

ENERGY AND INTERNATIONAL DEVELOPMENT

HEARING

BEFORE THE

SUBCOMMITTEE ON MULTILATERAL
INTERNATIONAL DEVELOPMENT,
MULTILATERAL INSTITUTIONS, AND
INTERNATIONAL ECONOMIC, ENERGY,
AND ENVIRONMENTAL POLICY

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WEDNESDAY, NOVEMBER 1, 2017

U.S. SENATE,
SUBCOMMITTEE ON MULTILATERAL INTERNATIONAL
DEVELOPMENT, MULTILATERAL INSTITUTIONS, AND
INTERNATIONAL ECONOMIC, ENERGY, AND
ENVIRONMENTAL POLICY,
COMMITTEE ON FOREIGN RELATIONS,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:35 p.m. in Room SD-419, Dirksen Senate Office Building, Hon. Todd Young, chairman of the subcommittee, presiding.

Present: Senators Young [presiding], Barrasso, and Merkley.

OPENING STATEMENT OF HON. TODD YOUNG, U.S. SENATOR FROM INDIANA

Senator YOUNG. Good afternoon. This meeting of the Senate Foreign Relations Subcommittee on Multilateral International Development, Multilateral Institutions, and International Economic, Energy, and Environmental Policy will come to order.

The purpose of today's meeting is to receive testimony related to energy and international development. Today's meeting will be divided into two panels.

The first panel consists of Ms. Rachel Kyte, Special Representative of the United Nations Secretary-General for Sustainable Energy for All and Chief Executive Officer of Sustainable Energy for All. Ms. Kyte is appearing voluntarily today as a courtesy to brief the committee, and we are honored to have you here today, Ms. Kyte.

Following this panel, we will convene a second panel with three witnesses. They include Dr. Todd Moss. He is Senior Fellow at the Center for Global Development at Rice University's Baker Institute. And Mr. Joao Talocchi. No, I did not practice that beforehand. He is Program Director at the Purpose Climate Lab. And finally, I would like to welcome a fellow Hoosier, Mr. Paul Mitchell. Paul is the President and Chief Executive Officer of the Energy Systems Network based in the great City of Indianapolis, Indiana.

On behalf of the subcommittee, I welcome each of you.

As I said, the purpose of today's meeting is to discuss the intersection between energy and international development. But before we begin, I would like to offer a few observations to frame that discussion.

Earlier this year, I co-chaired a bipartisan Center for Strategic and International Studies task force. The topic of that task force was reforming and reorganizing U.S. foreign assistance, focusing on increasing the efficiency and effectiveness of U.S. development efforts overseas.

Now, my starting point for that task force and my starting point for today's hearing is that U.S. international development is not an end in and of itself. Development, rather, is a tool or a means to do good while promoting America's security and economic interests. Our country has seen that poverty, instability, and governance vacuums often create opportunities for our enemies. They generate threats to Americans and compel more costly military interventions later, more costly in terms of lives and treasure.

Benjamin Franklin is often quoted as saying that an ounce of prevention is worth a pound of cure. That is why I have been and will continue to be a strong supporter of U.S. international development efforts.

But that does not mean we should reflexively accept all U.S. international development programs as they currently exist. On the contrary, Congress must constantly scrutinize and reassess U.S. international development programs, asking tough questions on behalf of the taxpayers' international interests. We must ensure these programs are optimally designed and implemented.

Now, when I ask some of these questions and survey U.S. international development programs, a few key points emerge. Let me quickly highlight just three of them.

First, it is difficult to overstate the importance of energy in international development. It was Dr. Moss who stated in his prepared testimony, "mass electrification can be catalytic for reducing poverty and deprivation while generating growth and prosperity. It can also generate revenue for governments in the developing world, enabling them to address challenges within their borders more effectively with less foreign assistance. After all, we should seek to transition and enable recipients of U.S. foreign assistance, not perpetuate dependence."

Second, there have to be significant changes in the energy sector in the developing world that must guide our efforts. In addition to the fracking revolution and the increasing importance of natural gas, we also see many exciting innovations related to alternative energy and public-private partnerships. U.S. international development efforts should reflect and harness these developments.

That is one of the reasons why I am so excited to have Paul Mitchell here from Indiana's Energy Systems Network. The Federal Government and our international partners can benefit from some of the cutting-edge development that Indiana's Energy Systems Network has achieved. They have already done much internationally, and I am confident they can do more.

We also see there is enormous projected population growth in Africa, and we must help our partners there create jobs. As Dr. Moss states in his prepared testimony, "power is absolutely essential to creating the tens of millions of new jobs that Africa needs every year." He continues, "there is no scenario where Africa is stable and thriving without a rapid expansion of the power sector." I agree.

Finally, as I have researched this issue, I have been impressed, once again, with the goodness and generosity of the American people. We see many American companies, individuals, and cooperatives doing good abroad when it comes to energy and international development.

I would cite as an example Indiana Electric Cooperatives. They have a project known as Project Indiana. And as part of this effort, according to IEC, dozens of Hoosiers have traveled repeatedly to Guatemala at their own expense to install 61 miles of electric lines there in five villages. All 38 electric distribution cooperatives, and the two generation and transmission cooperatives, in my home State of Indiana have been involved in this impressive effort. More than 3,100 Guatemalans now have power for the first time as a result of these efforts. Churches, schools, and a health clinic now have power, improving the lives of Guatemalans and generating durable goodwill for the United States. This is just one example of Americans at their best.

With those observations in mind, I would now like to turn to Ranking Member Merkley for his opening statement. Senator Merkley?

**STATEMENT OF HON. JEFF MERKLEY,
U.S. SENATOR FROM OREGON**

Senator MERKLEY. Thank you very much, Mr. Chairman, and I sure appreciate our experts coming to share their insights with us today.

As those who are focused on international development know, many people around the world lack access to electricity and clean and reliable sources of fuel for cooking, for home heating, and for transportation. It is now 2017. We think of ourselves in a very modern era. And yet, one out of six individuals around the globe does not have access to electricity. 600 million of these individuals live in sub-Saharan Africa, another 300 million in India.

Access to clean and renewable energy in developing countries can provide affordable and reliable energy but also significantly impact local poverty and provide public health benefits.

As a result of technological innovation, we have seen the price of solar and wind energy drop dramatically, as has the cost of battery storage. This means that communities that lack access to electricity now have an affordable option to gain access by building micro-grids—smaller, self-contained grids that can meet the needs of the isolated community more quickly and affordably than waiting for an electric utility to make significant investments to expand the electric grid to the community. Decentralized grids powered by local renewable energy sources usually have far lower initial capital investment requirements. Not only that, but economically few things bring greater opportunities for impoverished communities to develop small business and other economic activity than providing electricity access.

For developing countries without universal or widespread access to reliable energy and electric grids, there are opportunities to bring these communities into the 21st century with more resilient, more economically viable, cleaner energy sources. Electricity can provide lights for schools and homes. It can power machines for

small businesses. It is a linchpin for participating in the modern economy. Electricity can also provide the opportunity for micro-enterprises that I have seen both in India, and in Africa, for example, when an individual has a small solar panel that charges a battery, and then they use that to charge cell phones for others, creating such a small business.

But electricity is not the whole story. There are twice as many individuals, as compared to those who lack electricity, who lack access to clean fuel for cooking food, and instead use wood or charcoal for cooking even when cooking indoors. These fuels can cause enormous indoor air pollution, causing an estimated 4 million premature deaths annually and contributing to a wide range of illnesses, including pneumonia, low birth weight in children, lung cancer, blindness, and heart disease. Women and children often bear a disproportionate share of these health impacts because it is common in many countries that they spend more hours indoors.

The good news is that there are clean and affordable fuel options for cooking as well, and I hope we will hear more about that today.

There are clear benefits to billions of people around the world to getting access to clean, affordable, sustainable sources of energy. But we should keep in mind that this transformation has significant benefits for us here at home. America is safer when we are able to make progress in addressing the root poverty issues that increase the possibility of radicalization and extremism. Bringing new sources of energy to underserved communities can also reduce conflicts among countries or ethnic groups fighting over limited resources. Investment in energy development, which has such immediate impacts on people's lives, promotes trust and good faith between developing communities and the broader international community.

And on the jobs front, as I believe our witnesses will attest today, our investment in bringing renewable, sustainable energy to developing communities is a win-win, creating new job opportunities in the countries where we are working to provide access while providing markets for U.S.-based businesses that produce technology to support sustainable energy solutions.

I really am looking forward to the testimony today. Sustainable energy access is transforming development in many parts of the world, and we need to understand it, promote it, and benefit from it here at home in terms of security as well. Thank you.

Senator YOUNG. Well, I thank our ranking member.

And, Ms. Kyte, once again thank you for appearing before the subcommittee. Your full written statement will be included in the record, and I welcome you to summarize your written statement in about 5 minutes, please.

**STATEMENT OF RACHEL KYTE, CHIEF EXECUTIVE OFFICER
AND SPECIAL REPRESENTATIVE OF THE UNITED NATIONS
SECRETARY-GENERAL, SUSTAINABLE ENERGY FOR ALL,
WASHINGTON, DC**

Ms. KYTE. Chairman Young, Ranking Member Merkley, I appreciate the invitation to brief you today. Thank you very much, other members of the subcommittee.

In 2015, the international community agreed to a set of sustainable development goals. Sustainable Development Goal 7 is to secure affordable, reliable, sustainable, and modern energy for all by 2030. Its targets include a doubling of the rate of improvement in energy efficiency, doubling of the amount of renewable energy in the mix, and universal access to sustainable energy.

Of course, later in 2015, the Paris Agreement on climate change put the energy transition at the forefront of a time-sensitive economic transformation to cleaner and more inclusive sustainable growth. Then, to meet the SDG and the Paris Agreement, the energy transition must embrace three drivers: decarbonization, decentralization, and digitalization.

Included in this energy transition is delivering electricity to over a billion people that currently lack access, and to do so over the course of the next 13 years. Twenty countries in Africa and Asia represent 80 percent of that challenge. In these countries, domestic and international public and private finance—the commitments that are made average just under half of the estimated needs in the period 2013 to 2014. So that is \$19.4 billion compared to \$52 billion. This finance has targeted critical support for economic and industrial growth. However, only \$6 billion of that has focused on connecting residential consumers. Nearly two-thirds of this finance was in India, the Philippines, and Bangladesh. Eleven of the twenty highest impact countries, all of whom are in Africa, each saw less than a billion dollars of investment a year.

Decentralized electricity systems could provide near-term, low-cost electricity to millions of rural consumers but face policy and regulatory uncertainty that constrains growth. Seventy percent of Africa's least electrified nations where access is below twenty percent have barely begun to establish an enabling environment for access. Electrification plans that help define the boundaries between centralized systems and decentralized services are generally lacking.

Now, countries in Asia with a strong policy framework, such as India and Bangladesh, have seen correspondingly high rates of electricity access. They do well across policies for grids, mini-grids, and standalone systems, suggesting that these efforts are complementary.

By 2030, the International Energy Agency suggests on a business-as-usual basis, 89 percent of the 674 million people who will still be without access will be in Africa. Some countries, such as Kenya have announced plans to close the electricity gap well ahead of 2030. It is possible to estimate the dividend in economic and development terms of achieving access to electricity as a priority. Benefits include significant savings in energy expenditures, as well as additional study time for children at home. With advances and dropping prices of distributed renewable technologies and with evidence of the benefits of connection, the question before countries with electricity access gaps and the international community is why wait for the grid to arrive.

Electricity represents one part of the energy needs of those without access. Clean cooking represents a significant added challenge. Just over 3 billion people lack access to clean fuels for cooking. Under a business-as-usual projection, 2.3 billion people in Asia and

Africa will remain without access by 2030. Current detectable financing flows for clean cooking are very low against an estimated need of just over \$4 billion a year. Stronger emphasis is needed on creating big markets for clean fuels in addition to investments in clean cooking technologies and funding for research and development. Use of traditional biomass, wood, charcoal, and animal dung, is devastating to human health and a driver of deforestation. The WHO estimates that over 4 million people die prematurely from illness attributable to household air pollution from cooking with solid fuels every year. Transitioning to cleaner fuels, including ethanol, LPG, and natural gas, will require long-term industry building.

These comments have been primarily focused on challenges in securing universal energy access. The good news, gentlemen, is that advances in technology, financing and business models and a focus on demand side efficiency in products and services mean that we can achieve the goal. However, it will require a shift in mindset from supporting centralized energy systems to more integrated systems with a greater share of renewables. The U.S. has been engaged in these efforts for many years. Its continued engagement at a time of advances in technology and business models and with an international focus on sustainable development could reap real rewards.

I would be very happy to answer any questions you may have. Thank you.

[Ms. Kyte's prepared statement follows:]

PREPARED STATEMENT OF RACHEL KYTE

Chairman Young, Ranking Member Merkley, distinguished members of the subcommittee, I appreciate the invitation to brief you today.

In 2015, the international community agreed a set of Sustainable Development Goals (SDGs). Sustainable Development Goal 7 is to secure “affordable, reliable, sustainable and modern energy for all by 2030”. Its targets include a doubling of the rate of improvement in energy efficiency, a doubling of the amount of renewable energy in the energy mix and universal access to “sustainable energy”. Later in 2015, the Paris Agreement on climate change put the energy transition at the forefront of a time sensitive economic transformation to cleaner and more inclusive sustainable growth. To meet the goals of the SDG and the Paris Agreement, the energy transition will embrace three drivers: decarbonization, decentralization, and digitalization

Included in the energy transition is delivering electricity to over 1 billion people that currently lack access, in the coming 13 years.¹ Twenty countries in Africa and Asia represent 80 percent of this challenge.² In these countries, domestic and international, public and private finance commitments averaged just under half of what estimated needs are in the period 2013-14,³ (\$19.4 billion compared to an annual estimate need of \$52 billion).⁴ This finance targeted critical support for economic and industrial growth, however only \$6 billion focused on connecting residential consumers. Nearly two-thirds of this finance was for India, the Philippines and Bangladesh. Eleven of the twenty highest impact countries, all in Africa, each saw less than a billion dollars a year of investment.

