to close the gap in access to life-saving medical technologies in sub-Saharan Africa, first by conducting research with health practitioners to determine the devices that, if developed, could have the greatest impact on saving lives and ameliorating suffering, and then working with engineers and public health experts to design them for use with We Care Solar’s suitcases.

It is worth noting that there are other efforts outside of CWP to explore some of the ideas surfaced during the course of the Forum that were not ultimately among the four supported for

²⁶ While not discussed in the Renewables working group, one participant suggested that it might be worth exploring engagement with private carbon-credit markets as well as the Paris Sustainable Development Mechanism in the context of this project.

²⁷ “Energy Access and Resilience,” World Health Organization, last accessed May 7, 2018, <http://www.who.int/sustainable-development/health-sector/health-risks/energy-access/en/>.

²⁸ “Maternal Mortality Fell by Almost Half Between 1990 and 2015,” UNICEF, last updated January 2018, <https://data.unicef.org/topic/maternal-health/maternal-mortality/#>.

²⁹ *Every Child Alive: The Urgent Need to End Newborn Deaths*, UNICEF, February 2018, https://www.unicef.org/publications/index_102640.html.

³⁰ Ibid.

further development as possible CWP projects. These include the project discussed in the Targeted Interventions working group on expanding access to energy and connectivity for refugees, and work on an integrated planning strategy proposed by The Nature Conservancy.

V. Next Steps: Project Development and Implementation

For the four projects that earned the most support from Forum participants, CWP will work with the project leads inside and outside of Columbia to develop a formal project proposal, which will include a basic description of the project, the objectives, the individuals and institutions that would be involved, a general sense of how long it is likely to take, and the amount of money it would cost. These proposals will also need to take into account the critical feedback raised in the Forum's working groups and plenary discussion. In May 2018, these proposals will be presented to the CWP Advisory Committee, which will review the respective projects and advise on whether they merit further development as CWP projects.

Projects that are determined to merit further development will undergo a rigorous project design phase, during which each project team's leaders will work with CWP staff and outside experts to develop the project's major deliverables, a precise timeline for implementation, a funding plan, a set of performance indicators to be used for project monitoring and evaluation, and both the internal and external team that would take the project forward – all of which will be synthesized in a “project design report.” CWP staff will then prepare an evaluation of the report, which identifies the project's potential impact, risks, strengths and weaknesses, as well as an overall recommendation for whether the project should be funded – and at what level – which will be presented together with the project design report for decision by CWP by the end of 2018.

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Finally, our greatest thanks go to the Forum participants, who are listed below:

Lee C. Bollinger

President, Columbia University

Lee C. Bollinger became Columbia University's nineteenth president in 2002. President Bollinger is Columbia's first Seth Low Professor of the University, a member of the Columbia Law School faculty, and one of the country's foremost First Amendment scholars. As president

of the University of Michigan, Bollinger led the school's historic litigation in *Grutter v. Bollinger* and *Gratz v. Bollinger*. These Supreme Court decisions that upheld and clarified the importance of diversity as a compelling justification for affirmative action in higher education were reaffirmed in the Court's 2016 ruling in *Fisher v. University of Texas*. As Columbia's president, Bollinger conceived and led the University's most ambitious expansion in over a century with the creation of the Manhattanville campus in West Harlem.

Philippe Benoit

Managing Director, Energy, Global Infrastructure Advisory Services 2050; Senior Associate, Center for Strategic and International Studies, Energy and National Security Program
Philippe Benoit is Managing Director, Energy, for Global Infrastructure Advisory Services 2050 and Senior Associate with the Center for Strategic and International Studies' Energy and National Security Program. Benoit previously worked for 20 years at the World Bank, including on access programs across Latin America and the Caribbean and Sub-Saharan Africa. He is currently the lead draftsman (for the Inter-American Development Bank) on the G20 access action plan for the LAC region. Benoit previously worked at the International Energy Agency as Division Head of Energy Environment and Energy Efficiency, and as a Director in SG Investment Bank's energy project finance department. He has a BA from Yale University and a JD from Harvard Law School.

