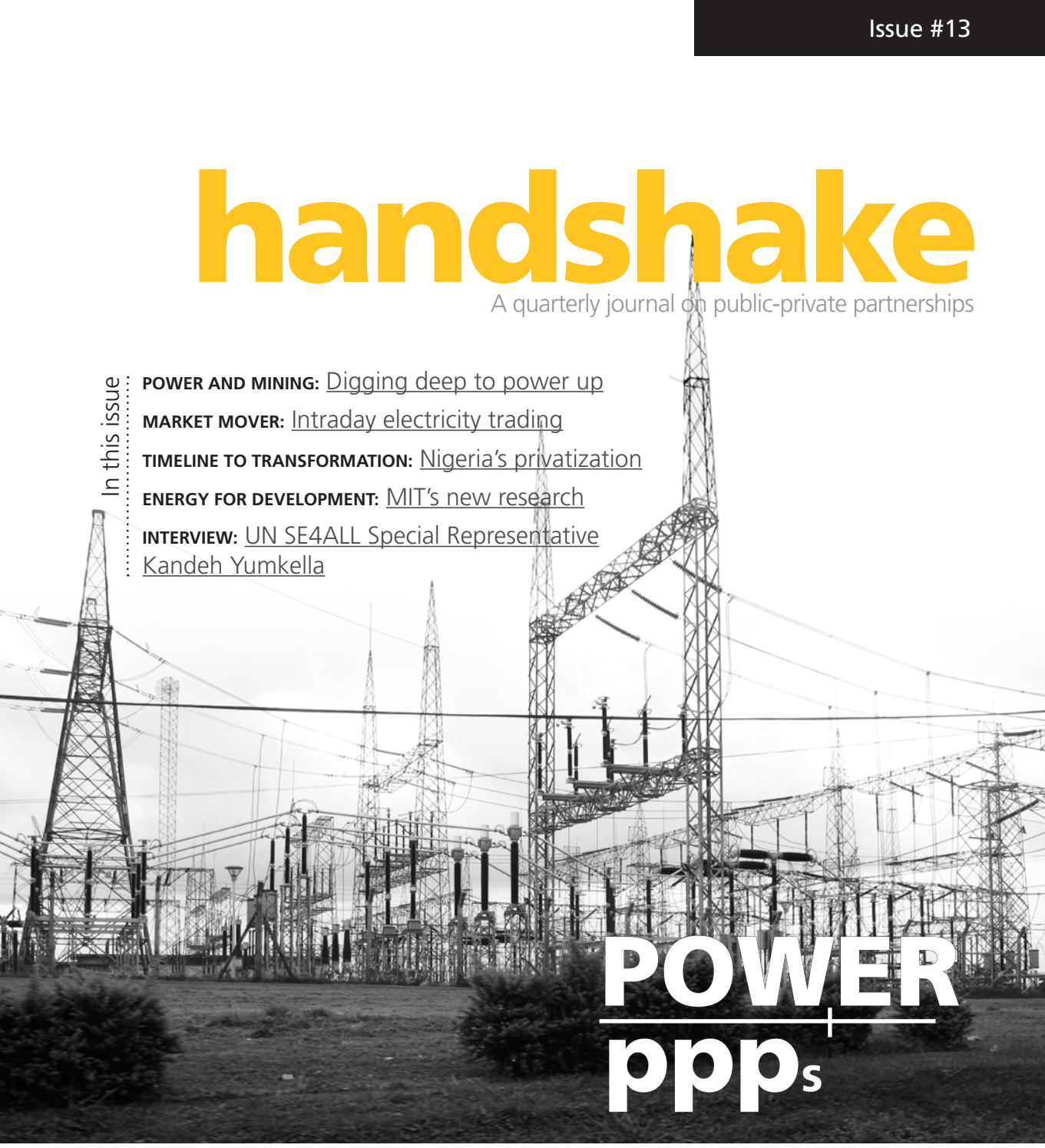
Issue #13

handshake

A quarterly journal on public-private partnerships

In this issue



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In this issue

In the 1924 *The Atlantic* article "Life as we know it," Arthur D. Little, an engineer who founded the world's first management consulting company, tried to predict the future. Amid all he got right—and wrong—two sentences still scream out for attention: "The rate of our economic progress is primarily a function of the abundance and cost of energy. The preparation and use of fuels and the generation and distribution of energy are basic industrial activities, which, in one way or another, vitally concern us all."

Almost an entire century later, energy continues to vitally concern us all—because progress will continue only if the energy that powers it keeps pace. By all accounts, it is not. The gap between what's being produced and what's needed continues to widen, and the effects of climate change threaten to deepen energy poverty in the regions that can tolerate it least.

The Special Representative of the UN's Secretary General for Sustainable Energy for All, Kandeh Yumkella, understands energy poverty first-hand. He recalls for *Handshake* readers a recent visit to his native Sierra Leone for his university's 50th anniversary celebration, at which power outages and other energy shortages marred the proceedings. His earliest demonstrations as a student at the university 30 years ago, he remembered, were in protest of these very same problems, which prevented students from studying at night and denied them clean water in the dormitories.

Yumkella and the other experts, officials, and industry leaders in this issue believe that public-private partnerships can help bring much-needed access to energy to students like these, and to people in all corners of the globe. With the world's energy future at stake, it's time to listen to these voices. Together, they can give a new meaning to "life as we know it."

Laurence Carter, Director

Tanya Scobie Oliveira, Editor

IFC Advisory Services in Public-Private Partnerships

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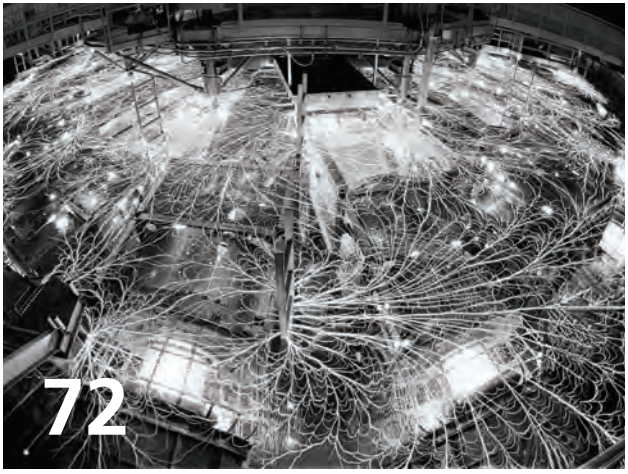

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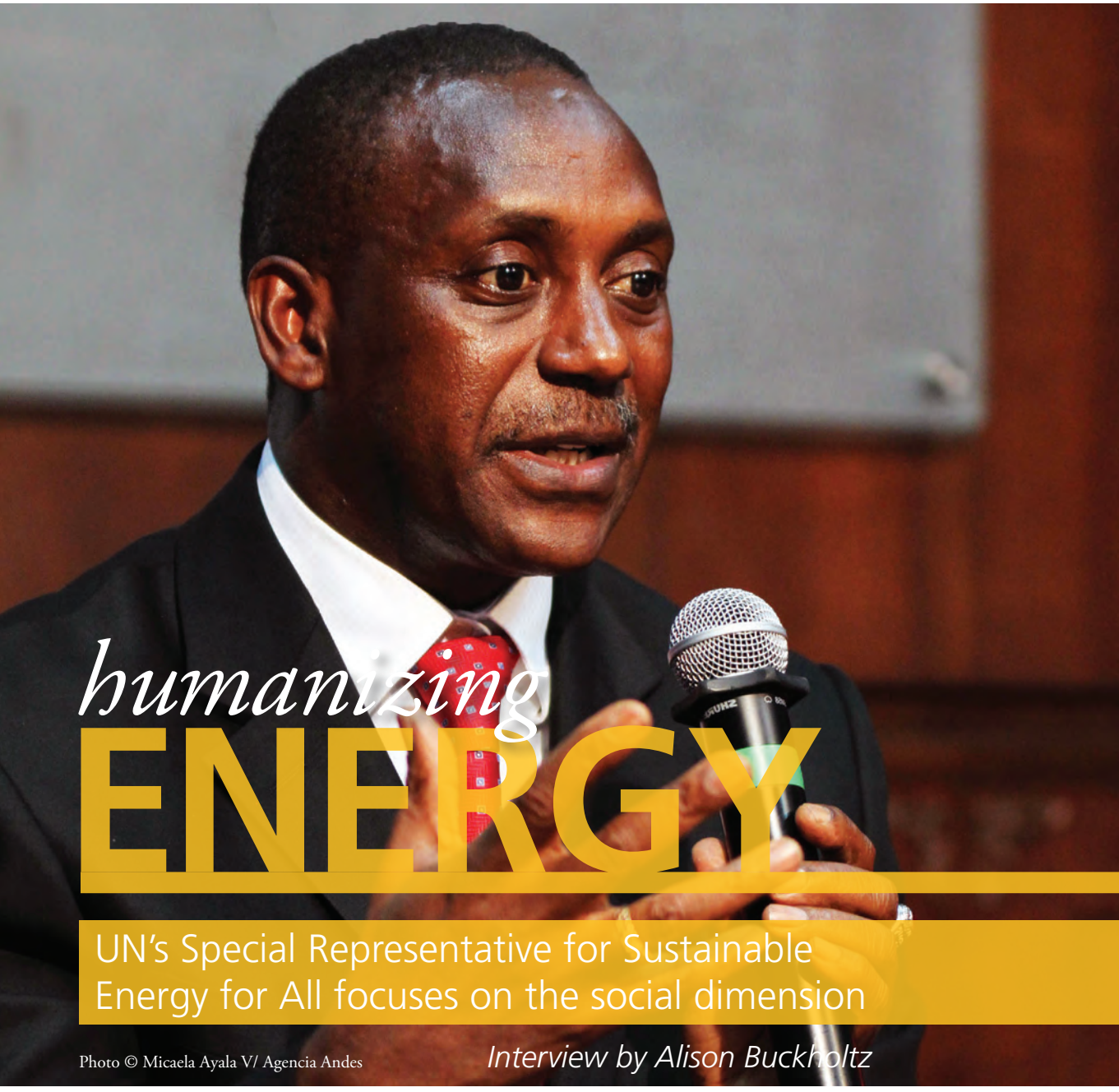


humanizing ENERGY

UN's Special Representative for Sustainable Energy for All focuses on the social dimension

Photo © Micaela Ayala V/ Agencia Andes

Interview by Alison Buckholtz

Kandeh Yumkella was appointed Special Representative of the UN Secretary General for Sustainable Energy for All (SE4ALL) in September 2012. In this role, he mobilizes commitments to positively transform the world's energy systems toward a sustainable energy future. Here, he talks to Handshake *about growing up energy-poor, the key role that public-private partnerships play in transforming the energy market, and the suite of policies that can jump-start the energy revolution.*

Your position is new at the UN. What does it feel like to be able to start something brand-new in the sustainable energy arena, and energy poverty in general?

For me personally, it was a culmination of my efforts over a period of almost a decade, trying to argue the case that I don't see the poor developing countries, particularly those in Africa, being able to achieve their goals without access to energy. There is a direct link between income poverty and energy poverty. Getting this appointment was an exciting opportunity because suddenly the UN believed we must institutionalize these issues in the context of ongoing development discussions. Now, having said that, I have to add that setting up a new institutional framework for this is more challenging than I thought. But it's an exciting challenge.

What has energy poverty meant to you in your own life, growing up in Sierra Leone and attending university there?

Let me put it this way. I was in Sierra Leone several weeks ago and I think of my trips there as going "back to the future." During my visit, we celebrated the 50th anniversary of the university that I attended as an undergrad, over 30 years ago. The same problems still exist: lack of regular electricity supply, lack of clean water supply. I remembered that the second demonstration I co-led against the administration of that university, at age 19, was about lack of energy—administra-

tors could not provide electricity and clean water to the dormitory. Thirty years later, here I am still trying to deal with the same issues.

How does climate change impact the energy issue?

Climate change makes it more urgent to take action on global energy systems—otherwise, we are all condemned to climate hell. Also, I see the inequity and unfairness of the global economic system through the lens of climate change. Those who pollute the least will suffer the most from "business as usual." Africa is a good example. They account for less than 3 percent of greenhouse-gas emissions, but when you look at climate change scenarios, going into 2030 to 2050, the worst impact will be in Africa. They lose 50 percent of their crop yield. For each one degree rise in global temperature, in Central Africa and parts of the Sahel, they experience 1.5 degrees—for something they did not cause. There will be an increase in diseases with extreme weather events, and because they don't have the economic wealth, they are less resilient. Climate change is the biggest risk multiplier.

> *"Climate change makes it more urgent that we need to do something on global energy systems. Otherwise, we are all condemned to climate hell."*

What role do public-private partnerships play in solving the problem of access to energy?