Decentralized electricity systems could provide near-term, low-cost electricity to millions of rural consumers, but face policy and regulatory uncertainty that constrains growth. Seventy percent of Africa's least electrified nations—where access is below 20 percent—have barely begun to establish an enabling environment for ac-

¹ IEA and World Bank, 2017. Global Tracking Framework 2017 (GTF) <http://gtf.esmap.org/>

² Those countries are Angola, Bangladesh, Burkina Faso, Chad, Democratic Republic of the Congo, Ethiopia, India, Kenya, Democratic People's Republic of Korea, Madagascar, Malawi, Mali, Mozambique, Myanmar, Niger, Nigeria, South Sudan, Sudan, Tanzania and Uganda.

³ SEforALL, 2017. Energizing Finance: Scaling and Refining Finance in Countries with Large Energy Access Gaps.

⁴ IEA, 2017. World Energy Outlook Special Report, Energy Access Outlook, 2017.

cess. Electrification plans that help define boundaries between centralized and decentralized services are generally lacking. Only one percent—\$200 million a year—in financing commitments in these 20 countries over 2013-14 focused on decentralized energy.

Countries in Asia with a strong policy framework, such as India and Bangladesh,⁵ see corresponding high rates of electricity access. They do well across policies for grids, mini-grids, and stand-alone systems, suggesting these efforts are complementary.

By 2030, the International Energy Agency (IEA) suggests that on a business as usual basis 89 percent of the 674 million people still without access (missing the Sustainable Development Goal) will be in Africa.⁶ Some countries, such as Kenya and Bangladesh, have announced plans to close the electricity gap well ahead of 2030. It is possible to estimate the “dividend” in economic and development terms of achieving access to electricity early.⁷ Benefits include significant savings to authorities and households from savings in energy expenditure as well as additional study time. With advances and dropping prices of distributed renewable technologies and with evidence of the benefits of connection, the question before countries with electricity access gaps and the international community is why wait for the grid to arrive and why push access down the priority list of investments needed.⁸

Electricity represents one part of the energy needs of those without access or little access. Clean cooking presents a significant added challenge. Just over 3 billion people lack access to clean fuels for cooking and stoves.⁹ Under a business as usual projection, 2.3 billion people in Asia and Africa are projected to remain without access in 2030.¹⁰ Current detectable financing flows for clean cooking is very low against estimated needs of \$4.4 billion per year.¹¹ Stronger emphasis is needed on creating big markets for clean fuels, in addition to the current often small-scale projects on clean cooking technologies. Funding for research and development and innovation in cooking technologies is also needed. Use of traditional biomass (wood, charcoal and animal dung) is devastating to human health and a driver of deforestation—this land degradation removes the carbon sink capacity of many countries. The World Health Organization estimates that over 4 million people die prematurely from illness attributable to household air pollution from cooking with solid fuels every year. Transitioning to cleaner fuels—including ethanol, LPG and natural gas—will require long-term, “industry-building” initiatives, which must begin immediately to meet the 2030 goals.

These comments have been primarily focused on challenges in securing universal energy access. The good news is that advances in technology, financing and business models and a focus on demand side efficiency in products and services, mean that we can achieve the goal and do so cleanly. However, it will require a shift in mindset from supporting energy systems that have been centralized, to ones that are integrated, with a greater mix of fuel sources, including more renewables. Securing access to reliable and affordable energy services delivers other economic, political and social benefits. The United States has been engaged in these efforts for many years. Its continued engagement, at a time of technology and business model advances and international focus on sustainable development, could reap real rewards.

I am ready to answer any questions you may have. Thank you.

⁵ World Bank, 2017. Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policy Makers. <http://RISE.worldbank.org>.—India and Bangladesh score 84 and 68 percent, respectively, in the Regulatory Indicators for Sustainable Energy compared to 33 percent on average in Africa

⁶ IEA, 2017. World Energy Outlook Special Report, Energy Access Outlook, 2017.

⁷ SEforALL, Power for All and ODI. 2017. Why Wait? Seizing the Energy Access Dividend (forthcoming).

⁸ The Energizing Finance reports recommend that to drive the energy transition, at the required pace, African governments, bilateral and multi-lateral financiers should consider urgently developing a shared vision and targeted work program to deliver SDG 7 that embraces energy access goals, enabling policies, utility participation, and financing. Integrated policy and regulation that embraces centralized and decentralized electricity solutions can increase market certainty, reduce the risk of stranded assets, decrease the risk profile of decentralized investments, and provide confidence to private investors. Complementary measures are required to enable access for the most vulnerable people who are beyond the reach of conventional markets. SEforALL. 2017. Energizing Finance: Scaling and Refining Finance in Countries with Large Energy Access Gaps.

⁹ IEA and World Bank, 2017. Global Tracking Framework 2017 (GTF) <http://gtf.esmap.org/>

¹⁰ IEA, 2017. World Energy Outlook Special Report, Energy Access Outlook, 2017.

¹¹ SEforALL. 2017. Energizing Finance: Scaling and Refining Finance in Countries with Large Energy Access Gaps.

Senator YOUNG. Well, thank you for your excellent testimony, Ms. Kyte. I know each of us up here have a number of follow-up questions for you.

Here today, as well as at greater length in your written testimony, you discussed the importance of the development of a strong policy framework, creating a policy environment that will facilitate a greater rate of uptake of electricity solutions, thus providing a higher rate of electricity access to citizens. India and Bangladesh you have cited as examples of countries that have developed this strong policy framework.

Could you discuss the importance of that relationship between the policy framework on one hand and electricity access on the other and perhaps outline what a strong policy framework related to electrification looks like?

Ms. KYTE. Thank you very much.

I think perhaps then to a Senate subcommittee, it is important to say that policy does matter. And what we see is where a strong policy environment is put in place, speed and scale of improvement is possible. That is not to say that there are not good things happening in many, many different countries, but the speed and scale relates to the policy environment.

We have been able, through pioneering work by the World Bank Group and others, to provide a sort of benchmarkable set of indicators around the regulatory environment for energy efficiency, for increasing the renewable penetration in the mix, which is important for decarbonizing the electricity system, and then also for policies which would lend themselves to speeding up access.

When it comes to access, which was the subject of my briefing, you hear what we see is that the traditional regulatory environment, the traditional incentive is around the performance of the grid. And that needs to continue to be a focus of policy in terms of the levels of subsidy, the kind of price, the reliability of the grid, et cetera.

But when we are looking at closing the access gap, those countries that are moving towards supporting a more integrated system, which means allowing off-grid systems to operate alongside grid systems, as well as allowing for a level playing field between energy sources, renewable as well as fossil fuel and other traditional sources, that in that circumstance, then we see a quicker closing of the energy access gap.

Some countries, the ones that we name, have also focused on the regulatory environment and what a rural electrification agency would look like. And I am happy to submit, perhaps in writing, more detail around that.

But I think that we do see that where you put access as a priority, you understand that efficiency will drive productivity throughout the economy and you wish to have a more modern energy mix that supports those initiatives is having an impact on closing the access gap more quickly.

Senator YOUNG. Thank you, Ms. Kyte.

In your prepared statement, you also discussed the health effects of using certain fuels, specifically biomass, for cooking. You said a World Health Organization report, indicating that over 4 million people die prematurely every year from illness attributable to

household air pollution from cooking with biomass and solid fuels generally.

In their statement that I entered into the record, the UN Development Program said that almost 3 billion people lack access to clean cooking fuel, depending on traditional biomass to meet their energy needs instead.

So, first of all, to make sure I understand this correctly—I have absorbed it from your reading—biomass is preferable to some of these solid fuels or biomass is one of the fuels that leads to adverse health effects among the populations.

Ms. KYTE. It is an excellent question, Mr. Chairman.

A traditional biomass, so the burning of wood or charcoal or cakes made from animal dung or a combination of those, is highly detrimental to health. It has heavy particulate matter.

Senator YOUNG. So that is all under the heading of biomass.

What kind of specific R&D and innovation do we need to address this health and development issue?

Ms. KYTE. So the R&D that is needed is over the improvement of the performance of cook stoves so that if you were to use some form of biomass, you would have much less emissions as a result of that. And there is a metric for understanding how good they have to be in order to not have any health impact. And then I think that there is also work to be done on building out markets for LPG, ethanol, and gas, as well as eventually solar induction stoves. But for those who are using biomass, we need more R&D into the actual performance of the stoves that burn that.

Senator YOUNG. Ms. Kyte, my time is running short here, and I want to make sure I pass it on to the ranking member.

Before I do, I would be remiss if I did not reiterate that Mr. Paul Mitchell from Energy Systems Network from my home State is testifying on the second panel. Have you had an opportunity to read his written testimony?

Ms. KYTE. I have. I have, sir.

Senator YOUNG. Well, thank you for doing that. And it strikes me that ESN has made some great progress on various projects that just might support your efforts at Sustainable Energy for All. Would you consider coming to Indiana and visiting with Energy Systems Network? This was not a trap. [Laughter.]

Senator YOUNG. But I would be grateful for your strong consideration, ideally your public commitment here and now.

Ms. KYTE. Mr. Chairman, it is an extremely kind and generous offer. I read with interest the testimony. We have a lot to talk about, and I would be delighted to take you up on that offer. Thank you.

Senator YOUNG. Thank you.

Senator Merkley?

Senator MERKLEY. Thank you very much. It is so much appreciated—your testimony and the work that you are engaged in, a very important role in the world.

And you mentioned policy and regulatory uncertainty. And one of the things that I have heard often is simply the access to lower interest financing as a significant hurdle. For example, at one point in a conversation with the power minister in India, he was relaying—this is now outdated—but that he wanted to reach two-thirds

of the 300 million folks in India without electricity with coal-powered plants and a third with renewable. And I asked what was driving the separation between those two, and he said it was the very high interest rate on the renewable energy projects, which I think he pegged at about 15 percent.

What kind of work are we seeing in the international community to provide affordable financing for renewable energy electricity?

Ms. KYTE. Thank you, Senator Merkley, for the question.

There are many, many layers to a full answer to that, but I think that increasingly countries are addressing the investment climate to make sure that there is a consistency in the way in which they both set the regulatory environment but also then encourage effective pricing and encourage state-owned banks, in the case of India, as well as commercial banks and other lenders to be able to be part of the energy transition. Since the quote that you gave me, India has been able to auction for power, grid-connected solar power, at very, very competitive prices and now believes that solar power is cheaper than coal without subsidy. And so the question really for India is the exposure of their state-owned banks to the coal sector, as well as to stimulate both commercial and state-owned banks and international investors into their renewable industry.

What we see in smaller projects around the world, in particular in Africa, is the lack of availability to well-priced, long-term debt and perhaps a lack of awareness within the banking sector in some of the developing countries around the future for off-grid renewable energy, and that is something that a number of development partners are starting to address.

Senator MERKLEY. I was really struck by just the transition in this single year between April and June driven, I think, by decisions in India related to that dropping price. Was that about 3 cents per kilowatt in those auctions?

Ms. KYTE. Yes.

Senator MERKLEY. I would not mind having more of that in Oregon.

Ms. KYTE. I am happy to provide the detail on that.

Senator MERKLEY. Thank you. That would be very helpful.

And part of your presentation was labeled "Dropping Prices—Why wait for the grid?" I think that part was about prices dropping in micro-grid technology, which I have seen everything from the household panel to the small village system. What are you seeing evolve between the marketplace and those settings that are far from grid connections?

Ms. KYTE. Thank you.

Well, Senator, I think the best figure comes from Bloomberg New Energy Finance, and the framing that they give is that the price of solar PV has fallen by more than 70 percent in just a few years, and the price of storage is also falling. And then you have, therefore, a market of products and services that can work off that solar PV. And so what you now have is the opportunity to introduce technology in standalone or solar home systems or in micro-grids and mini-grids at a reasonable price into remote rural communities as well as into the peri-open communities of cities.

That does not mean to say that it is easy to get the financing for these kinds of projects, but the actual price of the hardware has

meant that all kinds of business models are now evolving around the provision of those kinds of services. And so rather than just even 5 years ago when this goal seemed to be extremely aspirational, it now seems to be one that if we can align the finance with the right policy environment and with the entrepreneurs and the backing that they need, that this is actually achievable.

Senator MERKLEY. One thing that I saw was a very innovative strategy where individuals, instead of buying the system, they buy time on the system, and then when that time runs out, they can go buy more time. Meanwhile, they may have been able to sell electricity to other individuals for small televisions or for cell phones, et cetera to have made that. That seems to have tackled both the challenge of theft because you cannot operate it without the code and a more affordable financing direction.

I will close by mentioning that for some reason Cottage Grove, Oregon, has become a center for efficient wood stoves to developing countries around the world. One company, InStove, specializing in institutional cooking stoves and another, Aprovecho Research Center, specializing in family-based cooking. And they both have designed these stoves so that they squeeze every last ounce of energy out of the combustion of wood, but even if it is done indoors, which it generally is not, they burn so efficiently that they have far less byproducts in terms of indoor potential pollution. But those Oregon stoves are now all around the world, and I am very happy to see that development.

Senator YOUNG. Ms. Kyte, I appreciate your answers to those questions.

We have been joined by Senator Barrasso, a valued member of the subcommittee. Would you like to ask some questions?

Senator BARRASSO. Thank you very much, Mr. Chairman.

I appreciate you being here. I serve on both the Energy Committee, as well as the Environmental and Public Works Committee, and I am very interested in this and was here to hear your entire testimony. I appreciate it. I had the chance to review the written testimony as well.