Giulio Boccaletti

Chief Strategy Officer & Global Managing Director, The Nature Conservancy
Giulio Boccaletti, PhD, is the Chief Strategy Officer and Global Managing Director for Water at The Nature Conservancy. As Chief Strategy Officer, Boccaletti works to develop the organization's strategy and apply economic and scientific practice to its conservation agenda. Previously, Boccaletti was a partner at McKinsey & Company, where he founded the firm's Global Water Resource initiative and was a leader of its Sustainability and Resource Productivity Practice. He co-authored the *Charting Our Water Security* report, one of the first to address the question of global water scarcity through multilateral, private-public collaboration defining a cost-curve for investment in water infrastructure. He is a World Economic Forum (WEF) "Young Global Leader," sits on WEF's Global Futures Council, and has served on the OECD-WWC High Level Panel on Infrastructure Financing for a Water-Secure World.

Jason Bordoff

Professor, Professional Practice in International and Public Affairs, Columbia University
Jason Bordoff is a professor of professional practice at Columbia's School of International and Public Affairs and serves as founding Director of Columbia's Center on Global Energy Policy. He joined the Columbia faculty after serving until January 2013 as Special Assistant to the President and Senior Director for Energy and Climate Change on the Staff of the National Security Council, and, prior to that, holding senior policy positions on the White House's National Economic Council and Council on Environmental Quality. Bordoff's research and policy interests lie at the intersection of economics, energy, environment, and national security. Previously, he was the Policy Director of the Hamilton Project at the Brookings Institution, advisor to the Deputy Secretary of the U.S. Treasury Department during the Clinton Administration, and a consultant with McKinsey & Company. Bordoff graduated with honors from Harvard Law School and clerked on the U.S. Court of Appeals for the D.C. Circuit. He also

holds an MLitt degree from Oxford University, where he studied as a Marshall Scholar, and a BA magna cum laude and Phi Beta Kappa from Brown University.

Michael Bruce

Director, Emerson Elemental

Michael Bruce serves as the Director at Emerson Elemental where he is responsible for managing the for-profit investment portfolio dedicated to restoring and strengthening the symbiosis between humanity and nature. Prior to joining Emerson Collective, Bruce served as a Director at Hannon Armstrong Capital, a sustainable infrastructure finance company, where he helped take the company public in 2013 and focused on project finance and new financial products. Previously, Bruce co-founded Manifest Energy, where he developed innovative project models for value-added buildout and optimal deployment of emerging technologies. Bruce was Senior Advisor for Finance under President George W. Bush at the U.S Department of Energy. He started his career with the Credit Suisse Technology Group in Silicon Valley. He holds a BS in Management Sciences and Engineering from Stanford University where he was an NCAA champion swimmer.

Peter Corsell

Managing Partner, Twenty First Century Utilities

Peter L. Corsell is an entrepreneur and investor known for successfully bringing emerging technologies to market. Corsell is Managing Partner of Twenty First Century Utilities, an investment firm dedicated to acquiring and transforming regulated electric utilities. He is responsible for identifying and implementing smart grid and distributed clean energy technologies within the traditional regulated utility model. MIT's Technology Review recognized him as one of the world's top innovators under age 35, the World Economic Forum named him a Young Global Leader, and the National Association of Corporate Directors included him on its inaugural list of leading directors under 40. Earlier in his career, Corsell served in the Central Intelligence Agency and with the U.S. Department of State in Havana, Cuba. He holds a BSFS degree from the Edmund A. Walsh School of Foreign Service at Georgetown University.

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Partner, International Denham Power Fund

Justin DeAngelis is a Partner in the International Denham Power Fund, responsible for origination, analysis, structuring, valuation and execution of investments for the Power Deal Team. He joined Denham Capital in 2007. Previously, DeAngelis was a Director at Waypoint Energy, a Manager at Pace Global Energy and PG&E National Energy Group, and an Engineer at Delmarva Power. He is currently a member of the Board of Directors of Endeavor Energy, GreenWish Partners, and subsidiaries of Rio Energy. Denham has backed the successful development and realization of numerous ground-breaking power projects across the globe. Denham's projects have won numerous awards. DeAngelis is a member of the Advisory Council for NASP-USAID Investment Partnership for mobilizing institutional investors to develop Africa's infrastructure. DeAngelis received a BS in Mechanical Engineering from Drexel University and an MBA from LeBow College of Business at Drexel University.