Public-private partnerships will be the key to sustainable energy for all. That's why our initiative, SE4ALL, is what we call a mega partnership or a mega creative coalition. We have always included CEOs of private corporations, government leaders, and leaders of civil society. To achieve universal access to energy by 2030, we need about a $50 billion dollar investment per year. The total official development assistance is $9 billion. To reach $50 billion, you need private money, not given as aid but as investments blended with public finance. We want to create markets and incentives to deploy technology and get energy access for people.

The big question is how you create this and get the companies to be excited to make money and change the world. That's our challenge.

What do you say to persuade government officials who need to be convinced to make access to energy a priority?

Even in the very poor countries, many government officials don't see the link. They have been focusing, legitimately, on energy for economic

growth. I give them another reason, sharing with these leaders my views on the social dimensions of energy and providing some new data—like the fact that 4 million premature deaths each year are due to household air pollution. It's worse than HIV and malaria combined. They say, "Oh really?" Then I tell them, "Your women spend 20 hours a week collecting firewood and water. If they had solar power to pump that, it would free them up and the girls could go to school." Now people begin to see the numbers and it begins to resonate. This is why, at the beginning of the decade of Sustainable Energy for All, we are dedicating the first two years to energy, women, and children's health. This is the way to humanize the energy debate.

Which countries are handling access to energy the right way?

Brazil, China, and India are all doing this very well. Brazil pushed electricity for all; now they are at about 90 percent electrification. The current president, when she was Minister of Energy, led the campaign for energy access tied to poverty reduction and social inclusion. That was their message. And they saw the impact immediately. You bring energy to the rural community, and shops open up. You bring energy to the rural community, and they process more agricultural products. Incomes go up, and they buy more consumer goods.

These countries, and many others, have domesticated renewable energy technologies—reducing their size, making their costs lower, and getting women to install the equipment themselves, leading to social inclusion.

Morocco, which is at almost 90 percent electrification, is another good example. They are doing everything with solar and wind. And Bhutan might be one of those countries in the next five to 10 years that achieves all the targets for renewable energy. On rapid electrification, South Africa is a big success. Same with Vietnam and Cambodia.

> *"At the beginning of the decade of Sustainable Energy for All, we are dedicating the first two years to energy, women, and children's health. This is the way to humanize the energy debate."*

You always make it a point to say that sustainable energy for all is not just about poor countries. What do you mean?

It is about you and me living in the first world, doing our share. Germany is a great example.

Germans are doing distributive rooftop solar power to show that consumers of energy can become "prosumers"—they consume, and they produce. They have their solar power, they use some of it, and they supply the rest of it to the grid. This shows that if you go solar, you reduce your emissions, but your lifestyle does not suffer. You pay a little more. But you and I can afford it, can't we?

The same principle applies to energy efficiency. The Danes have reduced their energy intensity more than any other nation. Their GDP grew as their energy consumption declined at the same time. They have one of the best energy intensity measurements, but now they are pushing an even greater ambition: to have more renewables in their energy mix and reduce their footprint. The big question is how to convince the consumers to change their behavior, and incentivize this change.

SE4ALL

In December 2012, the United Nations General Assembly declared 2014 to 2024 the Decade of Sustainable Energy for All, underscoring the importance of energy for sustainable development and the post-2015 development agenda. The resolution by the General Assembly affirms support for the initiative's three goals of providing access to reliable and affordable modern energy services; doubling the global rate of energy efficiency, and doubling the share of renewable energy in the global energy mix.

2014 - 2024
UNITED NATIONS DECADE OF
SUSTAINABLE
ENERGY FOR ALL

It sounds like you're saying that the importance of incentives can't be overstated.

Incentives are important and regulations also matter. If you don't regulate, people will find short cuts. If you're going to create new markets, you have to incentivize research and development and bring private investment in. You need to incentivize corporations as well as individuals. Public policy is also important, generally, for creating that enabling environment that includes incentives, regulation, and also accountability measures. This is the suite of policies that you need if you want to see this energy revolution spread across the world.

THE WORLD BANK GROUP AND SE4ALL

The World Bank Group's President co-chairs the Sustainable Energy for All (SE4ALL) Initiative, which seeks to achieve three goals by 2030: universal access to electricity and clean cooking solutions; double the share of the world's energy supplied by renewable sources from 18 percent to 36 percent; and double the rate of improvement in energy efficiency. The World Bank Group's Energy Sector Directions Paper describes how it will help client countries secure the affordable, reliable, and sustainable energy supply needed to end extreme poverty and promote shared prosperity.

The World Bank Group is advancing SE4ALL goals in many other ways as well—by supporting capacity building, technical assistance, and knowledge services to help countries expand access in a sustainable way. These initiatives include:

THE ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAM (ESMAP)

ESMAP is supporting a technical assistance program to help countries achieve universal energy access by building portfolios of investment-ready projects for public and private financing. The $15 million program has begun in Senegal, Liberia, Guinea, Burundi, Mozambique, Nepal, and Myanmar, along with a program to promote improved cookstoves in Central America. ESMAP also manages a Global Geothermal Development Plan that seeks to mobilize $500 million to boost geothermal power in developing countries, as well as a Renewable Energy Mapping Program to identify renewable resource "hot spots."

THE GLOBAL GAS FLARING REDUCTION PARTNERSHIP (GGFR)

GGFR, managed by the World Bank Group, has supported efforts to cut flaring of gas associated with oil production by 20 percent worldwide, from 172 billion cubic meters (bcm) in 2005 to 140 bcm in 2011. This has reduced CO_2 emissions by over 270 million tons, roughly the equivalent of taking 52 million cars off the road. The World Bank Group and GGFR partners have agreed to step up flaring reduction efforts during the next four years as part of the SE4ALL Initiative.

SUSTAINABLE ENERGY FOR ALL

Kenya—a nation in the midst of rapid transformation.

POWER SURGE

By Bastiaan Johan Verink, World Bank & John Probyn, PPIAF

Strong economic growth, population increases, and rising levels of access are driving electricity demand to soaring new heights globally, and especially in developing countries. The International Energy Agency estimates that for the period through 2035, non-OECD countries will account for most incremental electricity demand, set to increase from 11,300 terawatt hours (TWh) to just over 26,000 TWh—more than the current generation capacity of the entire world. This makes electricity demand in developing countries the single greatest source of increased final energy demand from all sources—including liquid fuels—over the next 20 years.

Globally, the annual investment required to satisfy the demand growth is substantial: over $740 billion per year, close to $430 billion of that in greenfield project capacity. As electricity sectors in many countries deregulate and look to private capital for investment requirements, independent power producers (IPPs) will play an increasing role in providing the necessary generation capacity. Just how much private capital has been mobilized toward the power sector in recent years?

Photo © Beni/flickr

MAPPING IT OUT

Between 2002 to 2012, a total of $350 billion was invested into greenfield IPP assets in developing countries. About 44 percent of that investment was in renewable energy, which for the purpose of this article also includes large hydropower plants.

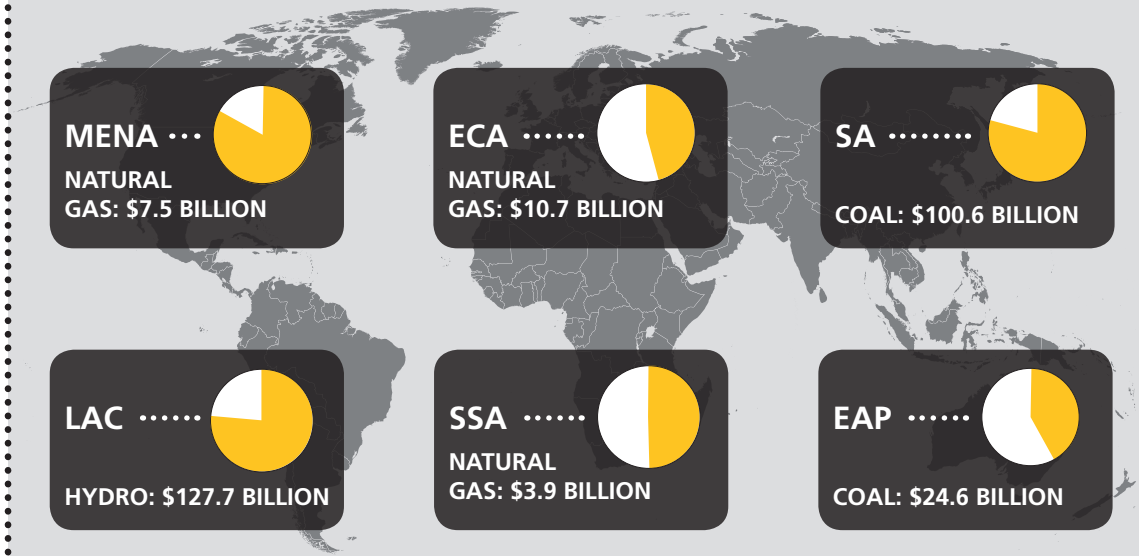
LATIN AMERICA

In the period between 2002 to 2012, $21 billion of investment has leveraged 31.5 gigawatts (GW) of non-renewable IPPs. The majority of this investment has been in natural gas-fired facilities. Renewable investments in the sector have contributed 140 GW of IPP capacity. However, 122 GW of this capacity consisted of hydro projects larger than 50 megawatts (MW).

SUB-SAHARAN AFRICA

Non-renewable investment IPPs in Sub-Saharan Africa totaled $4.2 billion, bringing a mixture of diesel-fired and natural gas generation. In natural gas, 19 plants over the last decade yielded $2.6 billion of investment for a total capacity of 3.2 GW. Nigeria led the way with 850 MW of new capacity. With $6.2 billion recorded, private finance of renewable facilities outstripped non-renewables. South Africa attracted two-thirds

LARGEST ENERGY TECHNOLOGIES USED BY REGION



EAP: East Asia & the Pacific; ECA: Europe & Central Asia; LAC: Latin America & the Caribbean; MENA: Middle East & North Africa; SA: South Asia; SSA: Sub-Saharan Africa.

of this investment through the Renewable Energy Independent Power Producer program.

EUROPE AND CENTRAL ASIA

The region of Europe and Central Asia has seen $13.8 billion of investment in non-renewable IPP facilities over the last 10 years for a total capacity of 14.5 GW. Among these were 3 GW of coal-fired facilities and 10 GW of natural gas. Turkey attracted the greatest share of investment, with 10.2 GW of capacity—all but one 700 MW diesel facility financed since 2009. However, the region has also seen an explosion of renewable energy investment: $18 billion financing for 9 GW of power projects. Once again, Turkey was the recipient of the highest level of investment, with $10 billion financing for 5.1 GW of capacity. This included 2.6 GW of large hydro and also 1.8 GW of wind—the most significant generation technologies attracting investment.

Electricity demand in developing countries [will be] the single greatest source of increased final energy demand from all sources during the next 20 years.

SOUTH ASIA

The region of South Asia saw $128 billion of investment in non-renewable facilities during the decade, with a spurt of $96 billion coming in the five years from 2007 to 2011. This was followed by a steep drop in 2012 to $2 billion. Coal was the technology most invested in, with $90 billion of investment leveraging 100 GW of capacity growth. There was also significant investment in renewables, with $17.7 billion bringing 12 GW of new capacity. India attracted the vast majority of this investment into its wind and hydro sectors—$15 billion total investment. In Pakistan, capacity shortage has recently led to a number of investments. Of these, nearly 80 percent were supported by international finance institutions.