Last year in the Environment and Public Works Committee, we had the President of the Center for Industrial Progress, Mr. Alex Epstein, come in. He has written a book about the moral case for fossil fuels. He states that you cannot be a humanitarian and condemn the energy humanity needs. Climate-related deaths are way down, including in under-developed countries. Our technologies and our wealth have given poorer countries better, cheaper everything, materials for building buildings, medicine, food for drought relief. He goes on. The scientific and medical discoveries that we have made in the time that has been bought with fossil fuel-powered, labor-saving machines benefit everyone around the world and that to oppose fossil fuels, he says, is ultimately to oppose the under-developed world.

Now, I believe, Ms. Kyte, that the United States should be working with countries to promote an all-of-the-above energy strategy. The United States policy should focus on making it easier and more affordable for these nations to achieve access to electricity, not harder and not more expensive.

And it appears that the United Nations and affiliated organizations and multilateral institutions are placing restrictions and prohibitions on the use of traditional energy sources such as coal and oil and natural gas.

So I would ask if you could describe the programs at the United Nations which actually support traditional energy resource development as a way to help underdeveloped nations grow their way out of poverty and improve the quality of life for the people who live there.

Ms. KYTE. Senator Barrasso, thank you so much for your question and for your long-held commitments to this issue. Thank you.

So as international organizations, we are guided by the decisions of our member states. And so for the first time I think after many decades of discussion, the agreement in 2015, which was unanimous, and then the almost unanimous agreement in the Paris Climate Agreement really frames the energy issue around reliability, affordability, and access to modern energy services. And there is a need to change the mix of those energy services if we are mindful of the concerns around the impact that warming of the climate is producing.

But on reliability and affordability, most member states of the United Nations—or most countries in the world—are struggling with how to produce that, and that means that we have a responsibility to look at the effective management of an energy service which will provide services for everybody. That means shifting perhaps to more resilient energy systems that use off-grid and grid. It means modernizing the grid using digital technology. And it means being much more productive with the use of energy now. And I think there is a real revolution there. It is something that the United States has led on in the past.

And it means counting in the cost of the impact of poor air quality. And this is what is driving most countries. So whether it is China or India or the capital city of my home state, so London in the United Kingdom, or whether it is Lagos in Nigeria, what is driving policy is the need for clean air because that is going to attract competitive companies. That is going to protect children and future generations.

And so I think that what we are seeing is a drop in price of renewables because of technological advance, and we are also seeing a choice that people want to make, if it can be affordable and reliable, towards cleaner energy sources because they cannot afford to have choked cities and an economic development that is being slowed for that reason.

So I think that the kinds of requests we are getting from member states are about help us with a transition for reliable, affordable, and cleaner energy because we do not see a pathway to sustained economic growth if we have the kind of air quality that we are beginning to experience now.

Senator BARRASSO. It just seemed interesting in some of my trips to Africa and being in some of the townships in South Africa, I know there are areas where there are people desperately looking for any sort of energy. And the cell phone has done remarkable information in terms of helping with making sure people were taking the HIV medication and helping with the mothers to mothers pro-

gram. But the problem that they are dealing with is there seems to be a lack of any energy, as we have heard the testimony—the billion people around the world.

So my concerns in terms of restrictions that are being placed on funding and things is that instead of regulating and placing impossible restrictions on underdeveloped energy sectors of developing nations, we should be encouraging growth so that these countries can compete in the international marketplace, create jobs, alleviate poverty. There are so many things that we can do. And it just seems that we want to all make energy as clean as we can, as fast as we can, but in ways that make this energy available. And if there are resources that can do it now, I think it is hard when we put additional restrictions and limit the kinds of energy that they can use because you talked about the dung that is burned compared to what we have used to advantage this nation, that we ought to be able to have that used elsewhere as well.

Thank you, Mr. Chairman. My time has expired.

Senator YOUNG. Well, thank you, Senator. I appreciate your bringing that important component to this overall conversation. I think that definitely needs to factor into our policymaking as well.

So thank you, Ms. Kyte, once again for your testimony here today.

This concludes the first panel, and we are going to take a few minutes for the second panel's witnesses to get situated. [Pause.]

Senator YOUNG. Everyone looks situated, and we are running against the clock. So I thought we would proceed. I call back into order this subcommittee.

And I would like to welcome again Dr. Todd Moss, Senior Fellow at The Center for Global Development and at Rice University's Baker Institute; Mr. Joao Talocchi, Program Director at the Purpose Climate Lab; and Mr. Paul Mitchell, President and CEO of Energy Systems Network.

Your full written statements will be entered into the record. I welcome you to summarize your statement in about 5 minutes or less, please. Let us go in the order I welcomed you. Dr. Moss, your testimony, please.

STATEMENT OF DR. TODD MOSS, SENIOR FELLOW, THE CENTER FOR GLOBAL DEVELOPMENT; NONRESIDENT SCHOLAR AT THE CENTER FOR ENERGY STUDIES, RICE UNIVERSITY'S BAKER INSTITUTE, BETHESDA, MARYLAND

Dr. MOSS. Great. Thank you, Chairman Young, Ranking Member Merkley, and other members of the subcommittee.

I proudly served in the State Department under Secretary Condoleezza Rice and continue to work closely on U.S. energy and development policies at the nonpartisan Center for Global Development and at Rice University.

I have three brief points today, and I will conclude with three brief recommendations.

Point number one, helping our allies build modern energy systems directly serves U.S. economic, national security, diplomatic, and development interests. Energy statecraft is a valuable lever for transforming our relationships with emerging nations and promoting the full array of U.S. interests around the world especially

in Africa, an increasingly important region. Africa's ambitions are not just for lights and phone chargers but for the modern energy infrastructure that every country needs to benefit from the global economy and to create jobs for their growing populations.

Our own country's experience shows that mass electrification can be catalytic for reducing poverty while generating growth and prosperity. Africa is vastly underpowered today. My refrigerator uses more electricity than nine people in Ethiopia. And these gaps are only going to widen as people grow richer and their energy demands expand.

Now, for the United States, the potential economic up side is tremendous. Closing Africa's power gap would help to unleash the massive consumer and investment potential of a continent that is already home to more than a billion people, and it is bursting with creative and entrepreneurial talent.

Conversely, the security down side of failure is frightening. There is simply no scenario where Africa is stable and thriving without a dramatic expansion of the power sector. And electricity will be one of the driving determinants whether the continent becomes a source of economic dynamism or a source of dangerous security threats.

A prime example here is Nigeria. Africa's largest economy could be a major destination for U.S. investment and a robust engine for global growth. Nigeria is also a critical U.S. partner in our fight against nearly every transnational threat we face such as terrorism, criminal networks, and disease.

Now, sometime in the next 25 years, Nigeria's population will be larger than ours. Yet, while we have about 1,000 gigawatts of electricity generation capacity, Nigeria today has about four. If we help Nigeria build a modern energy system, we will help a critical ally and generate opportunities for American companies. If we ignore Nigeria's energy future, either China fills the vacuum or Nigeria fails and becomes a hotbed of dangerous threats.

Point number two, Power Africa has made an extremely promising start. So far, Power Africa is right on track to meet its goals of 30 gigawatts of new generation capacity and 60 million new connections.

To be very clear, Power Africa is not using U.S. taxpayer funds to build power plants in foreign countries. It is instead deploying technical advisors and other tools to unlock the potential of the private sector. A core component of Power Africa is the Overseas Private Investment Corporation. Now, OPIC makes commercial loans to specific high-value projects where private credit is unavailable. This does not cost U.S. taxpayers as OPIC is profitable and returns money into the U.S. Treasury every year. So Power Africa is succeeding, but it must be sustained and it could be even better at little to no additional cost.

Point three is that in energy, big is still beautiful. Small-scale distributed power systems are definitely going to reach many, many poor people, but African economies will still require large-scale power plants and a modern grid. If you are poor and live today without any electricity, then getting a solar lantern or a small home system is a remarkable step up. However, three caveats to this.

One is that small home systems are really just the very first step on a long energy ladder. The global definition of rural modern energy access is just 50 kilowatt hours per person per year. This is what an average American consumes in about a day and a half. It is barely enough to power light bulbs or charge a cell phone. And 50 kilowatt hours is not an end goal. It is just a very, very first step. And it is really kind of crazy to call this modern energy access.

The second caveat is that electricity for development is not just about reaching homes. Reaching homes is important, but it is also about powering industry and commerce. No matter how many lanterns are delivered, Africa's growing cities and industrial zones will require large-scale power for job creation and economic growth.

And the third point is that all-of-the-above, which we heard Senator Barrasso mention, is not just an American approach. Every country exploits its own endowments to meet the energy needs of its people. Yes, solar, wind, geothermal, and hydro will all play an important role in Africa's future energy mix. Yet, natural gas will be part of the solution too. In Ghana, Nigeria, Kenya, Tanzania, Mozambique, Cote d'Ivoire, Senegal, and others, it is simply untenable to expect these countries to produce natural gas and export all of it to Asia and Europe while their people still need power. Now, we can either help these allies build smart infrastructure with modern American technology or we can cede this space to others.

Let me conclude briefly with three ways to make Power Africa even more effective in supporting U.S. interests and how Congress can help.

One, Congress should insist that the administration continue Power Africa and fulfill the goals of the bipartisan Electrify Africa Act.

Two, the very modest Power Africa team based at USAID must be fully funded. Their valuable work paves the way for private investment.

And three, Congress should work with the administration to turn OPIC into the U.S. Development Finance Corporation, a full-service development finance institution worthy of the United States and built for the energy statecraft of the 21st century.

[Dr. Moss's prepared statement follows:]

PREPARED STATEMENT OF DR. TODD J. MOSS

Thank you Chairman Young, Ranking Member Merkley, and other members of the subcommittee. I appreciate the opportunity to highlight how the United States can better utilize energy policy to pursue our objectives in sub-Saharan Africa, a region of growing economic and national security importance. I proudly served in the State Department under Secretary Condoleezza Rice and continue to work closely on U.S. energy and development policies as a Senior Fellow at the nonpartisan Center for Global Development and at Rice University's Baker Institute.

I have three points today and will conclude with three brief recommendations. My three main points are:

1. Helping our allies build modern energy systems directly serves U.S. economic, national security, diplomatic, and development interests.
2. Power Africa, using U.S. tools and expertise to unlock private investment in the power sector, has made a very promising start. But Power Africa must be sustained—and could be even better at little to no additional cost.
3. Small-scale distributed power is going to reach many poor people, but to grow their economies, create jobs, and meet escalating demand, African countries will

still require largescale power plants and a modern grid. In energy, big can be beautiful too.

First, helping our allies build modern energy systems directly serves U.S. economic, national security, diplomatic, and development interests. The old version of energy statecraft was the Carter Doctrine, which asserted the right to use military force to protect the flow of oil from the Middle East. Today's global energy marketplace is wholly different and requires a new approach by the United States. The fracking revolution and rise of natural gas has dramatically changed the geostrategic balance. Similarly, promoting energy access is a valuable new lever for transforming our relationships with emerging nations in sub-Saharan Africa and promoting the full array of U.S. interests in that increasingly important region.¹

Our own experience here in the United States shows that mass electrification can be catalytic for reducing poverty and deprivation while generating growth and prosperity. Africa is vastly underpowered today and the gaps are only going to widen. Africans already use far less energy than their income level would predict.² My refrigerator uses the same amount of electricity each year as nine people in Ethiopia.³ As people grow richer, demand for energy expands as people can afford higher power appliances and move into higher-value jobs that require modern power.

All African countries aspire to what we take for granted: affordable 24/7 electricity that is mostly hidden but fundamental to the way we live, work, communicate, and travel. For African governments building modern energy systems to deliver on the ambitions of their citizens, they understandably seek active U.S. engagement to help them connect with investors and advanced technology. These ambitions are not just for lights and a phone charger, but for the modern energy infrastructure that every country needs to benefit from the global economy and to create jobs for their growing populations.

Why should the U.S. even care about Africa's unmet energy demand? The economic upside is tremendous. Data show very clearly that lack of power for African businesses is among the very top constraints to economic growth.⁴ Resolving Africa's power gap would help to unleash the massive consumer and investment potential of a continent that is already home to more than a billion people and is bursting with creative and entrepreneurial talent.

Conversely, the security downside of failure is frightening. Power is absolutely essential to creating the tens of millions of new jobs that Africa needs every year. There is no scenario where Africa is stable and thriving without a rapid expansion of the power sector. It's not too strong to say that the continent will either become a source of new economic dynamism or a source of instability and threats—and that electricity will be one of the driving determinants.

A good example of the upside opportunities and the downsides risks is Nigeria, Africa's largest economy and most populous nation. Nigeria is an unavoidable American partner in our fight against nearly every transnational threat we face: terrorism, disease, criminal networks, and trafficking in drugs, guns, and people. With a population approaching 200 million, Nigeria is also a major investment and trading partner that we would be unwise to ignore.

To give you some perspective, in about 25 years, Nigeria's population will surpass the population of the United States. We currently have about 1,000 GW of electricity generation capacity in the U.S., a number that the Department of Energy expects to rise to about 1,200 GW by 2040. Today, Nigeria has 4 GW. If we help Nigeria build a modern energy system that meets its economic and human development needs, we will help a critical ally, support its path to better governance, and generate tremendous opportunities for American companies. Choosing to overlook Nigeria's energy needs leaves only two scenarios: China fills the vacuum or Nigeria disintegrates and becomes an epicenter of dangerous threats.

Second, Power Africa has made a very promising start, but must be sustained—and could be even better at little to no additional cost. The initiative, launched in 2013 in specific response to ally requests for U.S. assistance, aims to boost generation by 30 GW and to connect 60 million new homes and businesses by 2030. The

¹Bazilian, Morgan, Benjamin Sovacool, and Todd Moss. "Rethinking Energy Statecraft: United States Foreign Policy and the Changing Geopolitics of Energy." *Global Policy* 8, no. 3 (September 2017): 422-25.

²Moss, Todd, and Gailyn Portelance. "Do African Countries Consume Less (or More) Electricity than Their Income Levels Suggest?" Center for Global Development, May 31, 2017.