Morgan DeFoort

Co-founder & Managing Principal, Factor[e] Ventures

Dr. Morgan DeFoort is the co-founder and Managing Principal of Factor[e] Ventures, a venture development firm which supports early stage disruptive technologies in the areas of energy, agriculture, mobility, and waste. DeFoort has a background in technology development and entrepreneurship. Before starting Factor[e], DeFoort was a Co-Director of the Energy Institute at Colorado State University, leading R&D programs in a wide range of technology areas including engine systems, biofuels, and cookstoves. He also serves on the Board of Directors for Factor[e] portfolio companies Odyssey Energy and Homer Energy.

Kiki Del Valle

Senior Vice President, Commerce for Every Device, Mastercard

Kiki Del Valle is senior vice president, Commerce for Every Device at Mastercard. She leads Mastercard's Commerce for Every Device initiatives including developing its Internet of Things (IoT) global strategy enabling payments in a wide array of consumer devices and emerging technology across the automotive, fashion, wearables, smart home, and conversational commerce space while promoting our digital agenda to achieve scale via device manufacturers, digital vendors, and telcos. In her current role, Del Valle was recognized in Bank Innovation's 2017 Innovators to Watch. Prior to joining MasterCard in 2008, she was Senior Manager at The Home Depot in Financial Services. Del Valle holds a BBA and MBA from Goizueta's Business School at Emory University in Atlanta, GA.

Johanna Diecker

Policy Director, Global Off-Grid Lighting Association (GOGLA)

As GOGLA's Policy Director, Johanna Diecker drives the continuous development and improvement of policy & advocacy strategies. This includes the management of GOGLA's work on enabling environment, standards and guidelines, and the association's regional representation. Diecker joined GOGLA as its first employee in 2013 as operations and project manager. Between 2015 and 2017 she was in charge of the enabling environment program, aiming to establish a conducive policy environment catalyzing market development for GOGLA members. Previously, Diecker worked for the German Corporation for International Cooperation GmbH, or GIZ, where she was actively involved in the provision of advisory services to the German Federal Ministry for Economic Development and Cooperation regarding ICT4D. She holds Bachelor's degrees in Development Studies and Political Science, as well as a Master's degree in Political Science from the University of Vienna.

Christine Egan

Executive Director & CEO, Center for Law and Social Policy (CLASP)

Christine Egan is the Executive Director & CEO of CLASP, an organization dedicated to energy efficiency in our appliances both on- and off-grid. Over 15 years of leadership, Egan has grown CLASP from a small program to a well-respected international non-profit organization with offices and teams around the world. Egan is an expert in consumer energy behavior and energy efficiency label design. Under her guiding vision, CLASP has served at the epicenter of collaborative and ambitious efforts to mitigate climate change and the global movement for clean energy access. Prior to leading CLASP, Egan worked at the American Council for an Energy

Efficient Economy and the Consortium for Energy Efficiency. She holds degrees from the University of Delaware and the George Washington University.

Jonathan Elkind

Fellow & Senior Research Scholar, Center on Global Energy Policy, Columbia University

Jon Elkind is a Fellow and Senior Research Scholar at the Center on Global Energy Policy at Columbia University. From 2009 to 2014, Elkind worked on international energy and climate issues at the U.S. Department of Energy (DOE), serving ultimately as Assistant Secretary for International Affairs. Before DOE, he created and led Eastlink Consulting, LLC focusing on commercial energy projects in Europe and Eurasia, and also as a non-resident senior fellow at the Brookings Institution. Earlier in his career, Elkind focused on energy, environment and economic issues in Europe and Eurasia in positions at the Joint Global Change Research Institute, the National Security Council, the Office of the Vice President of the United States, DOE, and the Council on Environmental Quality. Elkind holds an MBA from the R.H. Smith School of Business at the University of Maryland, an MA from Columbia University, and a BA from the University of Michigan, Ann Arbor.