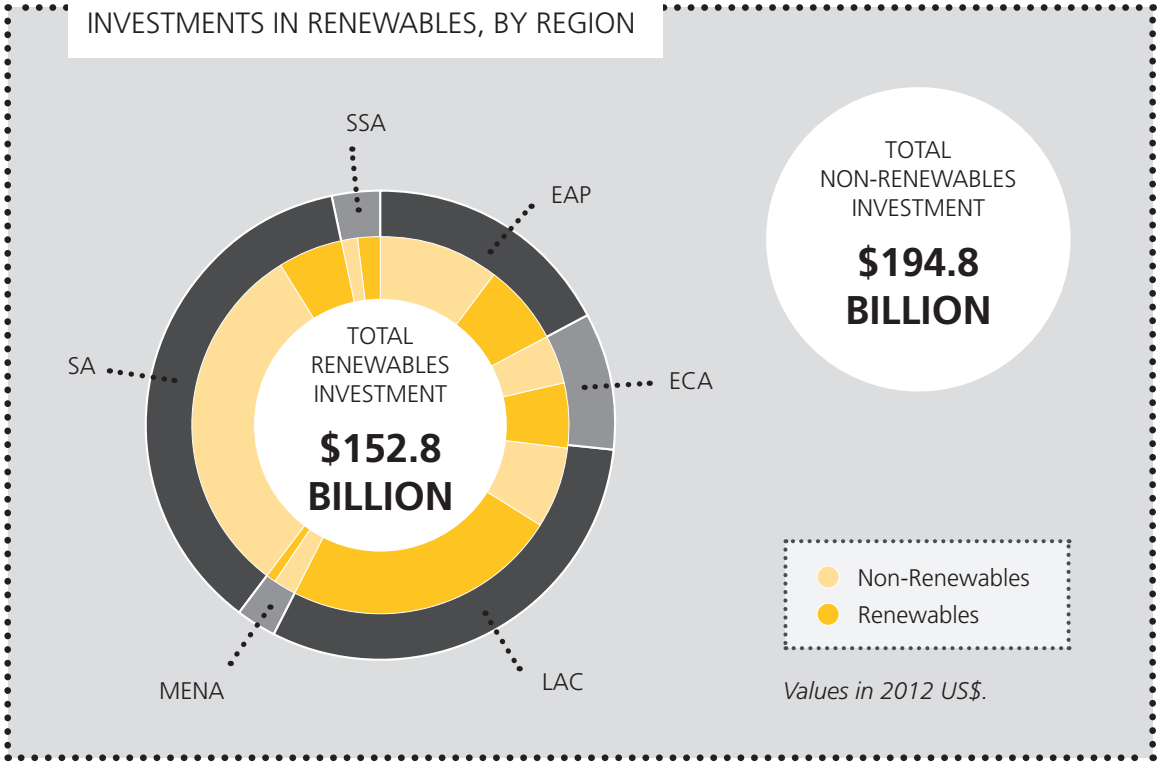
EAST ASIA AND THE PACIFIC

Perhaps surprisingly, it was not East Asia and the Pacific which saw the greatest investment in both renewable and non-renewable IPP infrastructure. There was a total of $33.1 billion of investments over the decade in non-renewables, far less than registered in South Asia. Of this investment, $26 billion was in coal. Natural gas-fired projects followed coal with over 16 GW of new projects in the period. Of these, close to 8 GW were in Thailand, including 3.8 GW of capacity financed since 2012.

There was a similar level of investment in renewables—$22.5 billion—which includes large hydro and brought 18.7 GW of capacity. After large hydro (11.5 GW), there was 3.1 GW of wind financed and 720 MW of solar photovoltaic.

MIDDLE EAST AND NORTH AFRICA

Though limited in absolute numbers, the Middle East and North Africa region experienced strong growth in privately financed greenfield capacity over the decade, from less than $1 billion in



2002 to over $4 billion in 2012. During that period, 7.7 GW of base load non-renewable capacity was financed, with 6.7 GW of that in natural gas-fired plants. Renewable investment was not high, but the 1.3 GW of capacity included the Ouarzazate signature solar thermal plant in Morocco and the 300 MW Tarfaya wind farm.

The World Bank Group (WBG) is well placed to assist developing countries to meet the growing demand for private investment in the power sector. Assistance is available via a range of programs, products, and initiatives across the project cycle to ensure that clients can structure successful projects. For example, downstream the WBG provides credit enhancement instruments including IBRD/IDA Guarantees to mitigate critical project risks and thus overcome the reluctance of private financiers to invest in key infrastructure projects. Upstream, the Public-Private Infrastructure Advisory Facility (PPIAF) assists with the development of enabling environments that facilitate private investment in power sector infrastructure.

Investment data is based on the Private Participation in Infrastructure Database. Updated annually, 2013 data is available in July 2014.

trading TALES

By Jeff Delmon, World Bank

One night, not too long ago, I was sitting at a bar with a friend of mine. He had just finished two weeks of painful negotiation of a power purchase agreement for a power public-private partnership (PPP): night and day, contentious and slow progress. So, as a sensitive and caring friend, I said, "Quit your whining! Power generation PPPs must be the easiest PPP around. You've got a tried and tested kit, clear demand, a commercially and socially valued product, a sophisticated sector with strong sponsors and keen financiers, an accepted standard model for PPPs, not too much land. As long as you can get fuel and connect to the grid, all is OK. In fact, the offtaker often takes fuel and grid risk. Easy, right?"

My friend was not amused. His response, while a bit harsh, brought a lot of perspective:

"The only hitch with your sunny view of power generation PPPs is the offtaker. In some countries, selling power to the local utility is like being a drug baron and selling drugs to a local dealer, and the dealer is broke, and the dealer isn't very good at math so he sells to his customers at a loss. In other words, he is getting more broke by the day. The only saving grace is that the dealer still lives with his parents, and they bail him out from time to time. Of course the irony is that the parents often force the kid to sell at a loss—so the neighbors get cheaper drugs and the parents are popular."

He explained further: "In some countries, the government has a system in place to bail out the offtaker in a transparent manner, by trying to get it to cut its own costs, only sell to customers who pay, find other sources of revenues, whatever. This gives us a little more comfort that the offtaker will pay its bills, but not much."

"Investors may also ask the government to allow the offtaker to raise its tariffs. This sounds like a sensible business proposition, but it often isn't. If the offtaker raises costs, it may find some of its best customers (the ones who actually pay their bills) go to some other source of energy like their own generation, or a rival independent power producer delivering directly. You see, the offtaker has borrowed from various lenders, often local and/or public banks, to keep electricity tariffs low to please the government. The offtaker is often more of a political than commercial animal, not incentivized to use good commercial practice, but instead to satisfy political agendas. This results in inefficiencies, low collection rates, and high theft."

"And this means what?" I asked, putting my drink down for emphasis.

"This means its costs may be higher than some of the other potential suppliers of electricity," he answered. "It's true even though they do not benefit from economies of scale, plus the quality available from smaller scale solutions may provide better quality services as compared to the offtaker—I'm talking about problems like brown outs, blackouts, and surges." Here he leaned forward and pointed at me for emphasis. "Raising prices, unless and until the offtaker improves the quality or quantity of services it is providing, may result in the loss of its best customers."

I nodded agreement, but noted the obvious: "OK, so how about a guarantee from his government," I said. "They are bailing the offtaker out anyway, why not pay the investors and lenders directly?"

"This is the usual approach," he responded with a smile, "but not one the government will like. Their utility is in trouble and needs to sort itself out. If they provide a guarantee it just reinforces bad behavior and may even incentivize non-payment since the government will take care of it. Plus, increasingly governments have to disclose such guarantees, which may result in higher interest on the government's other debt, or reduce the amount of debt to which it has access."

"Fine," I countered, "but how about an escrow of revenues? The investors and lenders can grab the money the offtaker earns selling electricity across its grid, and hold it to make sure they get paid first." I knew this was usual practice, having seen this structure a number of times.

Taking the last swig of his drink, he replied, "Good idea. But of course we cannot be sure the money the offtaker earns will actually make it to the account, since it is often obtained through cash-based transactions, and cash has a tendency to find its way to other uses. Plus, the offtaker is having a hard enough time making ends meet without its cash flow being constrained. Even with a generous definition of 'permitted costs,' an escrow arrangement may make the situation worse."

Now he knew he had me; he was on a roll. He continued, "The offtaker has learned over many years that the government is soft, it may threaten and complain, but it rarely follows through on its threats to cut off subsidies. The country still relies on the offtaker to supply most of its electricity, so they are unlikely to do anything drastic. And, of course, the bad boy act works well with the government, so reform might actually be against the offtaker's self-interests in the short to medium term."

He was right, of course. The security structures we tend to place in an effort to protect lenders and encourage them to lend can actually undermine these same utilities. Unfortunately, as investors we often ignore these issues and instead focus on what it will take to close the deal. Would we be better off working closely with the utilities to help them, which would then enable those same utilities to be more credit-worthy and do more PPPs?

Looking beyond the project to the entire system when formulating a security package might be harder work, and more burdensome, but may be much more sustainable and better business.

Clearly it is time for another drink.

BROWN OUTS *to* BRIGHT LIGHTS

The privatization of Nigeria's power sector

Photo © Peete Viisimaa/istock

Interview by Alison Buckholtz

Ibrahim Babagana, the Director of Power for Nigeria's Bureau of Public Enterprise, has had a front-row seat to the successful reform of the country's power sector. As of today, five generation companies and 10 distribution companies have been successfully privatized, for a total of $2.25 billion—the largest transaction of this kind successfully completed in Africa. Here, he gives Handshake *readers a sense of life in Nigeria before privatization, how government and labor worked together to agree on a way forward, and how officials plan to monitor the new transaction.*

Privatization of Nigeria's power sector took place in November 2013. What was the situation, pre-privatization, that made this transaction so important to Nigerian citizens?

For a long time, the power sector here was run and managed poorly. In a country of 150 million Nigerians, the level of power was under 4,000 megawatts. Although we live in a country with a lot of potential, the power sector was not operating to optimal capacity. That's why government decided there's a need to privatize the sector.

How did lack of power manifest itself among different Nigerian communities?

The lack of power has impacted on the populace in different forms. In industry, 90 percent of businesses had to sub-generate their power, which led to high cost of goods and services in the country. Because of the high level of brown outs, even small and medium industries could not function very well, and that affects the income of the populace.

In the rural community, which is a major segment of the country, lack of power has had a negative impact on things as varied and different as storage of vaccines and provision of light to the schools. The impact was overwhelming in all aspects of the Nigerian economy.

Was it difficult to convince stakeholders of the necessity of privatization? Did you have to engage audiences separately to demonstrate why this was necessary?

You can categorize the stakeholders and the outreach we conducted. Those who are in need of power overwhelmingly support the reform agenda. Reaching this group was not a problem, nor was getting investors and bankers involved. Even the general public of the country was solidly behind the transaction.

The key group of stakeholders we had to convince was labor. You have to understand that vertically integrated utility companies have about 47,000 workers in transmission, generation, and distribution. So with labor, we went through a long process of negotiation, discussion, and workshops—about 14 months—before we could arrive at an acceptable package to be paid out to the unions.

Was that key to the transaction's success?

That upfront agreement with the unions was one of the keys, and we were able to do that because we brought in external figures to assist in the negotiations. It's also important that we conducted a transparent, open process and we had the support of the President and the Vice President.

What are the plans for monitoring results, post-transaction?

We have entered into a performance contract with our new investors. In this performance contract, we incorporate what they have indicated they will do over a five-year period. We should be given access into the companies every six months to look at their books. But since we are aware we don't have the skills to monitor these companies technically, we are trying to also engage a competent consultant that can help us with monitoring. Indeed, monitoring is crucial to the success of the transaction.

TRANSACTION TIMELINE

By Arif Mohiuddin, CPCS Transcom International Limited

Privatization of the power sector will be different in every country, but the qualities of a successful privatization are shared among many nations. In Nigeria, the process began, as many do, in a time of great need, and launched due to political will. Here, one of the project's transaction advisors presents the timeline and process of reform, highlighting the details of the privatization process that were critical to bringing Nigeria a brighter future.

Photo © John Hogg/World Bank

Historically, Nigeria has operated a state-owned vertically and horizontally integrated electricity monopoly. The National Electric Power Authority (NEPA) was responsible for generation, transmission, distribution, and retail supply. In 1999, the Nigerian Electricity Supply Industry (NESI) reached its lowest point. Of the 79 generating units in the country, only 19 were operational—with average daily generation capacity of 1,750 megawatts. Between 1989 and 1999, no new power generation capacity was added to the power infrastructure. Notably, an estimated 70 percent of the population had no access to electricity, per capita consumption was 125 kilowatt hours, and industry system losses (technical, commercial, and non-payment) were estimated at 50 percent.

It's no surprise that the system experienced regular collapse, leading to a massive gap between power demand and supply. This was exacerbated by aged and overloaded transmission and distribution networks and excessive overmanning. These bitter experiences prompted the Federal Government of Nigeria (FGN) to embark on a power sector reform program aimed at meeting the growing demand for stable and reliable power.

Once Nigeria's power sector began moving toward reform, the country's National Electric Power Policy (NEPP) was adopted in 2001. To provide the appropriate legal framework for the reforms envisaged by the Policy, the FGN enacted the Electric Power Sector Reform (EPSR) Act in 2005. The EPSR Act authorized the unbundling of NEPA into distinct units. The unbundled units, comprising separate generation, transmission, and distribution companies, were held under the Power Holding Company of Nigeria (PHCN).

PRIVATIZATION ROADMAP

In August 2010, Dr. Goodluck Jonathan, President of the Federal Republic of Nigeria, unveiled the Roadmap for Power Sector Reform (now known as "the Roadmap"). The Roadmap sent a strong signal that power sector reform and improvement of NESI remained a top priority for the FGN. Consequently, it outlined the FGN's plan for the acceleration of the pace of activity with respect to reforms mandated by the EPSR Act.