³Moss, Todd, and Madeleine Gleave. "Seven Graphics that Explain Energy Poverty and How the US Can Do Much More" Center for Global Development, February 18, 2014.

⁴Ramachandran, Vijaya, Alan Gelb, and Manju Kedia Shah. *Africa's Private Sector: What's Wrong with the Business Environment and What to Do About It*. Washington, DC: Center for Global Development, 2009.

effort is backed by Congress through the Electrify Africa Act, which passed in 2016 with strong bipartisan support.

So far, Power Africa is right on track to meet these goals.⁵ Importantly, Power Africa has used a suite of public policy tools to convene, catalyze, and cajole private investment in the power sector. To be very clear, Power Africa is not using U.S. taxpayer funds to build power plants in foreign countries. It is instead deploying technical advisors and other tools to unlock the potential of the private sector. The limited public sector funding that is being deployed is largely from the Overseas Private Investment Corporation (OPIC), which makes commercial loans to specific high-value projects where private credit is unavailable. This does not cost U.S. taxpayers, as OPIC is profitable and returns money into the U.S. Treasury every year.

Third, small-scale distributed power solutions are going to reach many poor people, but African economies will still require large-scale power plants and a modern grid. The notion of universal energy access is a worthy goal and one that can be reached in our lifetime. If you live today without any electricity, then getting your first solar lantern or a small solar home system is a huge step up. However, there are important caveats:

- *Small solutions are just the first step on a long energy ladder.* The International Energy Agency currently considers a rural person to have “modern access” at just 50 kWh per person per year. It is what an average American consumes in a day and a half—barely enough to power a light bulb or charge a cell phone. No person will ever be satisfied with this much power, and it is absurd to call this modern energy access.⁶ Expecting Africans to stay at a very low level of energy consumption is to expect them to remain in poverty.
- *Getting energy to poor people in their homes is important, but the major development benefits come from energy for industry and commerce.* In a typical economy, the vast majority of electricity is used by industry and commerce, not households. No matter how many lanterns are delivered, Africa’s growing cities and industrial zones will require large-scale power for job creation and economic growth.
- *“All of the above” is not just an American approach.* Every country exploits its own endowments to meet the energy needs of its people. Solar, wind, and hydro will all play an important role in Africa’s future energy mix. Yet many countries will still need to use their own natural gas as part of their energy solution. Countries already producing natural gas include Ghana, Nigeria, Kenya, Tanzania, Mozambique, Cote d’Ivoire, Republic of the Congo, Angola, and Senegal. It is untenable to expect these nations to produce natural gas and export it all to Asia or Europe while their people need power. We can either help these countries build infrastructure smartly and with modern American technology or we can cede this space to others.

Allow me to conclude briefly with three ways to make Power Africa even more effective in supporting U.S. interests—and how Congress can help.

1. The administration should vigorously embrace the goals and tools of Power Africa with the continued support and encouragement of Congress. This requires a clear statement that Power Africa will continue and that the bipartisan Electrify Africa Act will be fulfilled.
2. The modest Power Africa team based at USAID must be fully funded. Their work covers a range of technical support, data collection, and other activities that pave the way, as it should, for private investment to do the bulk of the heavy lifting. USAID requires resources to do this job.
3. OPIC could do much more with additional flexibility and capabilities. At no additional cost to American taxpayers, OPIC could easily do two or three times the volumes of power deals in Africa if Congress provided multiyear authorization, equity authority, and allowed OPIC to invest a small portion of its profits in expanding its deal teams. Even better, Congress could work with the administration to turn OPIC into the United States Development Finance Corporation

⁵*Power Africa Annual Report August 2017.* Washington, DC: United States Agency for International Development, 2017. Moss, Todd. “Grading Power Africa.” Brief. Washington, DC: Center for Global Development, 2016.

⁶*More Than a Lightbulb: Five Recommendations to Make Modern Energy Access Meaningful for People and Prosperity.* Report of the Energy Access Targets Working Group. Washington, DC: Center for Global Development, 2016.

(USDFC), a full-service development finance institution worthy of the United States, and built for the energy statecraft of the 21st Century.⁷

Thank you.

Senator YOUNG. Thank you, Dr. Moss.
Mr. Talocchi?

**STATEMENT OF JOAO TALOCCHI, PROGRAM DIRECTOR,
PURPOSE CLIMATE LAB, NEW YORK, NEW YORK**

Mr. TALOCCHI. Chairman Young, Ranking Member Merkley, members of the committee, thank you for inviting me to testify on the important issue of energy access in emerging economies.

I was once in a community in the Amazon that was not connected to the grid when the diesel generator was turned on. Putting aside the less than optimal way that diesel was stored and handled, I was struck by one thing, and that was the noise. I asked a villager if it bothered him, and his answer was, “A little, but the worst part is we cannot hear the snakes.” As it happened, a kid had been bitten a few weeks before.

Senators, providing energy access to the 1.2 billion people around the world that lack access to electricity is a fundamental step to improve their social and economic conditions and that of their countries. But to do so, we need to focus on the best solutions, those that are fast to deploy, affordable, safe, and effective.

To address this need, policymakers face two distinct options that are complementary, though: extend infrastructure of a centralized electricity grid or provide local renewable energy solutions. To date, the primary approach to solve this problem has been to increase grid connectivity, but progress has been slow and the number of underserved households is expected to decline by only a few percentage points over the next few years.

The problem is that it makes little economic sense to extend and maintain the grid for long distances over rivers and across mountains with costs at the tens of thousands of dollars per mile just to sell underpriced electricity to a few houses. Utilities found this. Even if the grids reach these remote places, the utilities need to wait for subsidies that are slow to come. Or they need to spend money to send people to collect money from villagers that either cannot or do not want to pay because the electricity services are poor and power cuts are constant. As populations grow, this all-or-nothing grid-based approach will continue to leave millions in the dark.

Decentralized renewable energy systems, especially those with storage capacity, are a much smarter solution. These technologies like solar, wind, hydro, and biomass can operate in multiple configurations from a simple individual or home systems to more complex local mini-grids or even as complementary regional grids. They can work for a few hours or provide 24/7 power.

Renewable energy technologies are independent and resilient relying on locally available and usually free fuels, the sun, wind, and water, and do not depend on supply chains or power lines that cost

⁷Leo, Ben, and Todd Moss. “Bringing US Development Finance into the 21st Century: Proposal for a Self-Sustaining, Full-Service USDFC.” Policy Paper. Washington, DC: Center for Global Development, 2015.

a lot and can be disrupted by various factors as conflict or natural disasters. Just think about Puerto Rico.

But some will say many governments tried to install solar power before, and those experiments failed. I myself have seen many solar panels from the 1980s serving as doors to chicken coups in remote communities. The technology is not to blame. The problem was the approach. Public agencies tried to install the systems and they just left. The first time something went wrong and no one came back to fix it, that was the end of it.

Many governments are learning that lesson and, instead of doing it themselves, are working to create enabling environments for small and medium local enterprises. These enterprises can build deep rural distribution networks for renewable energy solutions as well as customers' trust. Because their returns depend on neither products working well or the sale of electricity, they are bound to offer guarantees, after-sale support, and perform repairs.

Decentralized renewable energy for energy access needs to be a business. This is already starting to happen. Because of renewable energy solutions are scalable. It is possible to reach communities in weeks instead of years and to do that in economical terms offering enough power at a price that can be afforded and that makes business sense for all involved.

This is a shift from the all-or-nothing approach based on grid connections. It creates a new model based on entry level power and the concept of an energy ladder. Communities can use their new sources of energy to keep small businesses open a bit later. They can store products in refrigerators and access communication and banking services.

Decentralized renewable solutions are being used for irrigation with solar water pumps and also grinding, milling, husking, drying, smoking, expelling oils, powering tools and so on. These are economic activities that provide income. I have met a woodworker in the Amazon who tripled his output just because he had access to energy. In turn, people can afford more electricity and energy systems can be scaled up.

Beyond making existing jobs more efficient, renewable energy solutions create local permanent jobs for maintenance, payment and collection, and after-sale support just as examples.

Energy access for rural communities strengthens local economies and job creations. It is a win-win-win for all. This is a new space and sharp reductions in the cost of generation, storage technologies are helping it grow quickly. The United States can play an important role in supporting it through technology, innovation, and finance. We can continue wait decades for the grid to reach these 1.2 billion people, but the smarter option is to create the conditions for markets to deliver energy access through decentralized renewable energy which can happen in a much shorter term. The benefits of jobs, resiliency, reduced air and water pollution, avoided climate change emissions, increased school performance, and new opportunities for social and economic development cannot be ignored or delayed.

Thank you.

[Mr. Talocchi's prepared statement follows:]

PREPARED STATEMENT OF JOAO TALOCCHI

Introduction:

Chairman Young, Ranking Member Merkley, members of the committee. Thank you for inviting me to testify on the important issue of energy access in emerging economies.

For the past 3 years I've directed campaigns at the Purpose Climate Lab, an initiative incubated by Purpose Campaigns and focused on accelerating the adoption of low carbon solutions through public engagement, communications and the coordination of collaborations among stakeholders. Working with a variety of stakeholders including social and environmental NGOs, local governments, the private sector, faith groups, celebrities and the UN, I have lead campaigns that mobilized and engaged more than three million people over the last two years and resulted in the adoption of renewable energy and clean transport policies. These campaigns simultaneously harness the reach and power of digital engagement platforms while fostering the deep connections created by innovative partnerships, offline activations and the influence of traditional media. The campaigns are developed using the best available knowledge, provided by scientific reports; technical reports developed by organizations specialized in the development and implementation of low carbon solutions and continuous interactions with multiple stakeholders collaborating towards similar goals.

Before Purpose, I held a variety of roles across at Greenpeace, including positions with the climate, energy and forest campaigns in the Brazil, International and United States offices. In addition to plan and implement multiple public campaigns, I worked with teams to commission a study that measured the hidden external cost of coal in South Africa and compared them to the potential for renewable energy investments. The results of this study will be referenced in my testimony.

I also directed the Amazonas State Climate Change Center, within the Sustainable Development Secretariat from the state of Amazonas, in Brazil. There, I lead the implementation of the state's climate change law, the development of the state's environmental services policies, supported pilot projects for renewable energy access in remote communities and created and the state's energy council.

Context:

Providing energy access to the 1.2 billion people around the world that lack access to electricity is a fundamental step to improve the social and economic conditions of these people, their countries and the world. No country has developed without access to reliable and affordable energy services.

How and when this done will have a direct impact over all of the 17 United Nations Sustainable Development Goals. It is unreasonable to consider that its possible to eliminate poverty, improve nutrition, ensure quality education, empower women and promote sustained economic growth without energy.

It is also unreasonable to consider that its possible to ensure sustainable management of water, to make human settlements resilient, to protect ecosystems and to combat climate change if that energy is the result of exploring and burning fossil fuels. Especially, but not only because of fossil fuel's role in exacerbating the potential risks of climate change, which is predicted to have severe negative impacts on food and water resources, ecosystems, economic growth, population dynamics and health, undermining and often reversing gains made through development.

One reason for this is fossil fuels have been around for decades, but have still failed to deliver energy to about one sixth of the world's population.

Another reason is the use of fossil fuels results in numerous negative externalities, such as long-term water pollution, the destruction of arable lands and crops, air pollution and climate change. I was part of the development of a scientific study in South Africa, entitled The external cost of coal-fired power generation: the case of Kusile. It showed that making consumers pay for the true cost of coal-fired electricity generation would add between 237 percent and 459 percent to the tariff.

Another key finding was that it would be possible to develop no less than 5 times the generation capacity of a specific proposed coal power plant, if only 30 percent of its external costs were used to fund renewable electricity generation. Despite these findings, this coal power plant, Kusile, is now under construction, with the support of 806 million dollars from the Export-Import Bank of the United States. The potential for it to increase energy access to under served communities remains to be seen.

Communities without access to electricity often approach it one of two ways. In most cases, they rely on diesel generators, which usually only operate for a limited number of hours a day. The costs of fuel and maintenance are often too high for communities, unless the cost of diesel is highly subsidized. In the Brazilian Amazon,

I've heard the communities complain about the smoke, the fluctuating costs, the storage problems, the supply chains and the noise that diesel generators create. The latter point is curious but important. When you are in a poorly lit community in the forest, silence is an important ally, as noises can indicate the presence of thieves, snakes, jaguars or other risks.

But for many communities, light comes from kerosene lamps. In this case, fires that burn entire houses and indoor air pollution are ever-present threats. These lamps don't produce enough light for kids to study at night and the streets remain dark, which creates security problems. In India, for example, Kerosene is heavily subsidized, with costs reaching U\$5.1 billion in financial year 2013/2014, although the government seems to be aiming to put an end to it.

For the past 3 years, I've been directing projects throughout the Indian states of Uttar Pradesh and neighboring Bihar, with combined populations approaching the size of the U.S. These are states in a region that houses many of India's thermal power plants and some of the world's most polluted cities in terms of air quality, and where fewer than half of rural households have power connections.

The lack of energy access for many in India is not only about building more power plants or access to fuel. India is a power surplus nation with significant electric power generation capacity idling for want of demand. The state-run coal mining company is the world's largest.

The problem is supplying rural homes with electricity from the grid isn't economical at this point. It makes little economic sense to extend and maintain the grid for long distances, over rivers and across mountains, with costs at the tens of thousands of dollars per mile, just to sell under priced electricity to a few houses. On top of that, technical losses and power thefts make grid power even less attractive.

But the suggestion of extending the grid makes political sense. In countries and regions where many people have no access to energy, political power and electrical power are closely linked.

The promise of abundant, free or heavily subsidized electricity is a great way to secure votes. Election after election, from local seats to the highest elected positions, candidates talk about how they will be the ones that will finally bring power to these communities. This could be positive if it resulted in the electrification of poorer rural households and communities that are usually forgotten after election cycles. But despite progress, rates of electrification in the countries with the largest populations currently without electricity are barely, if at all, keeping pace with population growth.