Alex Evans

President & Chairman of the Operating Committee, Global LPG Partnership

Alex Evans is the President and the Chairman of the Operating Committee of the Global LPG Partnership, a PPP among governments, UN agencies, NGOs, investors, research institutions, and leading LPG companies launched in 2012 that helps countries rapidly expand use of clean, modern energy. Evans is also President and COO of Energy Transportation Group, a multinational energy and logistics company focused on developing-country markets. He serves on the World LPG Association's (WLPGA) Industry Council and the International Chamber of Commerce G20 CEO Advisory Group Steering Committee, which creates and delivers private-sector policy recommendations to G20 leaders. He co-authored the WLPGA book series *Guidelines for the Development of Sustainable LPG Markets*. He holds a BSEE from Yale University and an MBA from Harvard University.

Karina Garbesi

Director, Environmental Studies Program, California State University, East Bay

Karina Garbesi is the Director of the Environmental Studies Program at Cal State East Bay, where she is the Vice Chair of the Academic Senate, Chair of the Senate Sustainability Committee, and Chair of the Climate Action Taskforce. Garbesi is also a founding member of the Board of Directors of We Care Solar, a Bay Area Non-profit which, in 2015, won the UN's Sustainable Development Award. Her work has focused on issues at the nexus of energy, sustainability, and social justice. She has served on the faculty of San Jose State University and Cal State East Bay, as affiliated faculty at the University of California, Berkeley, as an independent consultant, and as a visiting scientist and program manager at Lawrence Berkeley National Laboratory. Garbesi founded and co-leads Cal State East Bay's Social Impact Solar Program, a hands-on solar-education and social justice educational initiative, now replicated at five CSU campuses. She holds a Master's and PhD in Energy and Resources from UC Berkeley.

Peter George

Director for Enterprise Development and Investment, Global Alliance for Clean Cookstoves

Peter George leads private sector engagement at the Global Alliance for Clean Cookstoves as its Director for Enterprise Development and Investment. An investment professional specialized in the energy sector, George has held a number of positions investing in and advising energy businesses. Prior to joining the Alliance, he created and led a business advisory team at Energy4Impact (E4I) (formerly GVEP International), a donor-funded strategy consultant and investment advisor focused on distributed energy access services including mini-grids, PAYG solar systems, and clean cooking solutions. He also led the development of Prometheus, an East African energy access-focused impact fund in partnership with a Swiss fund manager. Prior to E4I, George worked at private equity firm ArcLight Capital Partners and in investment banking at Merrill Lynch. He earned his BBA from Southern Methodist University in Dallas, Texas. George is based in Amsterdam.

Michael Gerrard

Andrew Sabin Professor of Professional Practice, Columbia Law School

Michael B. Gerrard is Andrew Sabin Professor of Professional Practice at Columbia Law School, where he teaches courses on environmental and energy law and directs the Sabin Center for Climate Change Law. Gerrard is also Chair of the Faculty of Columbia's Earth Institute. Before joining the Columbia faculty in January 2009, he was partner in charge of the 110-lawyer New York office of Arnold & Porter; he is now Senior Counsel to the firm. He practiced environmental law in New York City full time from 1979 to 2008. He formerly chaired the American Bar Association's 10,000-member Section of Environment, Energy and Resources. He has served as a member of the executive committees of the boards of the Environmental Law Institute and the American College of Environmental Lawyers. Gerrard is author or editor of thirteen books, two of which were named Best Law Book of the Year by the Association of American Publishers. His most recent book is *Climate Engineering and the Law: Governance and Liability for Solar Radiation Management and Carbon Dioxide Removal*.

Avril Haines

Senior Research Scholar, Columbia University

Avril D. Haines is currently a Senior Research Scholar at Columbia University and a Lecturer in Law at Columbia University Law School. Haines served as Deputy National Security Advisor to President Obama, was the Deputy Director of the Central Intelligence Agency, and served as the Legal Adviser to the National Security Council. Before joining the NSC, she led the Treaty office at the Department of State, was the Deputy Chief Counsel for the United States Senate Committee on Foreign Relations, worked for The Hague Conference on Private International Law, and served as a law clerk for Judge Danny Boggs on the U.S. Court of Appeals for the Sixth Circuit. Haines received a Bachelor's degree in Physics from the University of Chicago, a law degree from Georgetown University Law Center, and founded and ran a bookstore café for five years while engaged in community service in Baltimore.