The Roadmap sent a strong signal that power sector reform and improvement remained a top priority for the Nigerian government.

In December 2010, the Bureau of Public Enterprises (BPE), under the direction of the National Council on Privatisation (NCP), commenced the privatization process with the engagement of CPCS Transcom International Limited (CPCS) as transaction advisor. Immediately afterward, a call for Expressions of Interest (EOI) in investing in six successor generation companies and 11 successor distribution companies was published. Following that, a series of roadshows were held in Lagos, Dubai, London, New York, and Johannesburg.

Based on a strong showcase of the opportunities through these roadshows, BPE received 341 EOIs indicating solid interest in the Nigerian power sector from various international and local investors. Following the submission of the EOIs, 207 EOIs were shortlisted, and out of these, 163 bidding entities purchased the bid documents and obtained the eligibility to submit the bids.

SUCCESS, STEP BY STEP

In August 2011, as part of creating a conducive investment environment, FGN formally commenced operations of Nigerian Bulk Electricity Trading Plc (NBET), with the primary objective of bulk purchasing of power from the generation companies and reselling them to distribution companies. Additionally, from March 2011 to April 2012, BPE (with support from CPCS), worked with the key stakeholders including the NCP, Federal Ministry of Power, Nigerian Electricity Regulatory Commission, Gas Aggregation Company of Nigeria, Nigerian Gas Company, Transmission Company of Nigeria, Nigeria Electricity Liability Management Company, NBET, and potential bidders.

This led to issuing the commercially attractive tariff, developing the appropriate contractual structure with allocation of various risks in the right places, and aligning the transaction structure with the objectives of FGN. All of the participants began to appreciate the existing situation of the power sector.

In May 2012, BPE issued the Request for Proposals along with the transaction and industry agreements containing the "entire deal structure"

to the eligible bidders. On July 17, 2012, at the close of the deadline for the submission of bids for the Successor Generation Companies, 23 proposals were received for six generation companies. Following evaluation of the bids, all but one of the generation companies (Afam Generation Company) failed to receive a technically qualified bidder. Again, on July 31, 2012, at the close of the deadline for the submission of bids for the Successor Distribution Companies, 54 proposals were received for 11 distribution companies.

Following evaluation of the bids, all but one of the distribution companies (Kaduna Distribution Company) failed to receive a technically qualified bidder. Thus, while 15 of the 17 companies moved ahead with the financial/commercial bidding stage, the remaining two were re-tendered. (Following successful re-tendering process, the relevant agreements with the bidders were executed in December 2013.)

In February 2013, following successful negotiations with the preferred bidders, transaction agreements as well as the industry agreements for all 15 companies were executed. All of these entities successfully paid their acquisition price. In November 2013, the Success Generation and Distribution Companies were handed over to the new owners, concluding the privatization process and launching a promising new era for Nigeria's power sector.

GAS SUPPLY RISKS IN NIGERIA

The domestic demands on Nigeria's gas resources are huge, and it would be a mistake to view the resource base as infinite. Nigeria's Roadmap for Power Sector Reform sets a goal of 20 GW of generation capacity by 2020 and most of this capacity will be gas-fired. Meeting this ambitious target will require more than doubling domestic gas supply from 1.5 billion cubic feet (BCF) per day to 3.4 BCF per day. Developing the roughly 30 trillion cubic feet of reserves needed to support such a production increase will require huge amounts of capital, perhaps $20 billion or more, and most of this will need to come from the private sector. To attract such an amount of capital to the gas sector, Nigeria will need to develop a bankable commercial framework for gas that includes price reforms, improvements in regulatory arrangements, a redefinition of the role of public companies in the gas sector, and an alternative to the current financing model. Otherwise, gas supply risks becoming the Achilles' heel of power sector reform.

Excerpted from the forthcoming report "Harnessing African Gas for African Power," from the World Bank's Africa Energy Department and Sustainable Energy Department.

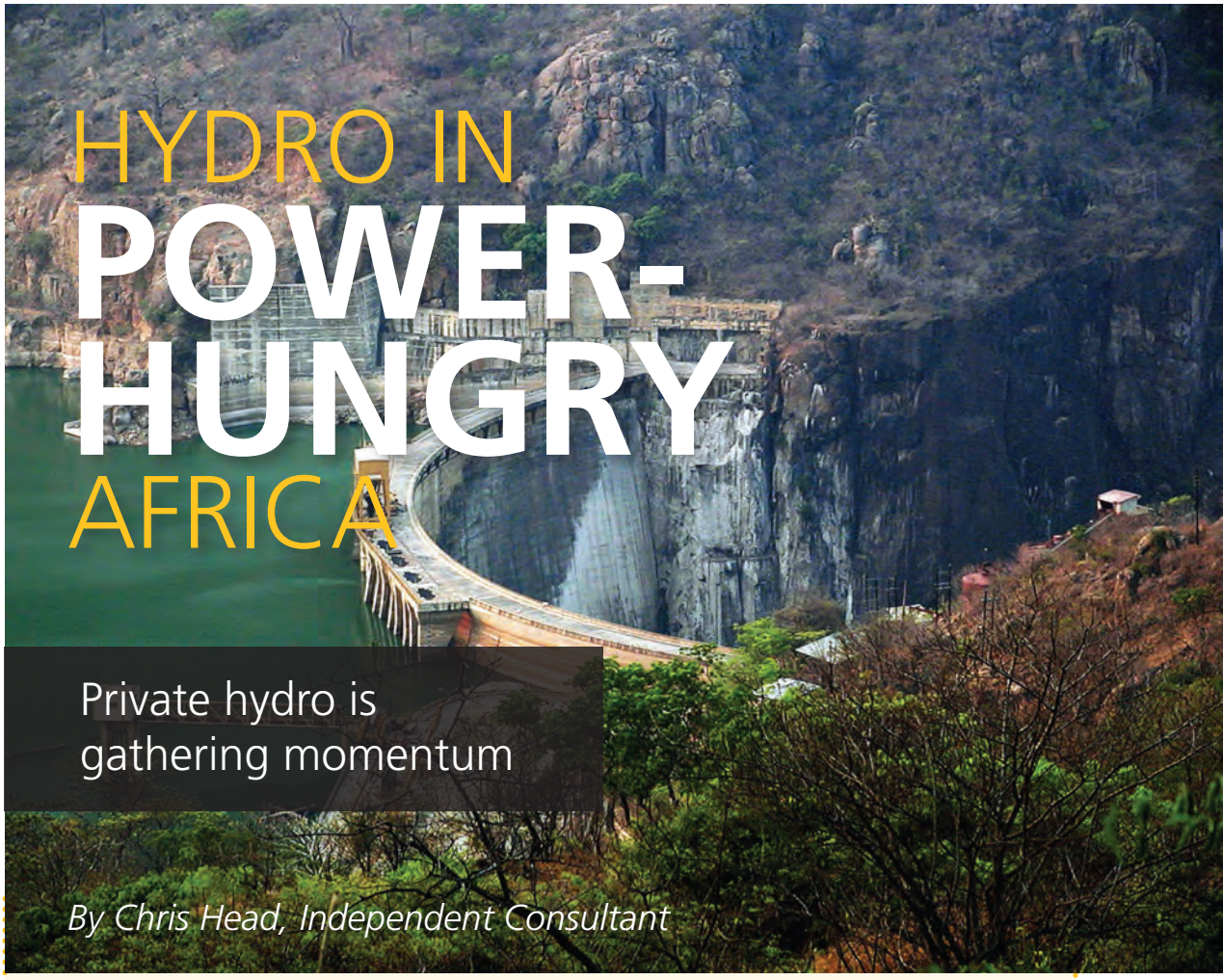


Photo © Rich Beilfuss, Cahora Bassa 2

HYDRO IN POWER-HUNGRY AFRICA

Private hydro is gathering momentum

By Chris Head, Independent Consultant

Africa is about to experience a wave of investment in its hydropower sector. But will it be able to avoid some of the problems that have bubbled up with other natural resource concessions?

Private investment in African hydropower has lagged behind the rest of the world, despite the continent having the largest untapped potential combined with chronic power deficits. This unsatisfactory situation is changing fast as governments struggle to meet rapidly growing demand from an increasingly prosperous middle class and a burgeoning, power-hungry mining industry.

FINDING THE FINANCE

A major challenge has been the capital-intensive nature of hydro projects. Faced with the need to invest in new capacity, most countries have only a limited range of options. The very poorest may still have access to concessionary financing, but the majority have to rely on commercial financing through private developers, or on sovereign loans from emerging economies such a China, through its EXIM bank. The latter are often linked to a trade agreement and the money is usually tied to Chinese construction companies.

To attract more varied sources of capital, many African governments are liberalizing the power sector. This is a challenging process for a continent that has traditionally been accustomed to a high degree of state ownership in all aspects of electricity supply. The process is more advanced in some countries than others, but the concept of privately financed generating stations is now well established. However, nearly all of these independent power producers (IPPs) have been thermal, wind, or geothermal projects; hydro has proved to be a more difficult nut to crack. This follows similar experiences in Asia and South America, where private hydro was initially slow to take off. Once established, however, it rapidly gathered momentum.

CRAFTING THE CONCESSION

Another significant challenge is negotiating concession agreements where there is little experience to draw upon. A recent review of 35 Sub-Saharan countries reveals that 14 are already engaging with private hydro developers, while 11 are moving in the same direction. This suggests that up to 25 African states may soon be negotiating hydropower concessions, most for the first time.

These highly consequential contracts not only determine the nature of the project to be developed, but also define what the host nation will receive for the use of its resources, and the impact on any existing or planned developments in the river basin. They reach far into the future and involve many stakeholders. Governments need help.

TURNING POINT

There are reasons for believing that African hydro is now at a turning point. The recent commissioning of the 250 megawatt (MW) Bujugali project on the River Nile in Uganda marks the successful completion of the first sizeable hydro IPP on the continent. There have been smaller schemes, but Bujugali has demonstrated that with the right combination of private investment

and public support, much of the continent's vast hydro potential could be developed by the private sector. It has boosted confidence among investors and developers alike, to the extent that there are now a number of international companies focusing exclusively on the African hydropower sector with a raft of projects under negotiation or development.

Securing financing will be the overriding challenge on a continent where credit ratings are weak.

These include projects like Bumbuna (250 MW) in Sierra Leone and Ruzizi 3 (145 MW) in Burundi, both nearing construction, and several large projects like Mphanda Nkuwa (1,500 MW) and Cahora Bassa North (1,000 MW) in Mozambique, which are in the planning stage. In the Democratic Republic of Congo, which holds 65 percent of Africa's hydro resources, plans are now in hand to develop the 4,800 MW Inga 3 scheme as the first stage of Grand Inga, which will eventually have a capacity of 40 gigawatts. For all of these, securing financing will be the overriding challenge on a continent where credit ratings are weak. In most cases it will involve a complicated blend of private and public money and guarantees, as funding such projects is usually beyond the reach of the private sector alone.

FROM GENERATION TO GENERATION

The new wave of private hydro in Africa offers great opportunities for nations to strengthen their power sectors and build their economies in the way that is happening elsewhere in the world.

First generation hydro concessions are relatively straightforward because they are structured around the IPP acting as a captive supplier to the state-owned grid company; the host government is therefore focused on achieving least-cost power. However, in a few parts of the world, such arrangements are giving way to open market concessions where the developer is free to sell power wherever he can find a buyer.

Under these second generation arrangements, the power produced moves from being a public service to a tradable commodity, and the focus of the host government changes to maximizing its share of the economic rent from the site. This is more difficult to address—and will remain an obstacle—in a situation where concessions can stretch 30 years into the future, and energy prices continue to escalate at an unpredictable rate.

Hydropower development in Africa faces many challenges, but perhaps the greatest is to achieve equitable and sustainable concession agreements that stand the test of time. h

MINING FOR LESSONS LEARNED

Under an open market model, hydropower is analogous to mining, as both are exploiting a natural resource to sell to third parties. In Africa, the mining sector embarked on privatization before hydro, with an influx of foreign investment that started about two decades earlier. This prompts the thought that there should be lessons to be learned from the mining sector, but anybody looking at the record of mining concessions in Africa will find a history of broken agreements; mining codes were constantly revised and often totally ignored. Many external observers are critical of what they regard as unequal contracts and one-sided promises, citing weak governance and a serious lack of local capacity to negotiate, monitor, and enforce such agreements.