Repeated again and again, the promise of abundant free or cheap power, which national grids can theoretically deliver, becomes a dream. It's no surprise that many villagers, especially older ones, will resist the suggestion of paying for some electricity from local renewable systems. But the constant power cuts from the grid, especially to rural villages, as part of load shedding and the falling cost of and advances in standalone renewable generation are making individuals optimistic about the potential for the technology to provide a solution for rural electrification.

On top of asking only for what has been promised, this demand for grid electricity is also grounded in negative past experiences with renewables. In previous decades, many governments have tried to electrify houses and communities using off-grid renewable energy, with varying levels of success.

In many places, solar systems were installed, with no cost to the consumers, but also no maintenance and support offered by the government. The lifetime of those systems was only as long as its first malfunction. I've seen solar panels from the 80s serving as chicken coops' doors in the Brazilian Amazon.

I want to stress that this does not mean decentralized renewable energy systems are not a solution. They are the best solution to will deliver energy access to remote and rural communities in the short term.

Decentralized renewable energy solutions as the best solution for energy access:

Decentralized renewable energy systems, especially those with storage capacity, can provide electricity for lighting, communications and productive activities. These technologies—solar, wind, hydro, biomass or biogas—can operate in multiple configurations—from individual and home systems to local mini-grids or as a complement to centralized energy generation systems. They are resilient and independent, relying on locally available fuels that are many times free—the sun, wind and water—and don't depend on supply chains or power lines that can be disrupted by various factors, as conflict or natural disasters.

After Hurricane Maria destroyed the power grid in Puerto Rico, Elon Musk from Tesla offered to rebuild the country's grid with solar power and battery storage, as has been done in smaller islands, as Kauai and the American Samoa. It can happen in Puerto Rico because there is no "scalability limit," as he put it.

This is a key feature of decentralized renewable solutions, as solar power. Because they are scalable, it's possible to reach communities in weeks instead of years, and to do that in economical terms, offering enough power at a price that they can afford and that makes business sense for all involved. This can put an end to the "all or nothing" approach based on grid connections and creates entry-level power. Simple solutions such as solar lanterns or solar home systems form the basis of an energy ladder in which individuals and communities have the option to scale up as income and technological development allows.

Communities can use the new source of energy to keep small businesses open late, store products in refrigerators and use communications and banking services, for example.

Decentralized renewable energy is being used for irrigation, grinding, milling, husking, drying, smocking, expelling oils, powering tools and so on. It increases the efficiency of economic activity and thus income. In turn, people can afford more electricity. It also allows kids to study after dark, providing billions of additional hours of study. Schools can have lights, fans, communication and refrigerators and stay open late. In the Brazilian Amazon, a local school started to offer adult education at night, after the community was connected to a solar micro grid.

These benefits could be created by any source of electricity, but because decentralized renewable energy, including storage capacity, can be deployed in a very short time, they become much more immediate, tangible and logical. On top of eliminating the costs of fuels, being, scalable and resilient, renewable energy powered systems also improve health through the displacement of indoor air pollution, produce no or low noise levels and reduce greenhouse gas emissions.

The problem with attempts for renewable energy from past decades were not technology based. It was the price—it was still too expensive—and the approach.

On costs—in India, an average small solar home system, that can provide power for a few lights, radio and charge phones, is priced below US\$65. If micro-financed, it can simply replace the costs of kerosene. And the Indian solar photovoltaic power tariff has fallen to US\$3.8 per KWh in May 2017, which is lower than any other type of new power generation in the country. Those prices will only continue to fall.

On approach—governments should not be responsible for maintaining and operating distributed renewable energy systems in remote areas. Instead, they need to create enabling environments for small and medium local enterprises, which can build deep rural distribution networks and customer trust. Distributed renewable energy for energy access needs to be a business.

A market led approach means that final consumers will have to pay for electricity, but it also forces providers to guarantee its supply, which means they'll service the systems when they stop working. In addition, it opens up a lot of room for innovation and collaboration.

This enabling environment requires policy stability and clarity. For example, because there is little clarity on where the grid is going next in India, many businesses in the space are afraid to install a solar system in a community, just to have that community connected to the grid in a year or two. Government's are addressing this by creating "exit policies" where they would either buy the electricity through the new grid, or purchase the entire system. Policies that specify minimum technical standards will help remove cheap but ineffective products from the market and improve competition. Finally, tenders that allow smaller and new players to become empaneled and serve communities as part of government programs can also play a role.

When I supported the installation of a solar micro-grid in a community in the Amazon in 2012, we quickly realized the need for social innovation, as some of the women bought electric hair straighteners and blow-dryers that demanded too much power and caused the system to shut down. There was a community meeting where a local protocol was created, setting rules that limited the times when people could use certain appliances. This kind of innovation is still used in communities today, although technology can now help solve the problem, with smart meters and pay-as-you-go systems—where people buy energy in advance, similar to putting credits on your phone, available.

Pay-as-you-go innovations and remote controlled smart meters will also reduce the risk and burden of collecting payments on a regular basis, which in many cases is done through regular visits to the communities. This is a real risk and has real impacts on the capacity of enterprises, especially new ones, to operate. Banks and other financial institutions are wary of their business models, based on high upfront costs and slim profit margins. Access to finance and affordable capital are some of the main challenges faced by companies trying to offer distributed renewable energy solutions. International investment from multilateral institutions, developed and developing countries play a key role in supporting energy access, though

efforts need to be scaled up. National governments can also be a significant source of finance for electricity by drawing from their own budgets and facilitating private investments. Innovation and market diversification is a real need of the sector and companies are filling those gaps.

For example, many companies are looking to develop strong relationships with banks and micro-finance institutions in order to ensure access to finance for the consumer, who can decide to pay for systems upfront, on installments or as they go. Companies are also aware that while the consumers of today are concerned with lighting and mobile charging, the consumers of tomorrow will want more fans, TVs and other appliances, and are diversifying their portfolios and offerings.

Distributed renewable energy solutions are also a source of employment and income generation for people in these remote areas. When I supported the installation of solar microgrids in Amazon communities, the company involved trained two of the villagers to perform regular maintenance and fix simple problems. These villagers were then engaged in the installation of other systems. Where companies operate in large, remote areas, this will be the most economical way of offering after sales support and a great opportunity to build trust with local consumers and strengthen the local economy.

On a larger scale, the work done by hundreds of groups—from civil society, academia, business and government—to develop and promote renewable energy around the world is producing very positive results. Grid connected renewable energy already represents the majority of investments in new electricity generation capacity, especially in the countries with the largest populations without energy access. This is very positive. It creates economies of scale, reduces costs, consolidates new players and creates jobs. It also facilitates policy development and proves that renewable energy is a real source of electricity.

The Purpose Climate Lab work on energy access

The large potential and multiple benefits of distributed renewable energy solutions for energy access are the core reason why the Purpose Climate Lab has promoted it as a solution and worked to close some of the gaps that remain ahead of implementation, especially in India but also in Kenya.

This work has been focused on creating awareness that renewable technologies are not too expensive, too high tech or too limiting for rural communities, in order to reduce communities' initial resistance and increase demand. Another objective is to secure stable and clear policies to allow market players to fulfill their potential. This work is happening through broad communication campaigns, the engagement with hundreds of local, national and international organizations and local government agencies. One of our approaches is to facilitate partnerships between micro-financial institutions, service and technology providers and local governments to accelerate the adoption of what we call "smokeless villages," where energy for cooking and electricity will come from clean sources.

Conclusion

While government efforts are expected to increase grid connectivity, in India and in other countries where large populations still have no access to energy, progress has been slow and the number of underserved households is expected to decline by only a few percentage points over the next few years.

Governments must decide if they want to keep their rural and remote communities waiting for the promise of grid connected power that will take decades to be fulfilled or to provide readily available, affordable, real electricity from decentralized renewable solutions. These are not trade-offs, as decentralized renewable energy solutions can be integrated to complement centralized energy generation systems.

If these governments opt for prioritizing the extension of the grid, the trend of focusing on new renewable energy generation capacity must be continued. Financial and economic indicators, as well as the imperative to mitigate climate change, reduce air and water pollution and create new jobs mean this is the natural path forward. But the smarter option is to create the conditions for markets to deliver energy access through decentralized renewable energy, which can happen in the short term. The benefits of jobs, reduced air and water pollution and climate change emissions, resiliency, increased school performance and opportunities for social and economic development cannot be ignored or delayed.

Senator YOUNG. Thank you, Mr. Talocchi.
Mr. Mitchell?

STATEMENT OF PAUL MITCHELL, PRESIDENT AND CHIEF EXECUTIVE OFFICER, ENERGY SYSTEMS NETWORK, INDIANAPOLIS, INDIANA

Mr. MITCHELL. Chairman Young, Ranking Member Merkley, thank you for the opportunity to appear before your subcommittee today to testify and update you on the many technology innovations that are taking place in the great State of Indiana and how they are directly applicable to international development.

We have been able to achieve significant innovations as a result of our collaboration with industry, academia, and government institutions. We have facilitated many successful public-private partnership ventures, and I am proud of the role that ESN has played in making this possible.

Energy Systems Network, or ESN, is an Indiana-based nonprofit consortium working to build an energy ecosystem that integrates all aspects of the energy landscape from generation and distribution to transportation and infrastructure. Founded in 2009 by a group of leading energy and transportation CEOs and with strong support from then-Governor of Indiana Mitch Daniels, ESN's mission is to leverage our network to develop integrated energy solutions that increase quality of life for today and tomorrow. Our collective focus is to reduce costs, emissions, and waste, influence policy, and advance technological innovation. To date, the public-private partnerships we have led have resulted in investment of more than \$700 million in the State of Indiana.

ESN projects have brought together dozens of global and Fortune 500 companies, numerous startups and scale-up firms, leading research universities, and federal labs with a common purpose: to accelerate the pace of energy technology innovation and adoption using the State of Indiana as a launching pad for solutions that will benefit the world.

Let me give you just a few examples of some of our successes.

The Development of BlueIndy, the largest electric car sharing system in North America with more than 300 electric vehicles and 500 charging stations across the City of Indianapolis offering low-cost, sustainable transportation to thousands of Hoosiers.

The founding of the Battery Innovation Center, a \$20 million world-class energy storage, research, testing, and prototype manufacturing lab in rural Green County, Indiana just outside of Naval Surface Warfare Center Crane building, a first of its kind mobile micro-grid in 2010 powered by renewable biomass and solar energy capable of supplying forward remote-operating bases with a sustainable energy supply using their own waste.

Or partnering most recently with the Indiana Housing and Community Development Authority to build six net-zero affordable housing developments with integrated transportation options for residents.

One of our founding principles is that no one company or institution has all the tools to solve our energy challenges. Solutions require a collaborative approach that cuts across traditional industry boundaries. Solutions require us to work together with a range of corporate, academic, and government partners. This type of approach to address the many challenges associated with international development also works perfectly. It is the power of pub-

lic-private partnerships and the collaboration that drives them which is best able to solve the complex and varied challenges of energy in international development.

While ESN is based in Indiana, we ensure that our projects are scalable well beyond the Hoosier State. In order to drive scalability, we partner with companies that are working around the world, and we reach out to nations to find ways for our best practices to be adopted abroad. ESN has formed partnerships with companies and institutions, with countries, most notably Japan, China, France. We have also worked to do outreach in less developed nations like the Republic of Georgia.

ESN's engagement around the world has taught us that energy solutions are truly global in nature. We have learned that sustainable and cost-effective and environmentally responsible energy solutions that we have helped deliver to Hoosiers can work in other countries too, including those, as we have heard about, that are struggling to develop modern energy infrastructure and supply.

For example, the increased adoption of distributed energy resources, which includes, of course, renewables but also small-scale fossil fuel plants, which are often coupled with energy storage, offer a revolutionary new approach to scaling the modern energy supply.

Or the rapidly increasing adoption of transportation electrification, which can trace its roots back to the State of Indiana where General Motors developed the first modern electric vehicle in the late 1990s. Today, electric vehicles are becoming commonplace and nearly every major manufacturer of light-duty passenger cars to heavy-duty trucks and buses are rolling out electric products.

ESN with our many partners are playing an important role in facilitating these dynamics. We are leveraging Indiana as a proving ground for the innovative technologies, business models, and regulatory policies that will support this transformation. Our more than half a billion dollars in successful public-private partnerships are proof that collaboration is working, and the ability to share these best practices with other nations is a logical step for ESN and one that our partners are eager to pursue with the support of this committee.

Thank you, Chairman Young and Ranking Member Merkley. I again welcome this opportunity to update you on what ESN has done at the intersection of energy and international development and look forward to answering any questions you may have.

[Mr. Mitchell's prepared statement follows:]

PREPARED STATEMENT OF PAUL J. MITCHELL

ABOUT ENERGY SYSTEMS NETWORK

Overview

Energy Systems Network (ESN) is a not-for-profit based in Indianapolis that is building an energy ecosystem which integrates all aspects of the energy landscape: energy generation, distribution, the built environment, and transportation. ESN's mission is to leverage our network of corporate and institutional partners and global thought leaders to develop integrated energy solutions that increase quality of life for today and tomorrow. Our collective focus is to: reduce costs, emissions and waste; influence policy; and advance technological innovation.

Launched in 2009, ESN has since implemented several collaborative projects and public private partnerships resulting in over \$700 million invested. Our partner organizations include representatives from industry (including a dozen Global and

Fortune 500 companies), leading research universities, federal labs, non-profits and government agencies. These partners are active in a diversity of industries including transportation, energy generation, transmission and distribution, equipment manufacturing, real estate development, information technology, and many others. Our facilitation of collaboration across traditional industry boundaries allows for innovation of new energy technology and accelerates commercialization and market adoption.

ESN also provides a range of services to support innovation including market studies, technology evaluation, project development and management, formation of joint ventures, brainstorming workshops, and research efforts.