Andy Herscowitz

Coordinator, Power Africa, U.S. Agency for International Development

Andrew M. Herscowitz has been the Power Africa Coordinator since 2013. Prior to this appointment, he served as USAID's Mission Director in Ecuador from 2011 to 2013, and as Deputy Mission Director in Peru from 2009 to 2011. He is a Minister Counselor in the U.S. Foreign Service. In 2008, Herscowitz served as USAID's Supervisory Regional Legal Adviser

for Colombia, Ecuador, and Peru. From 2002 to 2007, he was Regional Legal Adviser for the Caribbean. Since joining USAID in 2001, Herscowitz has served as the lawyer for USAID's Office of Development Credit and was a designer of the original framework for the Global Fund to Fight AIDS, Tuberculosis and Malaria. Following graduation from Georgetown's School of Foreign Service, Herscowitz spent a year as a Georgetown volunteer in Nicaragua. After earning a law degree from the Georgetown University Law Center, he worked for the law firms Piper & Marbury (now DLA Piper) and Brobeck, Phleger & Harrison in Washington, D.C. In 2005, the Federal Bar Association recognized Herscowitz as one of the five most outstanding lawyers under the age of 35 in the U.S. Government.

Darby Jack

Assistant Professor, Environmental Health Sciences, Columbia University

Darby Jack, PhD, studies environmental health risks in developing countries, the health impacts of climate change, and the role of the urban environment in shaping health. Jack is in the Department of Environmental Health Sciences at Columbia University's Mailman School of Public Health. Since 2007, his primary focus has been the health effects of exposure to indoor air pollution from biomass fuels. With support from the Center for Environmental Health in Northern Manhattan, he has helped to develop a Columbia-wide biomass working group, which coordinates and supports interdisciplinary research on the topic. These collaborations have given rise to current NIH-funded efforts to measure the health benefits of clean cookstoves in Ghana and Ecuador. In New York, he is collaborating with exposure scientists to estimate the effects of air pollution exposures on people who commute by bicycle. Jack received a BA in Economics and Biology from Williams College and a PhD in Public Policy from Harvard University.

Judith Karl

Executive Secretary, UN Capital Development Fund

Judith Karl is the Executive Secretary of the UN Capital Development Fund. Karl started her career in the private sector as a Management Consultant with a focus on optimizing business operations in the US private banking and real estate sectors. Karl moved to UNDP in 1988, starting as a management support officer in the Personnel division in New York. She has occupied management positions in UNDP Mali and Cambodia where she led programs in local development finance, decentralization, small and medium enterprise development, demining, and crisis response. Karl served for six years as the head of strategy and policy for UNDP's Crisis prevention and recovery, was the Deputy Director in UNDP's Washington Liaison office, and served five years as head of UNDP's operational performance group. She joined UNCDF as Executive Secretary in August 2014.

Emily Kirsch

Founder & CEO, Powerhouse

As Founder & CEO of Powerhouse, a seed fund and incubator that supports "intelligent energy" entrepreneurs building software-enabled technology for the clean energy industry, Emily Kirsch has emerged as a leader in the clean energy and entrepreneurial community. At Powerhouse, Kirsch builds strategic connections between venture capital, corporate leaders, and entrepreneurs to drive innovation. Previously, she worked as the Lead Organizer at the Ella Baker Center, where she founded and led the Climate Action Coalition which drafted and secured passage of the most ambitious Energy and Climate Action Plan of any city in the nation. She designed and

launched the Green Jobs Corps with Ella Baker Center Founder and former Jobs Advisor to President Obama, Van Jones. Kirsch serves on the Board of PV Complete and is on the Advisory Board of the USF's MS in Energy Systems Management. She is the winner of 2017 Entrepreneurship Award from C3E, a partnership between the U.S. Department of Energy, Stanford and MIT. Kirsch has guest lectured at UC Berkeley and Stanford.