Photo © Roman Betik, Phalaborwa Mines, South Africa

ONE SIZE DOES NOT FIT ALL

Tailoring hydropower plants to community needs

The technology for using falling water to create hydroelectricity has existed for more than a century. The evolution of the modern hydropower turbine began in the mid-1700s, when the French hydraulic and military engineer, Bernard Forest de Bélidor, wrote Architecture Hydraulique. *In this four-volume work, he described using a vertical-axis versus a horizontal-axis machine. A century later, in 1882, when the electric generator was coupled to the turbine, the world's first hydroelectric plant opened in the U.S. Today, hydropower plants combine cutting-edge technology with natural resources to serve the needs of many different communities. From small to extra-large, these facilities allow remote or inaccessible areas the power resources that have long eluded them, stalling progress and slowing development. The examples below illustrate how hydropower can be tailored to local needs with local resources.*

BUJAGALI (UGANDA)

The Bujagali hydropower plant is the first large-scale privately financed hydro in Africa. A 250 MW facility on the Victoria Nile River, it began operations in late 2012, providing an alternative to more expensive thermal power sources. The facility uses the power of falling water from a 30 meter high earth-filled dam to generate electricity.

LAKE MAINIT (THE PHILIPPINES)

The $62.5 million, 25 MW Lake Mainit hydropower plant, which is scheduled for completion by 2015, will use Lake Mainit as a natural reservoir to generate electricity. The project will reduce the magnitude and frequency of seasonal flooding during periods of rainfall. Flooding in Lake Mainit, the fourth-largest lake in the country, affects over 60,000 hectares of commercial, industrial, and agricultural land.

HYDROPOWER

S, M, L, XL

Facilities range in size from large power plants that supply many consumers with electricity to small and micro plants that individuals operate for their own energy needs or to sell power to utilities.

Large Hydropower: Although definitions vary, the U.S. Department of Energy (DOE) defines large hydropower as facilities that have a capacity of more than 30 MW.

Small Hydropower: DOE defines small hydropower as facilities that have a capacity of 100 KW to 30 MW.

Micro Hydropower: A micro hydropower plant has a capacity of up to 100 KW. A small or micro-hydroelectric power system can produce enough electricity for a home, farm, ranch, or village.

NGAYAK III (UGANDA)

Nyagak III is a 4.4 MW mini hydro scheme in the West Nile Region of Uganda. The Uganda Electricity Generation Company has hired IFC to serve as transaction advisor to assist in identifying a strategic partner to develop the project. Six bidders have been prequalified and the tender process is ongoing.

NAM THEUN 2 (LAO PDR)

NT2, the largest and most complex hydropower project in Lao PDR, supplies 75 MW of electricity for domestic use and exports 1,000 MW of power to Thailand.

ASHTA (ALBANIA)

The Ashta hydropower plant, with an installed capacity close to 50 MW, is the first major hydropower plant built in Albania in 30 years. Its success is based on innovative StrafloMatrix™ technology—a new concept for developing hydropower at low-head sites where dams, weirs, or canals already exist. Projects that may not be financially viable, based on conventional turbines and generators, may now be developed using this method. This technology has many advantages over conventional plants, including low investment cost, easy and inexpensive maintenance, and shorter construction periods.

Photo © Angelo Dell Atti, Ashta, Albania

MINING FOR *power*

Sub-Saharan Africa's suboptimal power situation exists amid vast energy resources. But African mines, with their substantial and growing need for power, could be the critical "anchor consumers"—high-volume customers that provide a captive source of demand and consistent revenues—that harness these energy resources.

Photo © Ivars Linards Zolnerovics/Fotolia

By Sudeshna Ghosh Banerjee, Zayra Romo, Gary McMahon, Perrine Toledano, Peter Robinson, & Ines Perez Arroyo

Mines are greedy for power, and in Sub-Saharan Africa's (SSA) power sector, this may be the sort of greed that is actually good. Because mining activities require large amounts of power to run their systems—power is rarely less than 10 percent of the operating costs of mining and often rises above 25 percent—these mines present themselves naturally as "anchor consumers" that can stabilize the sector. Leveraging mining's power demand and its capital investments in power infrastructure—also known as "power-mining integration"—is an opportunity to develop the power sector of Africa's mineral-rich economies and expand electrification.

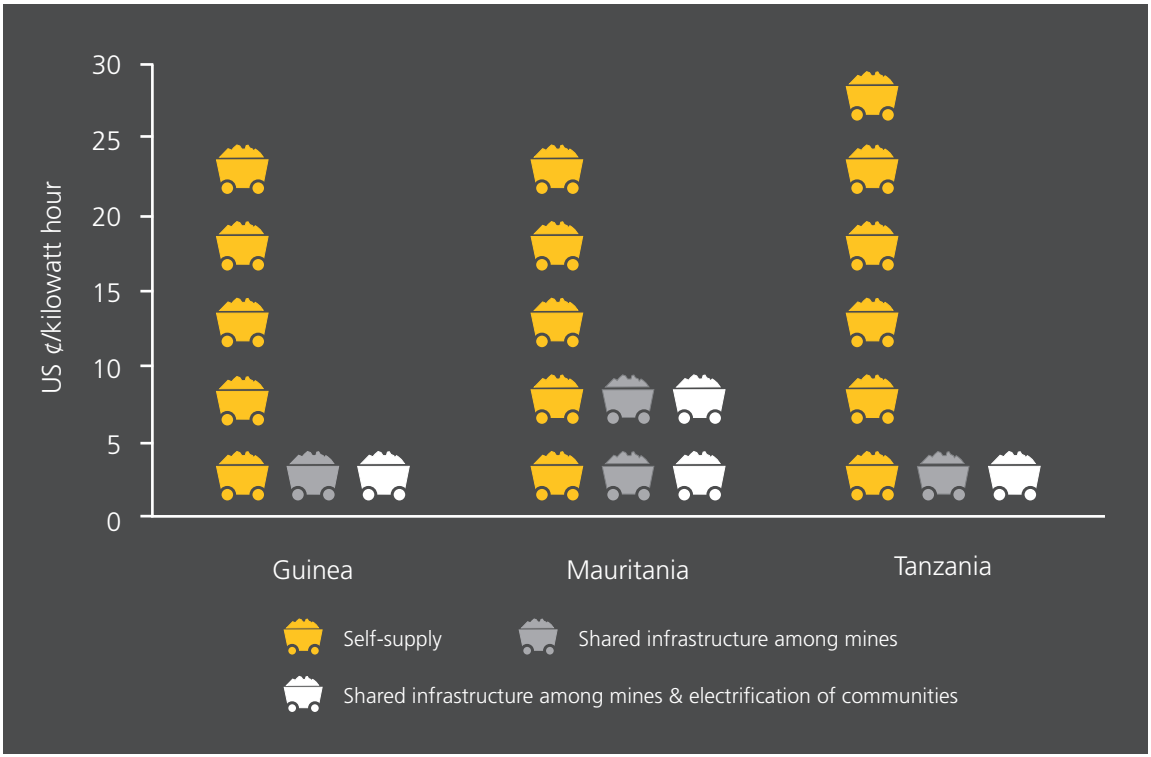
DEMAND EXPECTED TO TRIPLE

The future demand from mining for power is substantial and could reach up to 23,443 megawatts (MW) in 2020. While South Africa

is projected to add sizable mining demand for power and grow at 3.5 percent annually, the growth in other SSA countries, projected to be 9.2 percent, is more impressive. Demand will come overwhelmingly from the Southern Africa region, dominated by South Africa. Even without South Africa, Southern Africa will have the highest power demand from mining, largely due to the large requirements in Mozambique and Zambia, followed by Central Africa and Western Africa. Mining demand in Guinea, Liberia, and Mozambique is expected to represent more than total non-mining demand by 2020. This growing demand will create even higher pressures to close the supply gap. Compared with grid-supply in 2012, mining demand in 2020 could be as much as 35 percent.

INTERMEDIATE OPTIONS BETWEEN GRID-SUPPLY AND SELF-SUPPLY

Mines traditionally source power from the grid. However, in cases of high tariff, poor power adequacy and reliability from the grid, or the high cost of extending transmission and distribution networks to the mining site, some mines



POWER-SOURCING ARRANGEMENTS ACROSS AFRICA

Intermediate options

	Self-supply	Self-suppy & CSR*	Self-supply & grid sales	Grid-supply & self-supply backup	Mines sell collectively to grid	Mines invest in grid	Mines serve as anchor demand for IPP	Grid-supply
Description	Mine produces its own power for its own needs	Mine provides power to community through mini-grids or off-grid solutions	Mine produces its own power and sells excess to the grid	Mine is connected to the grid and is moving into its own generation	Coordinated investment by a group of mines, producers, and users in one large power plant off-site; connected to the grid	Mine invests with government in new, or the upgrading of, power assets	Mine buys power from an IPP and serves as an anchor customer	Mine doesn't produce any power, but buys 100% from grid
Main generation drivers	Diesel, HFO	Diesel, HFO	Coal, gas, hydro	Diesel, HFO	Diesel, HFO, solar	Hydro, gas	Any	Any
Presence	Mali & Guinea (hydro), Sierra Leone & Liberia (oil)	Guinea, Madagascar	Cameroon, Mozambique, Zimbabwe	DRC, Tanzania	Ghana	DRC, Niger	South Africa	Mozambique, Zambia
Energy demand by 2020	2,444 MW	5,730 MW						15,269 MW
CAGR**: 2000-2020 (projects)	11.5%	5.77%						4.66%
CAGR**: 2000-2020 (avg. annual energy consumption)	-5.7%	1.88%						0.29%

*CSR: Corporate Social Responsibility
**CAGR: Compound Annual Growth Rate

Source: Africa Power-Mining Database, 2013.

generate their own power (self-supply). Still more mines combine some form of both grid-supply and self-supply (intermediate options). There are about six intermediate arrangements reported by the mines.

Although it still remains a minority among power-sourcing arrangements, projects reporting self-supply rose the fastest at 11.5 percent. In fact, the mines envisage spending between $1.1 to $1.3 billion between 2013 and 2020 in self-supply based arrangements. Intermediate options grew at 5.8 percent and grid-supply grew at 4.7 percent. However, annual average electricity consumption rose only for intermediate arrangements, suggesting that self-supply is primarily chosen by relatively smaller projects.

POWER-MINING INTEGRATION CAN BE A WIN-WIN

Harnessing economies of scale can produce cost savings for both the mines and the population. This is especially true in Guinea, Mauritania, and Tanzania, where there is substantial potential for mines to be used as anchor consumers for local electrification. In these cases, mines that are contiguous to each other and are considering self-supply could jointly form or else contract with an independent power producer (IPP) and effectively form a mini-grid or sell excess power to the grid. This could occur through hydropower projects, as in Guinea; through gas projects, as in Mauritania; or through coal, hydro, or gas projects, as in Tanzania.

GROWTH LIMITATIONS

There are physical and financial constraints to growth in the concept of power-mining integration. The most common physical barrier is the lack of a national transmission grid capable of catering to additional flows as the mining sector and the rest of the economy expands. The other dominant constraint is the weak financial situation of the utilities.

Mines can be anchor consumers for local electrification.

Several different kinds of risks can also help explain why the power-mining integration has been limited. These include:

- Planned investments in mining may not materialize because of price swings, difficulties in raising capital, overly optimistic geological assessments, and political instability. Prices in international commodity markets fluctuate, sometimes wildly. The period since 2003 has seen the biggest sustained upswing historically, though prices have moderated since 2012.
- Mines and smelters may cut their output when prices fall, and thus their power needs fall as well.

- Mines have finite lives, usually shorter than those of large power facilities, so power investments will eventually need other customers who may not materialize.
- Mining interests can be (or may become) a powerful lobby to extract subsidies or special privileges from the power sector, particularly if overall demand for electricity grows and the mining operations are no longer needed as anchor customers. If that happens, mining demand may crowd out medium-size firms and residential consumers, reducing the possibilities for extending access to electricity.

Though many institutional roadblocks have threatened to derail the power-mining nexus, the integration of mining and power can be a win-win for Africa's next generation. Its potential is as rich as the minerals nestled underneath our feet, and the promise is well within the reach of those committed to transforming the landscape.

Forthcoming "Power of the Mine: A Transformative Opportunity for Sub-Saharan Africa" World Bank, 2014.

MAURITANIA SAYS "*oui*" TO PPP

Integrating power and mining

Although mining has a long history in Mauritania, partnerships between the power and mining sectors are making possible new options for industries as well as local residents. In this interview, Mohamed Ould Khouna, Mauritania's Minister of Petroleum, Energy, and Mines, talks to Handshake *about how the mining sector can play a stronger role in the development of new power generation options, and the advantages to governments that are open to this integration.*

Photo © Isuru Senevi, Mauritanian mines

How can the mining sector play a stronger role in the development of new power generation options in Mauritania?

The mining sector is one of the key levers to growth. Its contribution to GDP is over 25 percent, and it creates over 15,000 jobs directly or through subcontracting. However, it appears that the availability of competitive energy is the essential element needed to boost the development of the mining and industrial sectors with high added value.