ESN's Approach

ESN has developed the Path to Sustainability, a framework which guides our approach to project development and implementation. The framework consists of the following elements:

- *People and Place*: Each project starts with the customer/consumer in mind. Our goal is to use energy systems solutions to improve quality of life to individuals, organizations, and geographic locations.
- *Policy*: Once the customer and objectives are defined, ESN works directly with regulators, government agencies, and policymakers to build support for, or remove barriers to, project implementation.
- *Finance*: A wide range of creative financing models using public and private funding sources are leveraged to implement our projects.
- *Assets*: Financing is used to support the deployment of “assets,” which refers to all hardware, software, systems, and other tangible resources that are required to deliver integrated energy-related system solutions.
- *Total Cost of Ownership (TCO)*: We take a holistic approach to calculating the return on investment that our projects generate. By taking into consideration all possible costs of owning and maintaining the equipment or service, in addition to upfront capital costs, ESN provides TCO data to justify sustainable business models and solutions.

Partnerships

Since its founding, ESN has built upon its network of partner organizations—representing industry, academia, government agencies, non-profits, and others—to continue collaboration and broaden engagement to achieve the most innovative energy solutions. Past and current partners on ESN projects include, but are not limited to, the following:

A123 Systems	ITOCHU Corporation
AECOM	Ivy Tech Community College
Allison Transmission	LHP Engineering Solutions
Altairnano	MISO
Battery Innovation Center	Naval Surface Warfare Center Crane
Bolloré Group	Nissan
Cummins Inc.	Purdue University
Delphi Automotive	Rocky Mountain Institute
Duke Energy	SAIC
EnerDel	Simon Property Group
Hunt Construction	Sumitomo Electric
IBM	Toshiba
Indiana Economic Development Corporation	Toyota
Indiana Housing and Community Development Authority	Underwriters Laboratories (UL)
Indianapolis Power & Light	Vectren Corporation
	Wanxiang Group

Leadership—Board of Directors and Technical Advisory Council

ESN has engaged executive leadership representation on its Board of Directors, which includes Fortune 500 companies, academia, non-profits, and others. Current and past Board members include the following:

John Bear, President and CEO—MISO	Doug Esamann, Executive Vice
Carl Chapman, Chairman, President and CEO—Vectren Corporation	President of Energy Solutions;
Mitch Daniels, Jr., President—Purdue University	Midwest and Florida Regions—Duke Energy

David Glass, Chief Executive Officer— LHP Engineering Solutions	Tom Linebarger, Chairman & CEO— Cummins Inc.
David Johnson, President and CEO— Central Indiana Corporate Partnership and BioCrossroads	General Gene Renuart, Commander of North American Aerospace Defense Command and U.S. Northern Command (retired)
Eizo Kobayashi, Chairman—ITOCHU Corporation	Thomas Snyder, President Emeritus— Ivy Tech Community College

Previous Board Members

Hisao Tanaka, former CEO of Toshiba	Jeff Owens, former Chief Technology Officer at Delphi
Amory Lovins, Chief Scientist at Rocky Mountain Institute	Jim Rogers, former President and CEO of Duke Energy
John Kelly, Chief Technology Officer at IBM	France Cordova, former President of Purdue University

ESN has also gathered some of the greatest technical experts in advanced energy technologies to form a Technical Advisory Council (TAC) that helps direct and advise on ESN's current and new project activities. Current and past TAC members include the following:

Koji Abe, General Manager, Corporate Development Department—ITOCHU Corporation	Michael Rowand, Director of Technology Development—Duke Energy
Dr. Dan Hirleman, Chief Corporate and Global Partnerships Officer—Purdue University	John Waters, Chief Technology Officer— Energy Systems Network Previous TAC Members
Gary Johansen, Executive Director of Engineering for High Horsepower— Cummins Inc.	Dr. John Wall, former Chief Technology Officer—Cummins Inc.
Alec Proudfoot, Engineering Consultant—Proudfoot Design, Google	Dr. James Lyons, Chief Technologist— Novus Energy Partners
	David Mohler, former Chief Technology Officer—Duke Energy

Among ESN's portfolio of activities, there are four primary areas of work that fully demonstrate our strengths in public-private partnership development and implementation. ESN's most long-standing programs are centered around transportation electrification, through an initiative named Project Plug-IN. Additionally, ESN incubated and launched the Battery Innovation Center (BIC) in southern Indiana outside Naval Surface Warfare Center (NSWC) Crane. We have led a number of microgrid system projects including MicroGreen, a first-of-its-kind mobile microgrid. Finally, ESN's most recent program is called Moving Forward, which is a partnership with the Indiana Housing and Community Development Authority (IHCDA) to develop net-zero energy efficient affordable housing with integrated multimodal transportation options for low- to moderate income families.

Project Plug-IN

What began as one of the largest initial demonstration projects of plug-in vehicles in the nation in 2010 has evolved into supporting more than \$100 million invested in transportation electrification in Indiana. The first step in Project Plug-IN was an early adopters pilot in 2010 to introduce the first plug-in electric vehicles (PEV) in the state of Indiana. This resulted in more than 125 vehicles and nearly 200 charging stations deployed to support government and corporate fleets as well as private citizens across central Indiana. This pilot also led to one of the first time-of-use rates for PEV charging in the nation approved by the Indiana Utility Regulatory Commission. After our completion of the early adopters pilot, ESN engaged with the City of Indianapolis in 2013 to become the first city in the nation to announce conversion of its entire fleet to non-oil sources (i.e. electric, natural gas, and biofuels) by 2025. As a first step toward this goal, ESN worked with the City of Indianapolis to deploy 225 plug-in vehicles into its municipal fleet, representing the largest PEV fleet of any city in the nation.

ESN continued its partnership with the City of Indianapolis in 2014-2015 to establish a largest-in-the-nation all-electric car sharing program in Indianapolis with Bolloré Group of France. BlueIndy launched publicly in 2015 as the largest all-electric car sharing program in North America and operates more than 300 shared electric vehicles with more than 500 charging points located across the city. More than

50,000 trips have been taken in the first 18 months of operations and there are plans to grow the system to as many as 500 cars and 1,000 charging points. This project represents a public-private partnership with nearly \$10 million pledged by the City and local utility company and more than \$40 million from Bolloré Group.

ESN has also consulted with the city's public transportation corporation, IndyGo, to help select electric bus suppliers and technology options to include in the city's bus fleet, as well as provide our transportation electrification expertise to support the deployment of the nation's first electric Bus Rapid Transit (eBRT) line, the Red-line, that consists of a 13.6-mile route through the heart of the city. Today, IndyGo operates 21 electric buses—more than any city in the nation.

Battery Innovation Center

ESN launched the Battery Innovation Center in 2013 to accelerate the advanced energy storage market by linking manufacturers, government agencies and research labs, academia, and Fortune 500 companies.

The \$20 million R&D and prototype manufacturing facility is located next to NSW Crane, which houses a U.S. Department of Defense center of excellence in battery development and power electronics.

The BIC's proven capabilities attracted the attention of Underwriters Laboratories (UL), which made the BIC its Battery & Energy Storage Technology (BEST) Test Center. The BIC also serves as a U.S. Department of Commerce Proof of Concept Center and the first MESA Standards Alliance interoperability and testing center in the world.

To date, the BIC has contracted with more than 65 companies for a wide range of battery and energy systems development, testing and validation, or engineering services. This list includes large companies (Rolls Royce, SAIC, Cummins, Duke Energy, AES, GE, NEC, etc.) as well as emerging startups (BrightVolt, SiNode Systems, Black Diamond Structures, Pellion, etc.) and government labs and research institutions (NSWC Crane, Penn State University, Purdue University, Argonne Labs, etc.)

MicroGreen

In 2010, ESN launched a public-private partnership among technology, utility, and defense industry partners to develop a first of its kinds mobile renewable microgrid to provide scalable power to forward operating bases in remote locations without access to reliable power and who face dangers associated with delivery of diesel fuel. The project brought together a number of companies and institutions operating in the state of Indiana who worked together to design and build the MicroGreen solution.

Partners included SAIC, Cummins, EnerDel, Duke Energy, and NSW Crane. Funding for MicroGreen came from a \$1.5 million grant from the U.S. Department of Energy and was matched with more than \$3 million in private investment. In 2011, a prototype mobile microgrid system was completed that was capable of providing one megawatt of power using a combination of biomass, solar, and energy storage. The product was fielded and tested at Naval Support Activity Crane. System integrator SAIC used the IP and learnings to support a range of future projects for the U.S. Department of Defense and commercial customers.

Moving Forward Program

According to the U.S. Department of Housing and Urban Development, the budgeting rule of thumb for housing and transportation is 30 percent and 15 percent, respectively. That means that families usually spend nearly half of their income on these two necessities, and many spend more. For many families, covering these costs is a significant hardship. Current public subsidies, where applicable, do not consider the total cost of ownership (TCO) for either the home or the vehicle, such as utility costs, fuel, maintenance, and energy usage.

Moving Forward is a program that was developed between ESN and the Indiana Housing and Community Development Authority (IHCDA) in 2015 to address this challenge of affordable housing and transportation. Moving Forward approaches housing and transportation simultaneously to reveal additional solutions and efficiencies not typically seen when these topics are treated separately.

The program is an innovative, first-of-its-kind program to address the challenge of providing sustainable, integrated affordable housing and transportation. The program uses ESN's systems approach to create affordable sustainable housing that increases the quality of life for tenants, while decreasing the cost of living and transportation for low- to moderate income individuals and families. Using existing federal tax credits, IHCDA provides funding to support two affordable housing developments per year that integrate energy efficiency, the built environment, and transportation. The developers and their teams, selected by IHCDA, participate in ESN's

Innovation Workshop, a charrette-style brainstorming workshop which brings together an impressive collection of subject matter experts in built environment, transportation, systems integration, energy efficiency and supply, policy, finance, and poverty alleviation together to create two high-level designs. Developers then identify their own sites within Indiana and design their full-scale development plan.

Because the challenges of affordable housing and transportation are not specific to the state of Indiana, the Moving Forward program is one that can be replicated in other states with the same low-income housing tax credit programs as well as in other countries in which creating cross-efficiencies through a systems approach would result in cost savings and improved quality of life outcomes. This public-private partnership already has four net-zero housing developments with integrated multimodal transportation options for tenants in progress across the state, with two more beginning the process in November 2017. When completed these developments will house more than 200 low income families in six cities across the Indiana.

ESN INTERNATIONAL ENGAGEMENT

U.S.-China Advanced Vehicle Technology Summit, 2010

One successful example of our work to use energy technology to act as a bridge for international development was the U.S.-China Advanced Technology Vehicle Summit, held in 2010 in Indianapolis. The event brought together the largest ever delegation of automotive industry executives from China with a number of U.S. automotive technology supplier CEOs to discuss how the emergence of new hybrid and electric vehicle solutions developed in the U.S., including many from Indiana, could help China accelerate its adoption of cleaner vehicles. The summit hosted approximately 300 participants, including a number of government, institutional and corporate leaders including, among others:

Mitch Daniels, Jr., Governor of Indiana	David Sandalow, Assistant Secretary for
Chao Wang, Assistant Minister, Ministry	Policy and International Affairs at
of Commerce, Republic of China	U.S. Department of Energy
	President France Cordova, Purdue Uni-
	versity

CEOs and senior executives from a number of U.S. and Chinese automotive companies, including:

Allison Transmission	China FAW Group Corporation
Cummins	Dongfeng Motor Corporation
Delphi	Geely Automotive Holdings Limited
Remy International	SAIC
BYD	

Several memoranda of understanding (MOUs) were signed at the event between U.S. and Chinese companies, establishing international collaborative partnerships for advanced vehicle technology development and strategic cooperation. The signed MOUs include the following:

MOU of Two-Way Investment Promotion	Electric Vehicle Battery Joint Venture:
Cooperation: Investment Promotion	Wanxiang Group, Ener1 Group
Agency of the MOFCOM of China,	Agreement on Strategic Cooperation on
Indiana Economic Development	Vehicle Energy Efficiency and
Corporation	Environmental Issues: Guangxi
MOU on Cooperation: China Chamber of	LiuGong Machinery Company,
Commerce for Import and Export of	Cummins Inc.
Machinery and Electronic Products	Agreement on Strategic Cooperation on
(CCCME), ESN, China Association of	Research of Vehicle Energy Efficiency
Automobile Manufacturers (CAAM)	and Environmental Issues: Zhengzhou
	Yutong Group, Cummins Inc.

ESN AND INTERNATIONAL DEVELOPMENT

There are a number of ways in which ESN has impacted international development directly and indirectly through our projects and our diverse network of partners. Furthermore, there are several projects we have led which could be scaled internationally in ways that would support a variety of development goals and objectives including energy access, sustainable and efficient energy supply, energy secu-

ity, improved quality of life, and economic development. One of our founding principles is that no one company or institution has all the tools to solve our energy challenges. Solutions require a collaborative approach that cuts across traditional industry boundaries and leverages a range of corporate, academic, and government partners. This same guiding principle is directly analogous to addressing challenges of international development. It is the power of public-private partnerships and the collaboration that drives them, which is best able to address the complex and varied challenges of international development.

While ESN is based in Indiana and implements most of our work in the state, we ensure that our projects are scalable well beyond the Hoosier state. In order to drive scalability, we work to bring in partner companies that are working around the world and we reach out to other nations to find ways for our learnings to be adopted abroad. ESN has formed partnerships with companies and institutions in a number of countries including Japan, China, and France; we have also conducted outreach and engagement in the Republic of Georgia. Many of our past and present board member companies like Cummins, ITOCHU, Toshiba, Delphi, and IBM are active in nearly every corner of the world.