Satish Kumar

President & Executive Director, Alliance for an Energy Efficient Economy (AEEE)

Dr. Satish Kumar is the President and Executive Director of the Alliance for an Energy Efficient Economy, India's premier energy efficiency organization. Kumar was the convener of INSPIRE 2017 – the largest energy efficiency conference organized in India and has led major initiatives in sustainable cooling and thermal comfort for all, and ESCO market transformation. Under his leadership, AEEE has served as a senior energy efficiency advisor to numerous ministries and bureaus within the Government of India. Prior to AEEE, he was the Vice President and Energy Efficiency Ambassador at Schneider Electric India Pvt. Ltd. and a scientist at Lawrence Berkeley National Laboratory. He has a Bachelor of Architecture from IIT Roorkee and a PhD in Building Science from Carnegie Mellon University.

Nick Lemann

Director, Columbia World Projects; Joseph Pulitzer II and Edith Pulitzer Moore Professor of Journalism; Dean Emeritus of the Faculty of Journalism

Nicholas Lemann directs Columbia World Projects, a new initiative to connect academic work with entities beyond the academy that possess the power and influence to transform research into concrete consequences benefiting humanity. Lemann also directs Columbia Global Reports, a book publishing venture that presents reporting around the globe on a wide range of political, financial, scientific, and cultural topics. Lemann is Dean Emeritus and Pulitzer Moore Professor of Journalism at Columbia. During his deanship, the Journalism School completed its first capital fundraising campaign, started its first new professional degree program since the 1930s, and launched significant initiatives in investigative reporting, digital journalism, and executive leadership for news organizations. Board memberships include Columbia's Knight First Amendment Institute and the Russell Sage Foundation. Lemann is a member of the New York Institute for the Humanities and the American Academy of Arts and Sciences, and a staff writer for *The New Yorker*.

Ben Leo

CEO & Co-Founder, Fraym

Ben Leo is CEO and Co-Founder of Fraym, a geospatial data analytics company focused on the African continent. Fraym is the leading source of hyper-local social, economic, and security data on African population. Leo also is a Visiting Fellow at the Center for Global Development. He has conducted extensive applied research on African statistical systems, energy access and demand, data acquisition methods, and African financing issues. His work has been cited in numerous major media outlets. Previously Leo served as Global Policy Director at the ONE Campaign. In 2011, he worked for the African Union as a facilitator and technical expert in the secession negotiations between Sudan and South Sudan. Leo has worked at the White House as the Director for African Affairs, advising the President and national security advisor on central,

eastern, and southern Africa and economic issues. Additionally, he helped design and implement several development initiatives at the U.S. Treasury.

John MacWilliams

Fellow, Center on Global Energy Policy, Columbia University

John J. MacWilliams is a Fellow at the Center on Global Energy Policy at Columbia University. Prior to joining CGEP, MacWilliams served as Associate Deputy Secretary of the U.S. Department of Energy after being appointed in August 2015. He also served as DOE's Chief Risk Officer and before that as a Senior Advisor to the Secretary. Prior to DOE, MacWilliams was a partner of Tremont Energy Partners, LLC, a private investment firm based in Cambridge, Massachusetts. Prior to Tremont, he was Vice Chairman, Investment Banking, at JP Morgan Chase, a Partner of JP Morgan Partners, and a founding partner of The Beacon Group, LLC, a private investment firm located in New York acquired by JPMorgan Chase in 2000. He was also Partner and Co-Head of the Beacon Group Energy Investment Funds. Prior to the formation of The Beacon Group, MacWilliams was with Goldman Sachs & Co. and an attorney at Davis Polk & Wardwell. MacWilliams holds a BA from Stanford, an MS from MIT, and a JD from Harvard Law School.

Vijay Modi

Professor of Mechanical Engineering, Columbia University; Affiliate, Earth Institute and Data Science Institute; Director, Sustainable Engineering Laboratory

Vijay Modi's areas of expertise are energy resources/access, energy planning for access and renewable integration, demand estimation and role of novel payment systems in breaking barriers to upfront costs. His laboratory, the Quadracci Sustainable Engineering Lab (QSEL), has been responsible for innovations such as a low-cost lead-acid charge/discharge circuit for solar lanterns (2005), fully digital pay-as-you-go minigrids that have been continuously operating as pilots since 2011, battery-less PAYG smallholder irrigation systems (2013-15) and widely used tools such as "Network Planner" for making technology choices under demographic, demand and geographic variations. His recent work has been on energy infrastructure design and planning; solar energy; energy efficiency in agriculture, and data analytics spanning from urban settings to remote rural settings. He is currently working to understand how energy services can be more accessible, more efficient and cleaner and examining minigrids in the context of energy efficiency.