> *"Integrating power and mining can make a significant positive impact on peoples' living conditions."*

With this in mind, authorities have organized the power project from gas (discovered offshore), in partnership with major mining operators active in the country. The idea was to pool the electrical infrastructure and optimize its operation in order to ensure a cheaper electricity supply for all consumers. These sorts of partnerships can also optimize the exploitation of gas resources and help ensure the safety of the energy supply for mining operators.

What are some of the advantages for governments that are open to the idea of the "power-mining integration"?

A strategic approach to energy-mining integration presents benefits to all stakeholders. It allows for a national infrastructure that remains after the end of mining operations, it boosts investment in the sector through the involvement of creditworthy consumers, and everyone benefits from lower prices. But the success of this approach relies on professional, experienced management.

What sort of public-private partnerships (PPPs) do you envision with the greater acceptance of the power-mining integration? What would be the most realistic approach to partnerships in Sub-Saharan Africa (SSA)?

There is no miracle formula, as each case is unique. To structure the proposed electric Mauritanian gas station, we opted for funding in the form of a PPP that could meet three main conditions: ensure the bankability and viability

of the project, ensure a competitive price, and allow for quick finalization.

This approach led us to create a private company in mid-2012. This private company, MEPS, is responsible for the development of the Aval (power plant) component on behalf of its shareholders. This includes the mining and public electricity operator (SOMELEC). So far, this strategy has satisfied our needs.

Could you give an example of how country-specific needs for power-mining PPPs in SSA vary?

Several variants have functioned well elsewhere, like the development of the project by a public facility, or the hiring of a private developer. Each approach has its advantages and disadvantages.

What is your advice to governments that want to conduct community outreach to help citizens understand how the power-mining integration might affect them?

Integrating power and mining can make a significant positive impact on peoples' living conditions. In general, people have high hopes for the development of extractive industries, because of how its potential success might improve their lives. Citizens expect lower prices and greater access to electricity, and they assume these benefits will come quickly. Successful communication between the government and its citizens, as we have had here for nearly two years, can explain specific benefits, along with the timeline. This keeps everyone's expectations realistic.


Photograph courtesy of IISD/Earth Negotiations Bulletin (http://www.iisd.ca/irena/irenaa4/)

Mohamed Ould Khouna

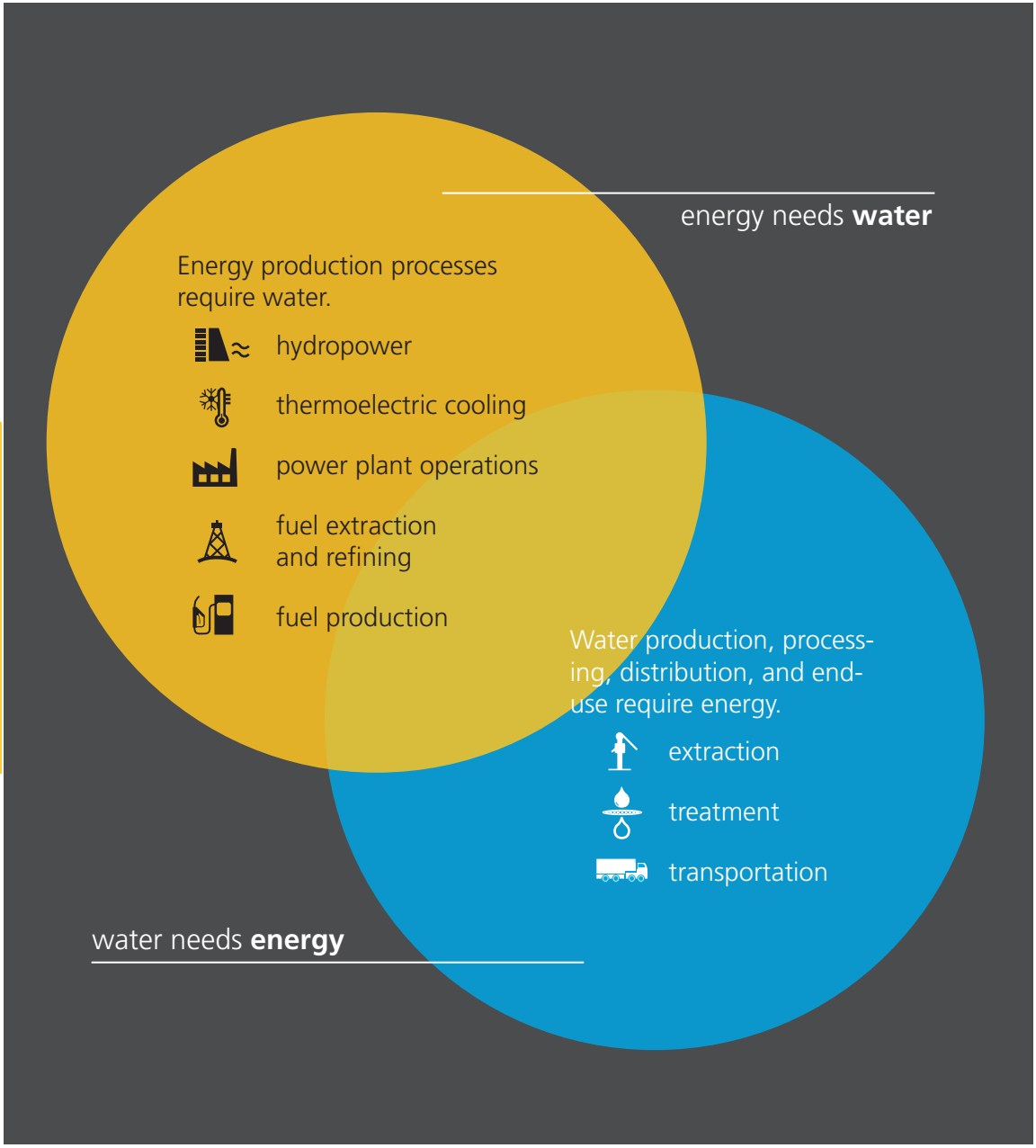
THIRSTY ENERGY

The World Bank's new initiative, Thirsty Energy, quantifies tradeoffs and identifies synergies between water and energy resource management. It aims to help governments prepare for an uncertain future by opening disciplinary silos that prevent cross-sectoral planning, and working with stakeholders to build country capacity that can plan energy and water resources. In this context, partnerships are important; the energy-water challenge is too large for any organization to tackle alone. The Thirsty Energy group works with an array of partners to design and implement activities and has also formed a Private Sector Reference Group to share experience, to provide technical and policy advice, and to scale up outreach efforts.

By Diego J. Rodriguez, World Bank

THE INTERDEPENDENCE OF ENERGY & WATER

Water produces power; power produces water. Almost all energy generation processes require significant amounts of water, and the treatment and transport of water requires energy, mainly in the form of electricity. Even though the interdependency between water and energy is gaining wider recognition worldwide, water and energy planning often remain distinct. The tradeoffs involved in balancing one need against the other are often not clearly identified or taken into account, complicating possible solutions.


energy needs **water**
Energy production processes require water.
hydropower
thermoelectric cooling
power plant operations
fuel extraction and refining
fuel production
Water production, processing, distribution, and end-use require energy.
extraction
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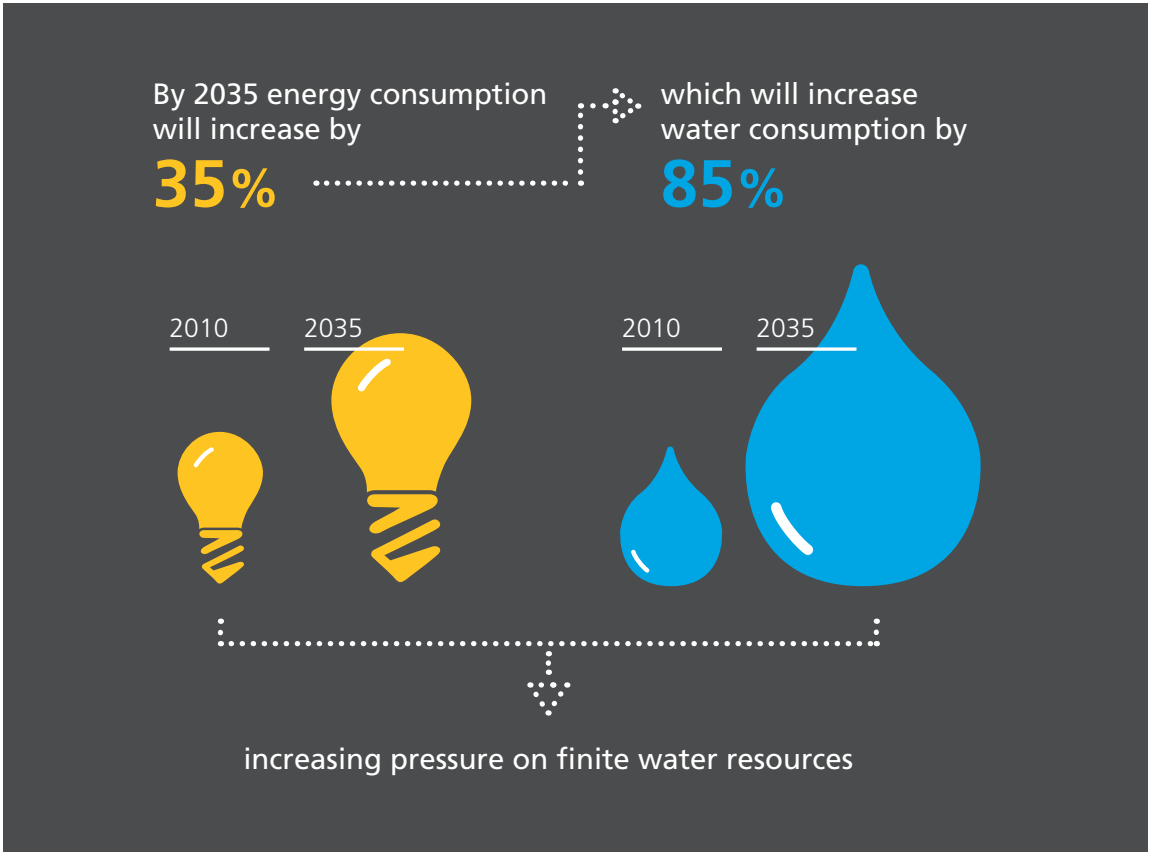
water needs **energy**



DEVELOPING COUNTRIES ARE VULNERABLE

Population and economic growth, urbanization, and increasing demand for food and energy place competing pressures on water. Water consumption for energy generation will increase by 85 percent from 2010 to 2035, posing a serious challenge to many countries around the world.

Recurring and prolonged droughts are threatening hydropower capacity in many countries, such as Sri Lanka, China, and Brazil. These stresses mount as emerging economies, like China, will double their energy consumption in the next 40 years.

A MARRIAGE OF EQUALS

Although the relationship, complementarities, and synergies between water and energy are now evident, these two sectors have historically been regulated and managed separately. Energy and water planning must be integrated in order to optimize investments and avoid inefficiencies. Cross-sectoral implications need to be further understood. To achieve this, planners should:

- Consider water constraints in the energy sector when planning power expansion.
- Understand the water requirements of electricity generation and fuel extraction technologies and their potential impact.
- Consider the complexities of the hydrological cycle and other competing uses when assessing plans and investments; consider joint development and management of water and energy infrastructure and technologies, maximizing co-benefits and minimizing negative tradeoffs.

integrate energy-water **planning**

- explore the use of multipurpose hydropower dams
- integrate energy-water infrastructure
- incorporate water constraints into energy planning
- strengthen joint energy-water governance and encourage political reform

enhance **efficiency**

- conserve water and energy
- replace old, inefficient power plants
- increase the economic value of water
- improve power plant efficiency
- improve biofuels' production efficiency

reduce water **dependency**

- use alternative cooling systems in thermal power plants
- recycle and reuse water from operations
- implement renewable energy technologies
- explore brackish and saline water options

Photo © sunjacc/flickr

BOTTLING SUNSHINE

By John Kjorstad, KPMG Global Services

Energy experts like to arm themselves with factual curiosities—little tidbits designed to make the general population think more about energy production and their own consumption.

Recently, I read such a fact in a promotional document published by Vattenfall. According to the Swedish power company, "every day more solar energy reaches the earth than 5.9 billion people could consume in 27 years."

What an incredible assertion. Given that most of the world's current production of energy relies heavily on coal and other fossil fuels (the relics of sunshine past), we are clearly not very efficient at converting the vast potential of what is presented to us each day at sunrise.