ESN's outreach and engagement around the world has taught us that energy solutions are truly global in nature. Many of the same challenges that we face bring sustainable, cost effective, and environmentally responsible energy solutions to the citizens of Indiana are present in most countries around the world, including those that are still struggling to develop modern energy infrastructure and supply. For example, the emergence of the increased adoption of distributed energy resources (DER)—such as renewables (solar, wind, biomass) as well as smaller scale fossil fuel plants, often coupled with energy storage in the form of advanced batteries—offers a revolutionary new approach to scaling modern energy supply. This approach moves away from a dependence on traditional centralized power plants with miles of transmission and distribution infrastructure needed to reach customers. Instead, energy supply is located closer to the demand and can be scaled up or down faster and with less cost over time. This DER approach is supported by advancements in controls systems that allow for microgrids to operate independently or link together in a broader system. Most traditional energy companies, including all of our ESN partners, are embracing this new approach to energy development and including it in their current and future systems buildout or upgrade plans.

A second revolutionary movement impacting the energy industry is the rapidly increasing adoption of transportation electrification. The development of hybrid and electric vehicles can trace their roots back to the state of Indiana. Indiana was the home of the General Motors Delco Remy Propulsion Division which developed the first modern electric vehicle, the EV1. The hybrid and electric powertrain technology from this effort preceded Toyota's famed hybrid Prius program. Later, the learnings of the EV1, developed largely in Indiana, resulted in the launch of the first hybrid bus system by Allison Transmission of Indianapolis. Today electric vehicles are becoming commonplace and nearly every major vehicle manufacturer for both light duty passenger cars to medium- and heavy-duty trucks and buses are rolling out electric products. Indiana's own Cummins, a global leader in diesel engines for more than a century, recently announced that it will be selling an all-electric powertrain into the market for trucks and buses by 2019. The trend toward more electric vehicles can, if managed correctly, perfectly complement the adoption of a DER approach to energy generation and distribution. This is because electric vehicles can charge and eventually, with improved technology, discharge into DER microgrid or networks in a way that supports the overall energy efficiency of the system. The electric vehicles, and specifically the batteries in the vehicles, in a sense become another distributed resource integrated into the network. This can be especially important in developing countries where the development of a DER network can support new forms of lower cost and lower emissions transportation, and where the alternative of building a traditional central power plan in addition to a supply chain for gasoline or petrol can be very expensive and take years to reach remote villages or communities.

The intersection of the DER and transportation electrification revolutions as well as other energy systems innovations are happening today through the work of ESN and our partners. We are leveraging Indiana as a launching pad for the innovative technologies, business models, and regulatory policies that will support its adoption. Our many successful public-private partnerships—including, but not limited to, the deployment of the largest electric car sharing network, the first mobile microgrids powered by renewable energy, development of advanced battery and energy storage solutions, and building of six net-zero affordable housing developments with integrated transit—are examples that our collaboration is working. The ability to share these learnings and models with other nations is a logical next step, and one that

ESN and our partners are eager to pursue with the guidance and support of this committee.

Senator YOUNG. Well, thank you, Mr. Mitchell. And thank you again to each of you for your insightful comments.

Before we proceed to questions, I would like to address one administrative item. Andrew Herscowitz, the Power Africa Coordinator for USAID, as well as Joe Scheuer, Director with the United Nations Development Program, Bureau for Policy and Program Support, have submitted written statements to the subcommittee. With unanimous consent, I would like to include them both in the record.

Senator MERKLEY. Consent.

[The material referred to above was not made available in time to be included in this hearing transcript.]

Senator YOUNG. Dr. Moss, in your testimony you state that the, “fracking revolution and rise of natural gas has dramatically changed the geopolitical balance.” Can you describe in more detail these broad developments and what their significance is and most importantly how U.S. policy should address them?

Dr. MOSS. Yes. If we think about the intersection of energy and U.S. foreign policy, a lot of people are still stuck in the Carter doctrine era where we just think about oil resources, making sure that the oil can flow, and it kind of stops there. But today we are looking at an incredibly dynamic global energy marketplace where the role of the United States is both a supplier and buyer. And in sub-Saharan Africa in particular, energy is such in high demand both economically and diplomatically that this is a new lever for the United States to help build alliances, to help support our partners and to help our allies become more capable to deal with a whole panoply of issues.

You know, Power Africa was not cooked up in the basement of some government building. Power Africa came out of a long series of consultations with African allies where they said we really want American partnership in the power sector. And that is what I mean. It is a new global energy statecraft where helping countries build energy systems is in our interest.

Senator YOUNG. Mr. Mitchell, Indiana has such a fine history of innovation. You spoke to some of the things we have done in the energy and transportation space. What do you see as the most promising R&D and innovation initiatives in the energy field right now? And what role is ESN playing in some of those cutting-edge areas?

Mr. MITCHELL. Well, you know, there is such a rich diversity of R&D and tech transfer going on it is hard to speak to that in a short period of time. But let me talk about two areas where I see a lot of interest in investment.

The first one is energy storage, and we have heard about that quite a bit today I think from each of the speakers. The energy and transportation industries have been looking for a low-cost, scalable way to store electricity for decades. And it seems we are finally reaching the tipping point where the family of lithium-ion battery technology could provide a viable solution. Costs are coming down

at rates once thought impossible. But it is still an expensive technology, and it has a ways to go.

In Indiana, we invested in launching something called the Battery Innovation Center that I spoke to earlier. And this lab really brings together industry, academia, and government institutions, and we are working with 65 companies from big corporations like GE and Duke Energy and Rolls Royce to promising startups like BrightVolt and SiNode. And what we are seeing is a number of game-changing innovations in the energy storage space from the coupling of batteries into really large grid storage systems that would look like a large data center all the way down to taking nano-materials and putting them on a small, flexible battery that fits into a medical device. Within the very near term, battery technology is going to be so ubiquitous you are going to see it on virtually—if you are not already, seeing it on every car, every airplane, every Internet-connected device, every drone, and every good system around the world. So this is a really important area of innovation.

Senator YOUNG. Are there things we should be doing from your vantage point here at the federal level to scale up some of these existing technologies, to catalyze new ones, especially as it relates to our international development efforts?

Mr. MITCHELL. Yes. I mean, I think one of the issues we have is that we certainly do not want to give up the battery industry to Asia. China is investing huge sums in building a number of large factories called giga-factories for battery technology. And I think there needs to be a concerted effort in the U.S. to make sure that U.S. innovation continues to play a leadership role in that space.

I think another area where we need to play a bigger role is something the previous panelist spoke to in terms of our innovation in unconventional oil and gas production. We have unleashed an amazing innovation in that type of fracking and that type of production. We are now producing volumes at prices and in locations once thought impossible of oil, gas, and non-liquid gases. And I think we have got to help other countries in unlocking that same potential in their markets and to use exports of oil and gas as a tool for U.S. interests around the world.

Senator YOUNG. Senator Merkley?

Senator MERKLEY. Thank you very much. All of you brought different perspectives to bear and expertise. Much appreciated.

Mr. Talocchi, as you talked about the variety of ways you can address the challenge of energy with micro-grids, you mentioned things such as irrigation, milling, drying, smoking, anyway small-scale—I do not know if you can quite call it manufacturing but small-scale energy applications. Can those be achieved with village-level grids?

Mr. TALOCCHI. Thank you for the question, Senator.

Some of those technologies are already nascently connected to the power generation as, for example, solar water pumps. With village-scale grids, it will all depend on the scale of the grid. So it depends on where you are on the energy ladder and the capacity of both the company that is there to make the initial investment but also capacity of the villagers to pay for that electricity. So some of

that can be definitely achieved with the technology. It is there. It just needs to be built in the right size for those activities.

Senator MERKLEY. Let me reframe the question a little bit. I have seen in villages in a variety of places fairly quick adoption of small solar panels that provide enough energy for communications, including very low energy television screens, cell phones, LED lights to study by or to cook by at night. But I have not seen much adoption for kind of day-to-day tasks done in the village in terms of husking, drying, grinding, milling, and so forth.

Are you starting to see that now in your broader exposure to what is going on?

Mr. TALOCCHI. Yes. And I was part of that in the Amazon when we installed grids there and we supported the supply chains of fish with refrigerators. So that was a big step so people could store fish, keep it there, and only transport it back to markets when they had better opportunities or volumes.

In India, there are opportunities. Husking, for example, is happening with the support of biomass. So you have micro-grids there built using not necessarily only solar technology but hydro and biomass and that then can be scaled to support the activities. And it is a win-win because they have the fuel right there.

Senator MERKLEY. So one of the things I have often heard as a critique of distributed solar is that you cannot essentially enable there to be manufacturing activities. And I think that is fair. Large energy demands, especially ones that require a lot of heat. But in an economy, normally those are done in centralized urban areas anyway because of the networks of transportation. So you do not really put a factory that takes—even if you have electricity, you do not put it in a village far out somewhere.

But you mentioned that there is another advantage, which is eliminating power line disruption. And it took me back to a situation in West Africa where power lines would go up, and then they would disappear because of copper theft. Is that still a problem with the effort to expand grids?

Mr. TALOCCHI. I do not know if the power lines are a problem. I know that in Brazil we have seen a lot of politicians promise access to energy during campaigns, and if elected, they would sometimes bring the light poles and then nothing would happen. And then 4 years later, they would run again, and maybe the cables would be connected but not necessarily the electricity. So the grid was kind of a choke point that was used and not to supply electricity but to achieve votes.

Senator MERKLEY. And you mentioned in your written statement how the sociology changes as people become used to what is possible. And for example, maybe it was the Amazon community you referred to where women started buying hair dryers, and that proved incompatible and had to drive a community discussion.

Mr. TALOCCHI. Yes. So one of the systems we installed—we quickly realized that because, of course, we were dealing with a limited supply of electricity, you needed people to be responsible with the amount of electricity that they would use. So, yes, some of the women in the village got hair straighteners or blow dryers, and those systems made the solar grid shut down. That was sorted with a community meeting, but now smarter grids, remote con-

trolled grids, and pay-as-you-go systems would probably solve that through the technology side.

Senator MERKLEY. Wind can also produce very low-cost energy, but you tend to see a lot more solar. Why is that?

Mr. TALOCCHI. Sorry?

Senator MERKLEY. Wind can also produce very low-cost energy, but in terms of micro-grids, at least what I have seen, there is a lot more solar. Why is that?

Mr. TALOCCHI. I think, one, there is less data on the availability of wind in remote communities they need to measure, and the initial capital investment for a wind turbine is higher than for solar. And also it is much more complicated to fix and repair, and there are not enough suppliers in the market that can offer that technology.

Senator MERKLEY. Thank you.

Senator YOUNG. Thank you, Senator Merkley.

Dr. Moss, would you like to reply to Senator Merkley's line of questioning, please?

Dr. MOSS. I think the hair dryer example is pretty telling in that we are talking about, very often in many cases, very, very low power systems where you have to have a village meeting to coordinate who is going to use a hair dryer when. You know, this is something that we absolutely take for granted in the United States.

And I think it is worth thinking a little bit about the scale of power we are talking about. So there is no such thing in the world as a rich country that is a low-power economy. It does not exist. In the United States, we use about 13,000 kilowatt hours per person. Nigeria is at 150. So the gaps are so tremendous that we really need—you know, all-of-the-above is usually used in the context of fuels mix. It is also in terms of delivery systems. So, absolutely, rural isolated communities, should not have to wait for the grid. They are absolutely going to use decentralized systems, and those systems are getting better and cheaper every day. It is actually a super exciting time to be working in the energy field, but the big cities, the big industrial zones are, I do not think in our lifetime, going to be running on small systems. So we are going to need all-of-the-above in every way possible.

Senator YOUNG. Is this why you make the point that many countries are still going to need their own natural gas as part of their energy mix moving forward and that we have an interest in helping those countries, a point Mr. Mitchell made, exploit their natural resources?

Dr. MOSS. Absolutely. I mean, many of the countries that have the greatest unmet power needs are producing natural gas, and there is no question whether they are going to produce it or not. It is a question of whether they are going to export all of it to richer markets or whether a small portion of it will be used for power generation at home. And that is where initiatives like Power Africa can be very helpful because you have got to deal with a lot of policy issues around the grid, around the utilities, around the pricing structure to get a complicated power deal in place.

Senator MERKLEY. Well, how can we improve that? You indicated that there are some improvements that could be made over at

OPIC. In fact, you said that we could easily do two or three times the volume of power deals in Africa. That would be a lot more deals. But Congress is going to have to take some specific steps. What are those steps?

Dr. MOSS. Well, with OPIC specifically, OPIC is a very high performing agency that was built in the Nixon administration and it is still living with rules from the Nixon administration. So there are things like multiyear authorization, the authority to take equity positions, which is very important in certain kinds of deals, the ability to just invest in its own teams to have enough staff to handle the deals, and a number of other ways that would not cost American taxpayers money. Ideally, a super-sized OPIC would actually even generate greater profits and save taxpayers even more. So that is really the crux of turning OPIC into a bigger, better institution.

Senator YOUNG. Thank you.

Mr. Mitchell, ESN has been involved in a number of public-private partnerships with respect to energy and transportation. You have some sense of when those public-private partnerships make sense and when they do not. Tell me. In what instances should government play a large role? When should the private sector play a larger role, and when is there an opportunity for a blending, if you can give me some general rules of some rules to go on in this area?

Mr. MITCHELL. Public-private partnerships are really at the center of what we do at Energy Systems Network. And so we have got a lot of experience in this area.

What I would say is in almost every instance, successful public-private partnerships are industry-led and are driven by industry funding. I think if you look at the Power Africa experience and the ability to leverage a lot of private capital, that is going to be the fastest way to succeed. You absolutely need a joint partnership and collaboration between government and industry, but if you cannot get industry to the table, if you cannot get them to risk their own capital and to put money into projects, the challenge is when that public money starts to dry up or the priorities move somewhere else, the projects kind of end. We heard about that earlier where maybe some solar panels were put in but then never fully exploited. And so you have got to find ways to bring private innovation and private capital to the table.