Hon. Ernest J. Moniz

Former United States Secretary of Energy (2013-2017)

Ernest J. Moniz served as the thirteenth United States Secretary of Energy from 2013 to January 2017. As Secretary, he advanced energy technology innovation, nuclear security and strategic stability, cutting-edge capabilities for the American scientific research community, and environmental stewardship. Dr. Moniz joined the Massachusetts Institute of Technology faculty in 1973 and was Founding Director of the MIT Energy Initiative. He is the Cecil and Ida Green Professor of Physics and Engineering Systems emeritus and Special Advisor to the MIT President. Dr. Moniz is co-chairman of the Board of Directors and CEO of the Nuclear Threat Initiative. He served on boards of numerous companies, non-profits and government agencies in the energy and security arenas. Dr. Moniz received a BS summa cum laude in physics from Boston College, a doctorate in theoretical physics from Stanford University, and eight honorary

doctorates. He received the Distinguished Public Service Medal of the Department of Defense, the Grand Cross of the Order of Makarios III (Cyprus) and of the Order of Prince Henry the Navigator (Portugal), and the Grand Cordon of the Order of the Rising Sun (Japan).

Ellen Morris

Adjunct Professor of International and Public Affairs, Columbia University

Ellen Morris, PhD, is a world-recognized expert on energy and international development, with a particular focus on policy analysis, research, and strategy development on energy access, gender equality, and enterprise development throughout Africa, Asia, and Latin America. Dr. Morris teaches at Columbia University's School of International and Public Affairs and is a Faculty Affiliate at the Center on Global Energy Policy. Dr. Morris is an Ambassador for The Clean Energy Education and Empowerment Initiative that was launched by the Clean Energy Ministerial to close the gender gap in STEM fields. In addition to her faculty appointment, she is the President and Founder of Sustainable Energy Solutions, an international consulting services company that promotes the increased use and deployment of clean energy technologies as a means to support economic development and reduce poverty in developing countries. She holds a BS in geophysical engineering from the Colorado School of Mines and a doctoral degree in marine geophysics from the University of Rhode Island.

Arvind Panagariya

Professor of Economics & the Jagdish Bhagwati Professor of Indian Political Economy in the School of International and Public Affairs, Columbia University

Arvind Panagariya holds a PhD from Princeton University and is currently a Professor of Economics and the Jagdish Bhagwati Professor of Indian Political Economy in the School of International and Public Affairs at Columbia University. In the past, he has been the Chief Economist of the Asian Development Bank. Panagariya has authored more than a fifteen books. His book, *Why Growth Matters*, with Jagdish Bhagwati, has been described by *The Economist* as "a manifesto for policymakers and analysts." Professor Panagariya's scientific papers have appeared in top economics journals such as the *American Economic Review* and the *Quarterly Journal of Economics* while his policy papers have appeared in *Foreign Affairs* and *Foreign Policy*. He writes a monthly column in the *Times of India* and his guest columns have appeared in the *Financial Times*, *Wall Street Journal* and *India Today*. The President of India recently honored Panagariya with the Padma Bhushan award.

Brad Plumer

Reporter, The New York Times

Brad Plumer is a reporter covering climate change, energy policy and other environmental issues for the climate team of *The New York Times*. He was previously a reporter at *The Washington Post* covering climate and energy policy.

Kenneth Prewitt

Carnegie Professor of Public Affairs, Columbia University; Special Advisor to the President

Kenneth Prewitt is the Carnegie Professor of Public Affairs at Columbia University. He taught Political Science at the University of Chicago from 1965–1982, and was on the faculty of Stanford, Washington University, the University of Nairobi, Makerere University and the New School University (where he was also Dean of Graduate Faculty). Prewitt's professional career

also includes: Director of the United States Census Bureau, Director of the National Opinion Research Center, President of the Social Science Research Council, and Senior Vice President of the Rockefeller Foundation. Among his awards are a Guggenheim Fellowship, honorary degrees from Carnegie Mellon and Southern Methodist University, a Distinguished Service Award from the New School for Social Research, the Officer's Cross of the Order of Merit from the Federal Republic of Germany, the Charles E. Merriam Lifetime Career Award, American Political Science Association and a Lifetime National Associate of the NRC/NAS.