It's not for a lack of good intentions. Vattenfall, for example, is wholly owned by the Swedish government and arguably one of the most progressive and diverse utilities in the world. Although the company has invested in new technologies like offshore wind energy, more than half of its generation mix still comes from fossil fuels. As of 2010, its portfolio included coal (44 percent), nuclear (25 percent), hydro (21 percent), natural gas (8 percent), wind (1 percent), and biomass (1 percent). While the company clearly embraces the future, its carbon footprint reflects the real struggle global energy producers face when legitimately trying to employ new technologies or convert new sources of energy.

RISKY ROUTES TO CHANGE

Changing the way we generate and distribute energy is not easy. It requires long-term planning, efficient financing, and careful management of existing assets—many of which still have a lot of useful life left in them. Some countries, like Spain and Germany, have taken bold steps to accelerate change, but the Spanish stumbled when the financial burden of their actions put too much pressure on the country's balance sheet. As a result, private investors learned a harsh lesson on the realities of political risk.

Spain's experience was unfortunate. While the country's leaders should be applauded for creating the ideal environment to accelerate private investment and promote the development of cleaner renewable sources of energy, they must also accept responsibility for letting the situation escalate beyond their control. Governments are consistently walking a tightrope of affordability while trying to incentivize meaningful change. If they do not get the balance right, there is a very real risk that the whole policy might collapse with painful consequences.

This is why, despite the nearly universal public desire to generate and distribute cleaner, more efficient energy, it may seem at times like the world is standing still. Power stations operate for decades—a half-century, even—and the coal-fired plants being built today will still be part of the energy mix in 2050 and possibly even 2075.

A ROLE FOR COAL

Coal is still a popular choice for new power capacity. The need is great, the resource is plentiful, it's cheap to operate, and it generates an awful lot of capacity in a relatively small space. Until we value air on par with land, the carbon footprint of an energy project won't matter as much as the physical one.

That is not to say that the world of energy isn't changing, but exactly how much or how fast is open to debate. Generation and distribution are still largely the domain of big utilities like Vattenfall. The business model remains fairly straightforward: generate large lumps of electricity (slightly more than demanded) and distribute it to consumers at the lowest possible cost. While renewable energy, smart grids, and efficiency technologies are clearly driven by climate change awareness, the reality is that people mostly want reliability at a low cost.

Our expectation—particularly in the developed world—is that energy is automatic. Flip a switch and the lights come on. We typically give it about as much thought as we would the sun rising each morning. You would only notice if it wasn't there (or if it failed to cut through the smog). This is why energy experts peddle their incredible facts. They want to grab our attention. Warm, fuzzy marketing may be a less effective approach than, say, a 7 percent rate hike, but it does offer consumers a less jarring and more fascinating window into a world they often take for granted.

Yet not everyone gets this essential level of service. For some, the annoyance of poor power infrastructure struggling to cope with rapidly growing demand is an unfortunate fact of life. The exhaust from millions of resulting backup generators is far worse, in my opinion, than the smoke billowing out of massive chimneys at a coal-fired power station. I'm dumbfounded by how much petrol is wasted, and carbon emitted as the result of poor power infrastructure. A recent blog written by Todd Moss at the Center for Global Development states that while a coal power plant might produce around 1,000 grams of CO_2/kilowatt hour, an individually-owned 5 kilowatt diesel generator emits twice as much.

There has to be a better way to serve our energy needs and tap the incredible abundance of what Vattenfall says we ignore every day. The global demand for power will never cease. In order to keep the lights on (and our digital devices charged), governments and the private sector must work together to provide sensible economic and environmentally-friendly solutions. We have both already, but rarely in a single form.

This must be our ambition, and the path to succeed is as clear as the light of day. Of the many diverse sources of energy already available, only nuclear, tidal, and geothermal do not originate from our sun. We just need to get better at bottling sunshine.

ENERGY & CLIMATE CHANGE

powering the 2°C trajectory

The world is not on track to meet the target agreed by governments to limit the long-term rise in the average global temperature to 2 degrees Celsius (°C). Global greenhouse-gas emissions are increasing rapidly and, in May 2013, carbon-dioxide (CO_2) levels in the atmosphere exceeded 400 parts per million for the first time in several hundred millennia. The weight of scientific analysis tells us that our climate is already changing. We should expect extreme weather events (such as storms, floods, and heat waves) to become more frequent and intense, as well as expect an increase in global temperatures and rising sea levels.

Policies that have been implemented, or are now being pursued, suggest that the long-term average temperature increase is more likely to be between 3.6 °C and 5.3 °C (compared with pre-industrial levels), with most of the increase occurring this century. While global action is not yet sufficient to limit the global temperature rise to 2 °C, this target still remains technically feasible, though extremely challenging. To keep open a realistic chance of meeting the 2 °C target, intensive action is required before 2020, the date by which a new international climate agreement is due to come into force.

Energy is at the heart of this challenge. The energy sector accounts for around two-thirds of greenhouse-gas emissions, as more than 80 percent of global energy consumption is based on fossil fuels. The International Energy Agency (IEA) has researched the role of energy and its potential to limit climate change. Key findings include:

The energy sector is not immune from the physical impacts of climate change and must adapt.

THE ENERGY SECTOR IS KEY TO LIMITING CLIMATE CHANGE

Despite positive developments in some countries, global energy-related CO_2 emissions increased by 1.4 percent to reach 31.6 gigatonnes in 2012, a historic high. Non-OECD countries now account for 60 percent of global emissions, up from 45 percent in 2000. In 2012, China made the largest contribution to the increase in global CO_2 emissions, but its growth was one of the lowest it has seen in a decade, driven largely by the deployment of renewables and a significant improvement in the energy intensity of its economy. In the United States, a switch from coal to gas in power generation helped reduce

Photo © Martin Ramsner

emissions by 200 million tonnes, bringing them back to the level of the mid-1990s.

However, the encouraging trends in China and the United States could well both be reversed. Even after allowing for policies now being pursued, global energy-related greenhouse-gas emissions in 2020 are projected to be nearly 4 gigatonnes CO_2-equivalent higher than a level consistent with attaining the 2 °C target, highlighting the scale of the challenge still to be tackled just in this decade.

Governments need to design and implement frameworks that encourage prudent adaptation, while the private sector should assess the risks and impacts as part of its investment decisions.

FOUR ENERGY POLICIES CAN KEEP THE 2 °C TARGET ALIVE

The IEA's 4-for-2 °C Scenario proposes the implementation of four policy measures that can help keep the door open to the 2 °C target through to 2020 at no net economic cost. The policies in the 4-for-2 °C Scenario have been selected because they meet key criteria: they can deliver significant reductions in energy-sector emissions by 2020 (as a bridge to further action); they rely only on existing technologies; they have already been adopted and proven in several countries; and, taken together, their widespread adoption would not harm economic growth in any country or region.

The four policies are:

- Adopting specific energy efficiency measures (49 percent of the emissions savings).
- Limiting the construction and use of the least-efficient coal-fired power plants (21 percent).
- Minimizing methane emissions from upstream oil and gas production (18 percent).
- Accelerating the (partial) phase-out of subsidies to fossil-fuel consumption (12 percent).

ADAPTATION TO THE EFFECTS OF CLIMATE CHANGE IS NECESSARY

The energy sector is not immune from the physical impacts of climate change and must adapt. In mapping energy system vulnerabilities, we identify sudden and destructive impacts (caused by extreme weather events) that pose risks to power plants and grids, oil and gas installations, wind farms, and other infrastructure. Other impacts are more gradual, such as changes to heating and cooling demand, sea level rise on coastal infrastructure, shifting weather patterns on hydropower, and water scarcity on power plants.

Disruptions to the energy system can also have significant knock-on effects on other critical services. To improve the climate resilience of the energy system, governments need to design and implement frameworks that encourage prudent adaptation, while the private sector should assess the risks and impacts as part of its investment decisions.

ANTICIPATING CLIMATE POLICY CAN BE A SOURCE OF COMPETITIVE ADVANTAGE

The financial implications of stronger climate policies are not uniform across the energy industry and corporate strategy will need to adjust accordingly. Under a 2 °C trajectory, net revenues for existing nuclear and renewables-based power plants would be boosted by $1.8 trillion (in year-2011 dollars) through to 2035, while the revenues from existing coal-fired plants would decline by a similar level. Of new fossil-fuelled plants, 8 percent are retired before their investment is fully recovered. Almost 30 percent of new fossil-fuelled plants are fitted (or retro-fitted) with carbon capture and storage (CCS), which acts as an asset protection strategy and enables more fossil fuel to be commercialized.

A delay in CCS deployment would increase the cost of power sector decarbonization by $1 trillion and result in lost revenues for fossil fuel producers, particularly coal operators. Even under a 2 °C trajectory, no oil or gas field currently in production would need to shut down prematurely.

Delaying further action, even to the end of the current decade, would result in substantial additional costs.

THE PRICE OF INACTION

Delaying stronger climate action to 2020 would come at a cost: $1.5 trillion in low-carbon investments are avoided before 2020, but $5 trillion in additional investments would be required thereafter to get back on track. Delaying further action, even to the end of the current decade, would therefore result in substantial additional costs in the energy sector and increase the risk that the use of energy assets is halted before the end of their economic life.

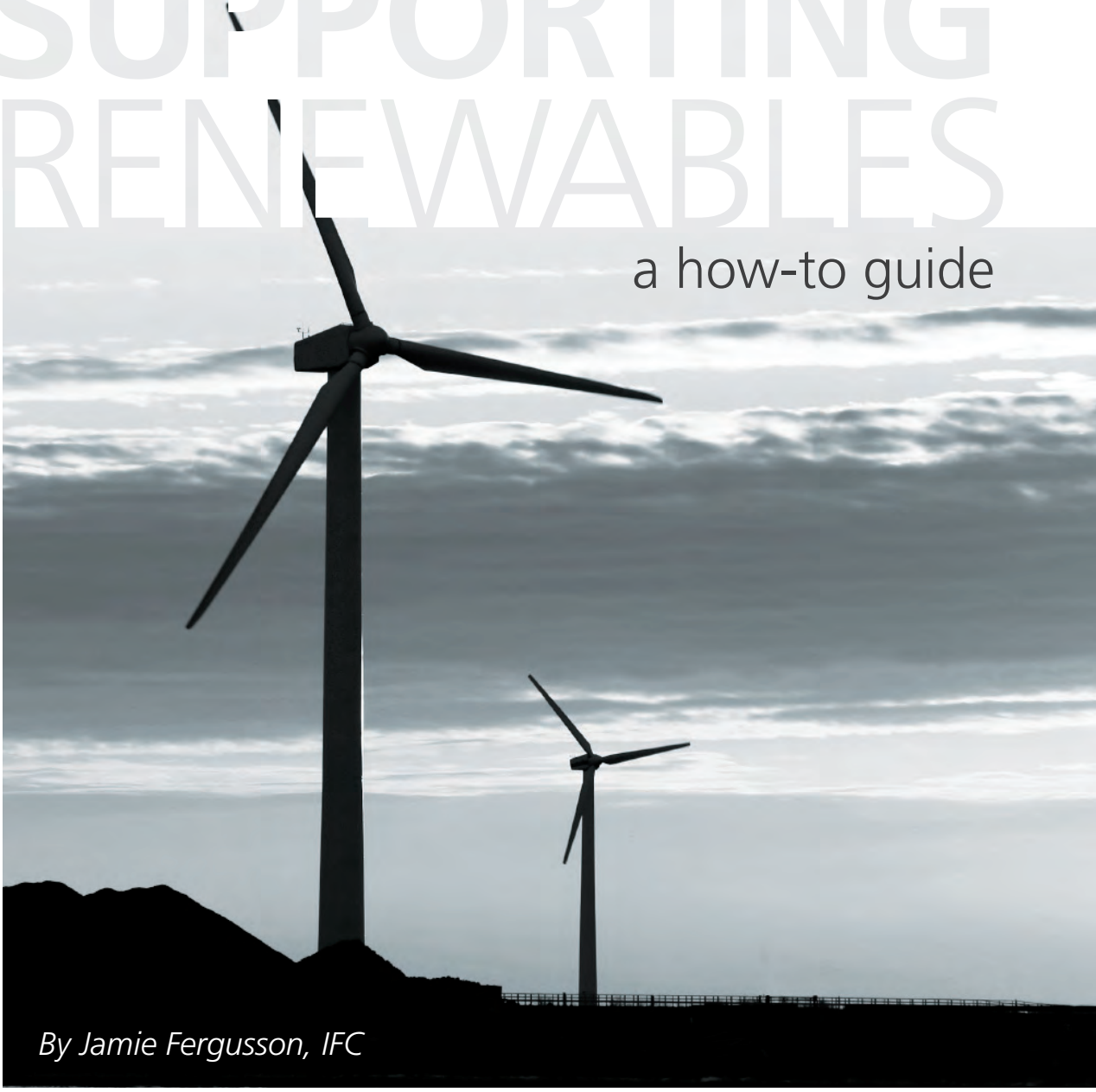
The strong growth in energy demand expected in developing countries means that they stand to gain the most from investing early in low-carbon and more efficient infrastructure, as it reduces the risk of premature retirements or retrofits of carbon-intensive assets later on.