And I actually think one of the things that is holding that back is a lack of awareness. In my experience, a lot of the companies that are doing the most innovative things in Indiana or the United States are small to medium-sized businesses, and many of those companies view international development projects as something that is reserved for the large multinational corporations or large global NGOs when the reality is if we could find ways to connect and learn more about what is going on in the Hoosier State but also other States and connect those to business partners overseas, some of these development goals are going to happen on their own.

Senator YOUNG. Are there specific steps that we as policymakers can take, to your mind, so that U.S. companies can compete more successfully for U.S. Government projects, for multilateral development projects, or other contracts that are out there?

Mr. MITCHELL. So one step—it seems simple enough, but it may be one of the most important—is awareness. It is finding a way to get the USAIDs, the Millennium Challenge Corporations, the OPICs, and others out into the States interacting with organizations like mine, Energy Systems Network, and others so we are even aware that these programs are available because, again, I think a lot of companies in the U.S. think of this as something that is happening somewhere else that they do not have available to them. So outreach and engagement.

The other thing I would say that would be important is a lot more business-to-business partnerships that are driven between States or regions and provinces or communities overseas, so not necessarily nation state to nation state. But we have seen a lot of successful partnerships come from sister city relationships between Indianapolis or Indiana and communities overseas.

Senator YOUNG. Thank you, Mr. Mitchell.

Senator Merkley?

Senator MERKLEY. Thank you.

Mr. Mitchell, you talked both about renewable but also about oil and gas development. And one of the circumstances we face is that the level of carbon pollution driving climate disruption has risen substantially, and the rate of pollution has increased almost three-fold between 1960 and now. That is, we are polluting the air at a three times faster rate now than we were decades ago. And we are seeing the impact in many ways. The point was brought home to us most dramatically by the energy contained in the recent set of hurricanes. And while it is often noted that any single hurricane is hard to attribute directly to the warming of the ocean, the warming ocean does in most cases—most scientists would acknowledge—creates greater power in a hurricane, a greater punch. We were hit pretty hard.

As you wrestle with advocating for energy systems around the world and we have this particular global challenge, how do you weigh that in your decision on how we should proceed?

Mr. MITCHELL. Let me say that every project that we have led at ESN has had a net positive impact on reducing carbon emissions, but those have not been the primary driver or the primary goal of the project itself. The primary goal has always been technology innovation.

I am glad you are asking me this question because one of the things I think that we need to recognize is the phenomenon of distributed energy resources, which is a term we have heard a lot today, is not limited to renewables. In the United States and specifically in Indiana, what distributed energy resources means is having the generation closer to the demand source. And so that includes, of course, renewables and things like energy storage to help balance those renewables. But it also includes in many cases distributed fossil generation plants, usually smaller-scale natural gas combined cycle plants that are far more efficient, have a much lower CO₂ impact than, say, large baseload coal plants of the past. And I really think that if you are going to achieve this combination of energy access but also abundance, which is necessary for economic growth, serious, long-term economic growth, you have to blend distributed energy in the form of renewables with combined

cycle natural gas, usually smaller-scale systems, and this new phenomenon of energy storage. That trifecta gives you the reliable power source that you need that is also scalable to support the kinds of economic development growth opportunities that can allow a manufacturing site to be in a more rural location.

Senator MERKLEY. And, Mr. Talocchi, we have seen the impact on economic development in some cases flowing from carbon pollution both in terms of fisheries, droughts affecting farming, hurricanes destroying significant areas. As you ponder our energy choices, how do you weigh into your decisions the observable impacts of carbon pollution?

Mr. TALOCCHI. I think that when we look at the development goals that we have ahead of us—the UN has 17 of them—climate change, if it happens as predicted and as the models that are most accepted say it will, it will impact our ability to meet each one of those goals, all 17 of them.

So our understanding is that we need to prioritize and continue to invest in renewable energy at all scales. We believe it is possible to achieve the same kind of energy access in abundance through renewable energy technologies paired with, of course, storage technologies and even accelerate that to the transport sector. You see the governments of China and India making commitments to go 100 percent electric on the transport. Of course, that is going to increase electricity demand. And those commitments must now be paired with commitments to also increase the amount of renewable energy generation and capacity so when we get to stages where all the vehicles are being electrified, that electricity is also clean.

We believe it is doable. It is happening. Governments around the world are already adopting that vision. Forty-eight of the world's least developed countries, known as the Climate Vulnerable Forum, have made a commitment to go 100 percent renewable, and now we need to find ways to support them in getting there.

Senator MERKLEY. Thank you.

Senator YOUNG. Dr. Moss, you know, I hear a lot of these public pronouncements by countries in international forums, and sometimes I wonder whether or not they are genuine, thoughtful, believable commitments or, if instead, they are public relations, or maybe a little bit of both. So we just heard about a pledge by—was it 40 countries, sir? What are your thoughts about that, Dr. Moss? Are we really moving that boldly into a new frontier where that will be possible, 100 percent renewable?

Dr. MOSS. International fora—governments make certain commitments all the time. Some of them are real; many of them are not. I would be surprised if we would see 48 countries go entirely renewable. The countries that have very, very high proportions of renewable—it is mostly large hydro, which also faces significant challenges. There is still a lot of hydro potential in sub-Saharan Africa. So we could see a lot more of that. So that is certainly one option.

When I hear talking about the poorest, most vulnerable countries of the world and how they are going to lead on this, it is true. They are going to have a much higher renewables mix. These are a lot of tropical countries with a lot of wind and solar resources. But these are also the poorest countries in the world, and these bright

lights that are shining on us right now—95 percent of the power in Washington, D.C. comes from coal, gas, and nuclear. And so there is more than a whiff of hypocrisy when we are trying to restrict finance for the world's poorest countries to use their own resources in ways that we are already doing especially since these countries are not the ones causing the emissions in the first place.

Senator YOUNG. Well, thank you, and I would request that in the future, when you answer, do not be so politically correct. Just tell us what you mean. [Laughter.]

Senator YOUNG. Thank you, Dr. Moss.

Dr. Moss, could you and Mr. Mitchell address the following? We know many U.S. companies work in the international energy sector, but their interests are not always aligned with our government. How can we in the U.S. Government better leverage the efforts of U.S. firms in developing resources in certain countries to actually promote U.S. policies?

Mr. MITCHELL. Let me give you an example of a company that I have worked with closely, Cummins, and they are an Indiana-based company and they are active around the world. And one of the things they sell is diesel and natural gas gen sets that are used for providing remote power, in some cases all the way up to multi-megawatt power systems.

And so I think to the point that was made earlier, you need to have an all-of-the-above approach. You need to make sure that you are engaging with the companies that are involved in the natural gas and the oil and gas industries in the United States and think about what role they can play in this broader solution of access and abundance.

What can we do to get companies more directly involved or make sure we are all swimming in the same direction? A lot of it goes back to information sharing in forums and engagement.

The other thing is to ensure that there are ways that companies can co-invest in these projects and that they are not restricted in terms of regulatory or financial restrictions on how they can invest in overseas development projects. Some of that has to do with some of the tax issues of getting money invested overseas and bringing the profits back and so on and so forth, which I know we are trying to work on and folks are working on right now. I mean, those are the kinds of things that you can do.

But definitely the key is to get more companies involved and I think strategically to get more small to medium-sized businesses involved.

Senator YOUNG. Dr. Moss?

Dr. MOSS. The United States—we do not have China's model. We are not using our companies to directly implement our foreign policy, and I do not think that we should.

I do think, though, that the United States—the way our companies operate overseas helps to set a higher bar in terms of behavior, in terms of transparency. I think the Foreign Corrupt Practices Act is one of the most important things that the United States brings to the world because, A, it helps protect our companies from poor corporate governance and misbehavior in certain circumstances, but it also raises the bar for everybody else and helps to create a more level playing field and promote good corporate gov-

ernance and good governance in the countries in which they operate. That is one of the greatest things that we can do.

Senator YOUNG. Senator Merkley?

Senator MERKLEY. Dr. Moss, I believe you have written some about the challenge of energy-rich, fossil-rich countries facing the energy curse, that is, that the value of these resources is so high, they drive an enormous amount of corruption, make decision-making on behalf of the country benefiting from those resources extremely difficult. Advocates sometimes end up dead.

Equatorial Guinea has a per capita income of \$20,000. Envyable for a developing country around the world. But the majority of the population of that country lives on less than \$2 a day. Any thoughts or insights on how we address that?

Dr. MOSS. Yes. Well, thank you for that question. I mean, this is one of the biggest challenges that a lot of countries face, and we collectively as the development community have some answers but they are not very satisfactory. It seems to work best in countries that have strong institutions that are relatively democratic and that deliver services for their people. But this is kind of akin to telling an insomniac that you have diagnosed their problem and they need more sleep. It is true but it is not very helpful.

So one of the things that I have been working on—I actually wrote a book with colleagues at the Center for Global Development in 2015—is if there are lessons we could learn actually from the U.S. State of Alaska which, as you know, provides a dividend to every State resident every year. Now, that was the genius of Governor Jay Hammond back in the early 1980s, and he did that not because Alaskans were poor, but he wanted every Alaskan to feel it in their pocketbook to pay attention to what the politicians were doing with their money, with their natural resources. So we did a book called “Oil to Cash,” which explores the possibility of using citizen dividends in resource-rich countries to try to ignite greater public interest in how resources are used and to see if we can create a positive dynamic rather than the negative dynamic that, as you rightly point out, we have seen in places like Equatorial Guinea.

Senator MERKLEY. Any success?

Dr. MOSS. So there are a lot of countries that have become wealthy and successful from natural resources. We live in one. Canada, Australia. These are resource-rich countries that have managed to avoid the resource curse. There are a lot of countries on the other side that are not doing well.

You know, one of my favorite countries that I have already spoken about, Nigeria, is still struggling with this. I do think things are getting a lot better. Nigeria now reports on all of their oil income, where it is going. We now have a better idea of how it is being spent. But it is a long process. It is a very political process.

And I do think we are seeing some progress with countries experimenting with cash dividends in very specific cases, but we have not seen the full Alaska model replicated anywhere else yet.

Senator MERKLEY. So I will just close my comments by saying I would encourage you to be careful with charges of hypocrisy. It is kind of a below-the-belt shot. There are many parts of the developing world that are deeply afflicted by changing climate suffering

significant starvation. We have seen that starvation trigger tribal wars and significant chaos. In Syria, we saw the collapse of the village economy help drive the civil war that led to the mess that we have been dealing with for years and will for many years to come. Many fishing communities, island communities, are extremely worried about rising sea levels and salt water infiltration of fresh water sources, and many of them have fisheries that are driven by coral reefs that are dying. So these are very important issues in global economic development. And I want to try to steer away from doubting the sincerity or integrity of the conversation.

Senator YOUNG. Well, thank you, Senator Merkley.

I want to accept some measure of responsibility. I sort of led into my question with Dr. Moss by admitting that occasionally I have some skepticism when these international pledges are made. But I am grateful for our constructive relationship. I understand the depth of conviction you have about the importance of these issues. He has played a very important leadership role in these issues, and I am still learning from you. So thank you very much.

I am going to ask one final question of Dr. Moss. Because Power Africa has been such an important model not just for the United States but really for the world with respect to electrification and energy development, what best practices have we seen with Power Africa that might potentially be applied to other sectors of international development?

Dr. MOSS. Thank you for that question.

Let me just briefly just take the opportunity to clarify. I absolutely believe that developing countries are being tremendously impacted by climate change. I believe that it is real. The issue is that Tuvalu did not contribute one bit to the Global Climate Change Challenge. That came from Europe, the United States, and other rich countries. The countries that suffer the most are those least responsible for those problems. That was merely my point.

Power Africa I think has actually done—yes?

Senator YOUNG. Senator Merkley, do you have any follow-up there? I just want to make sure everyone is good at the end of this hearing. We want to continue to do some good together.

Senator MERKLEY. I think that point is accurate. In April, when I was meeting with India's power minister and we were discussing the challenge of financing renewable energy, he indicated it was somewhat irritating to have this conversation with Americans who for 150 years were burning the coal and the oil that created a lot of this problem. And I acknowledge it. That is an accurate representation of our energy history.

And I said we can wrestle with that, but looking forward, what does a single kilowatt of new coal energy cost? And the answer is about 7 cents. And what was the cost of a new kilowatt of solar energy? The answer is about 3 to 4 cents. And I said, so how do we work together to help take advantage of the changing economics for renewable energy? And I said, and by the way, there is a big difference between what is outside your window and you could not see in New Delhi 200 yards down the road because of the—it was not just it comprises your sight. It is the fact that people breathing that is having enormous health consequences. And so there is a huge bonus on top of the fact that solar is cheaper.

And 3 months later, the power minister who told me at that meeting he was going to build 40 new power plants in a 2-year period, announced a couple months later that they were canceling those plants and were doubling down on their strategy with renewable energy. And I think that is part of the conversation around the world.

Senator YOUNG. Dr. Moss?

Dr. MOSS. Thank you, Chairman.

So I think Power Africa—you know, I was skeptical that Power Africa, which at times is wrangling 12 federal agencies to cooperate around a small set of projects, that that would work. I think they have done an admirable job doing it. But I do think that Power Africa is kind of the exception that proves the rule that you need a presidential initiative, you need a special coordinator to kind of make all of our agencies cooperate. So I am actually quite skeptical that we can replicate this many times over because it is such a heavy lift and it is such a deliberate effort.

I do think that it is absolutely worth continuing, but I would not like to see us try to have a Power Asia, a Water Latin America, all of those efforts. I think that would be an interagency nightmare.

Senator YOUNG. Well, thank you. We are now officially out of time. So I want to thank each of you for appearing before us today.

We are going to leave the record open for additional questions until 5:00 p.m. on Friday.

Thank you again to everyone in attendance, as well as our witnesses and most especially to my ranking member, Senator Merkley.

This hearing is officially adjourned.

[Whereupon, at 4:20 p.m., the hearing was adjourned.]