Jim Rogers

Former CEO, Duke Energy

Jim Rogers, lawyer, CEO, and author. He was most recently CEO at Duke Energy and served as CEO for almost 25 years in the electric utility industry. Rogers did a series of mergers and acquisitions culminating in the creation of Duke Energy, the largest electric utility in the US. He also owned and/or operated assets in 17 countries in Africa, South Asia, Europe, and Central and Latin America. In the 1980s he operated one of the largest gas pipeline companies in the U.S. He has served on the boards of eight Fortune 500 companies. He currently is a senior partner at Stonepeak Infrastructure Partners and is a visiting professor of the practice at Duke University. He also serves on the boards of Cigna, Center on Global Energy Policy at Columbia University, Invenegy, The Aspen Institute, Brookings Institution, The Nature Conservancy, Bloomberg New Energy Finance, among others. In 2015, he authored *Lighting the World: Transforming Our Energy Future by Bringing Electricity to Everyone*. He is a co-founder of the Global Brightlight Foundation. In 2009, *Newsweek* named him one of “The 50 Most Powerful People in the World.”

David Sandalow

Inaugural Fellow, Center on Global Energy Policy, Columbia University; Co-Director of the Energy and Environment Concentration at the School of International and Public Affairs

David Sandalow is the Inaugural Fellow at the Center on Global Energy Policy and co-Director of the Energy and Environment Concentration at the School of International and Public Affairs at Columbia University. He launched and directs the Center’s U.S.-China Program and has written, most recently, on energy diplomacy and energy finance. Sandalow has served in senior positions at the White House, State Department, and U.S. Department of Energy. At the Department of Energy, he served as Under Secretary of Energy (acting) and Assistant Secretary for Policy and International Affairs. Prior to serving at DOE, Sandalow was a Senior Fellow at the Brookings Institution, as well as Energy and Climate Change Working Group Chair at the Clinton Global Initiative. He has served as Assistant Secretary of State for Oceans, Environment and Science and a Senior Director on the National Security Council staff. Sandalow serves on the Board of Directors of ReNew Power, India’s leading renewable energy developer, and as an advisor to a number of companies. He is a graduate of the University of Michigan Law School and Yale College.

Kristina Skierka

CEO, Power for All Campaign

As the CEO of the Power for All campaign, Kristina Skierka has helped create a movement dedicated to achieving universal energy access by 2025. With expertise in both energy and public awareness campaigns, Skierka has led a number of well-known environmental leadership

initiatives in the energy sector for both private companies (Applied Materials' "Bright Futures", Sun Microsystems' "Eco Responsibility," d.light's "Future of Energy") and public organizations (the State of California's Energy Efficiency Strategic Plan, as well as the award-winning Flex Your Power campaign). She was named Energy Foundation's Senior Fellow in 2009 and finalist for the 2015 Clean Energy Ministerial's C3E award.

Richenda Van Leeuwen (participated in the Targeted Intervention working group)

Chair, International Institutions, Global LPG Partnership

Richenda Van Leeuwen is an energy access expert who led Energy Access at the UN Foundation and with the UN Sustainable Energy for All Initiative. She launched the 2,300 member "Energy Access Practitioner Network," focused on off-grid and mini-grid renewable energy solutions. She is now Chair, International Institutions at the Global LPG Partnership, addressing cooking energy access and a member of the World Bank's Energy Program Technical Advisory Group (ESMAP). Van Leeuwen previously worked in emerging markets renewable energy private equity investment and was CEO of an international women's entrepreneurship NGO. She is a board director of SELCO India and Energy 4 Impact, a founding U.S. Women's "Clean Energy Ambassador" (Clean Energy Ministerial C3E initiative) and an advisor to many leading and emerging off-grid companies and social enterprises.