Excerpted from the forthcoming report "Redrawing the Energy-Climate Map" © OECD/IEA, 2013, pp. 9-12, modified by the authors.

Read more in Redrawing the Energy-Climate Map.

SUPPORTING RENEWABLES

a how-to guide



By Jamie Fergusson, IFC

Photo © Tor Lindqvist/istock

Renewable energy (RE) technologies such as hydro, wind, biomass, geothermal, and solar power offer the potential of increased energy security, limited local and global environmental impact, and reduced exposure to fuel price volatility. Many of them are also experiencing rapid cost reductions as the technologies improve and the industries grow to scale. However, except in areas of particularly good natural resources, or in countries that are otherwise dependent on expensive imported diesel, renewable energy is yet to be cost competitive with traditional sources of power such as coal and gas. Increasing the contribution of renewable energy within a county's energy mix often faces other challenge—such as perceived higher risk by investors, unsuitable contractual or regulatory frameworks, and existing infrastructure and subsidies that weight decisions in favor of traditional thermal power.

In response, many countries have and are implementing specific regulatory support systems to encourage renewable energies. Multiple different approaches exist, including fixed long-term elevated "feed-in" tariffs, auctions for specific amounts of new renewable energy capacity, and requirements for utilities to source specific percentages (or "portfolio standards") from renewable sources.

Each approach has its supporters but none has proven a panacea: all have their strengths and weaknesses and often their success comes down to the details of implementation. Feed-in tariffs were once the darling of many as Europe's schemes encouraged rapid scaling of wind and solar power. But the shine has come off these solutions with painful retroactive reductions of tariffs in Bulgaria, Spain, and the Czech Republic. Auctions have more recently been very effective in Brazil, South Africa, and elsewhere in creating competition and driving down tariffs, though such approaches might be less successful in periods of inflating prices and interest rates.

As regulators and markets learn from past mistakes, many hybrid approaches are being designed that optimize the benefits of several different approaches.

IFC has financed renewable energy projects under a variety of regulatory support systems. The table below provides a comparative analysis of the four broad categories of regulatory support based on IFC's experience.

TAX INCENTIVES

Accelerated tax depreciation, transferable tax credits (which can be used to raise capital), and other tax-based investment incentives.

STRENGTH: Can accelerate pay down of capital cost. | Can drive competition among RE technologies, delivering similar incentives to all. | Public "subsidy" is delivered upfront so regulatory reliance and public liability are not long-term.

WEAKNESS: Burden is directly on government finances with reduced tax income. | Can lead to stop/start markets if support is only approved on an annual basis (such as in the U.S.) or with economic cycles affecting the availability of profits to shelter from taxes. | Reduced operating incentives can lead to less well-run generation assets. | May disadvantage some RE technologies.

PORTFOLIO STANDARDS

A government-required percent of all power generated to be sourced from RE, often twinned with a credit or tradable certificate system by which suppliers demonstrate compliance.

STRENGTH: Can drive competition among RE technologies, delivering the government target at the lowest cost. | Can achieve an exact volume target if measured against metered output. | Cost efficient (depends on floor price of certificate).

WEAKNESS: Low TLC*. | Price volatility. | Disadvantages some RE techs so likely to only support the single lowest cost technology for that country. | Complexity. | Bureaucracy in administering and managing the RE credit scheme. | Setting right percent can be a challenge in understanding the cost implications on the sector (this can be mitigated by setting a suitable safety valve or penalty price above which the credits cannot go).

**TLC=Transparency, Longevity, Certainty*

FEED-IN TARIFF ("FiT")

A FiT gives a guaranteed fixed price or premium per kilowatt hour (set by a regulator) to the generator for all projects of a technology (renewable energy) type for a fixed period of time.

STRENGTH: TLC. | "Pull" incentive on the market. | Separate FiTs can allow multiple technologies to be supported and deliver diversification.

WEAKNESS: Getting the price right is hard, as equipment and financing prices are dynamic. A FiT that is too low will result in no investment and a FiT that is too high will give away excess returns and add to public costs. | A FiT alone is not enough to spur the market—also need access to grid, bankable PPAs, etc. | FiTs create long-term liability—suitable caps on the amounts of RE supported are needed, so sustainability depends on who is paying—are the tariffs passed through to consumers or subsidized by government funds—and how much is supported?

AUCTIONS

Government or utility-run competitive tendering of fixed amounts of capacity for specified RE technologies.

STRENGTH: Combination of market efficiency with the auction and the TLC of a guaranteed price once set. | Greatest regulatory control on expansion of RE in the system. | Separate auctions can allow multiple technologies to be supported and deliver diversification.

WEAKNESS: High transaction costs and long lead times associated with running the auctions. | Risk of non-delivery if auction entry requirements and bid scrutiny are inadequate. | Setting suitable bid deposit/guarantees is essential to successful outcomes. | Harder to achieve success in context of volatility in capital costs and/or costs of capital, particularly related to currency markets (bids may become quickly unviable).

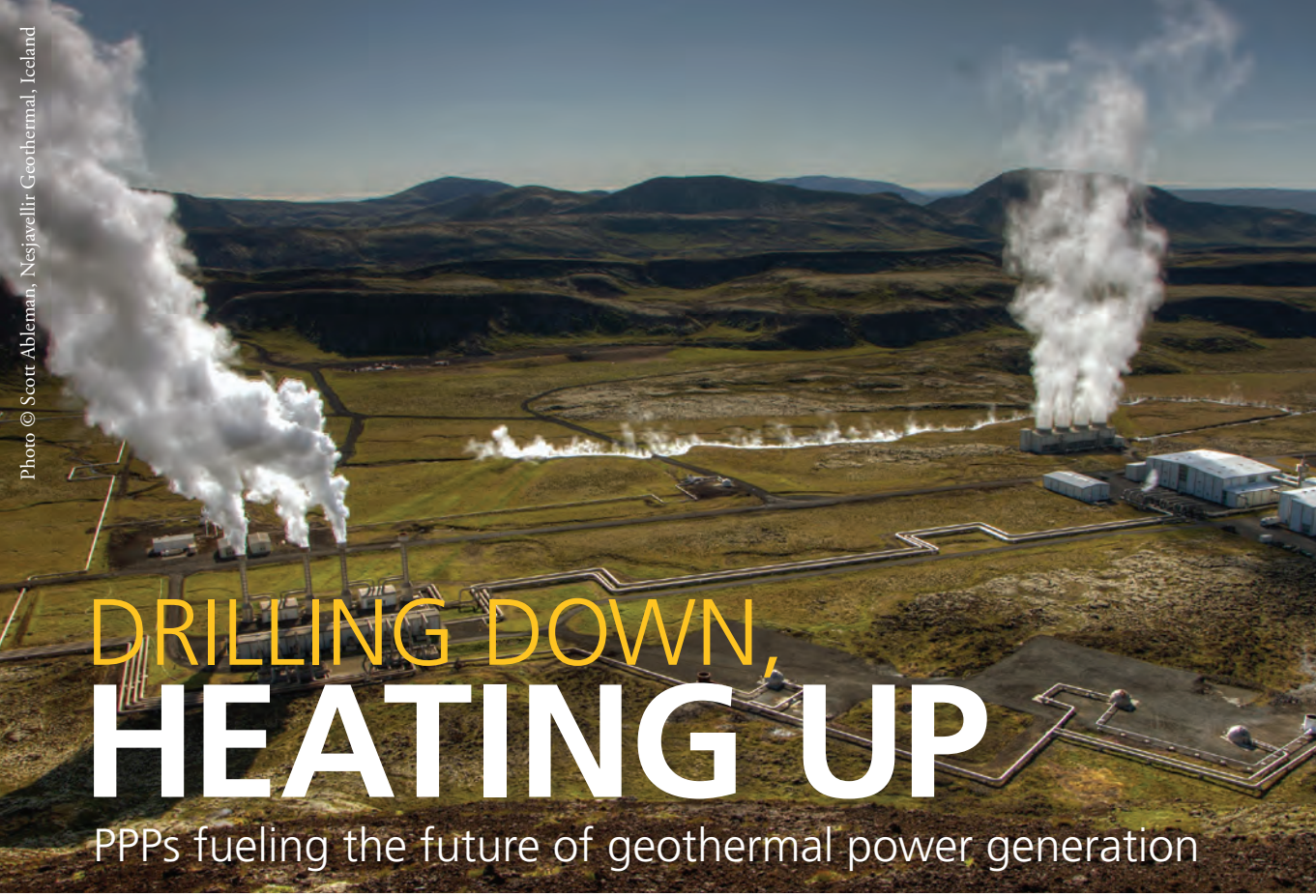


Photo © Scott Ableman, Nesjavellir Geothermal, Iceland

DRILLING DOWN, HEATING UP

PPPs fueling the future of geothermal power generation

By Pierre Audinet & Almudena Mateos Merino, World Bank

It's hot at the center of the Earth—nearly 6,000 degrees Celsius—and the promise of public-private partnerships (PPPs) for geothermal energy, power derived from the planet's internal heat, is heating up as well. Geothermal energy has wide appeal because it is a renewable resource that produces sustainable base load power with a fraction of the greenhouse emissions of fossil fuels. Around 40 countries worldwide, including several low and middle income countries, have the potential to meet a sizeable proportion of their electricity demand through geothermal power, at a relatively low cost (around $.08 per kilowatt hour [kWh]).

As of 2012, however, global installed capacity had only reached 11.4 gigawatts (GW), about 0.3 percent of the world's total generation and only a fraction of its technical potential. What risk factors are holding back the potential of geothermal energy, and how can tailored PPPs help restore this promise?

RISKY BUSINESS

Unlike other renewable energy technologies, such as wind, solar, and hydro, it is not possible to confirm the existence of the geothermal resource with sufficient confidence for commer-

cial development without performing at-depth drillings to assess specific geologic, chemical, and physical conditions in the field. Therefore, geothermal's risk profile is substantially more significant than the other renewable options.

While surface exploration is relatively cheap, validation of geothermal resources through exploration and confirmation drilling is expensive, often requiring $15 to $25 million per field. In other words, at least 10 percent of the capital expenditure of a new geothermal plant needs to be put at risk before it is clear whether a site has the potential to recover the costs. Although the rate of success for drillings increases with the numbers of wells drilled, production drilling is not free of resource risk. This means that project developers need to invest significant resources (up to 50 percent of the total project cost) before fully securing the geothermal fuel to meet a given power plant capacity.

Geothermal projects also have relatively long lead times from the start of exploration to power plant commissioning and the first revenues. Together with the high upfront costs and resource risk, this contributes to the high financing risk of these projects. Lack of commercial debt for resource validation and most of the production drilling stage complicates matters further.

PROMISING PATHS

Several models have the potential to mobilize capital and share the resource risk among promoters of geothermal projects, restoring the sector's promise. These models can be broadly grouped into three categories, based on the extent and nature of public and private sector participation across the phases of project development.

Public Entity: Under this model, the entire project development cycle—including risks, costs, and benefits—is undertaken by public entities. This is true whether there is a fully vertically integrated national entity (such as in Ethiopia and Kenya, KenGen at Olkaria), a group of unbundled national entities operating in the upstream phases and power sector separately (as in Indonesia), or a combination of national and municipal entities (as in Iceland). Although the purely public model has the advantage of directly benefitting the consumers through lower electricity tariffs (since no "private equity" return on investment is required), this approach has limitations. These include the insufficient level of government and other public resources that can be brought to bear on the development and execution of a country's geothermal development.

Private Developer: At the other end of the spectrum is a vertically integrated, private developer model, which is typically undertaken only by large multinational companies with strong balance sheets who are willing to take the entire project risk (Chevron in the Philippines).

PPP: In most developing countries, the private sector cannot put the required equity at risk for the riskier phases of project development, even with risk mitigation instruments in place, and the government has limited capacity to fully assume the costs of developing its geothermal potential. In these cases, a PPP model helps

mobilize private developer funds and reduces overall financial risk that would be taken by either the government or private developer when operating alone. Different PPP variants can be used depending on the country risks and associated commercial, market, off-take, and other risks. Most typically, the public sector will take on part of the risk of upstream resource exploration and development, with the private sector carrying out power generation activities.

Geothermal's risk profile is substantially more significant than the other renewable options.

DRILLING DOWN TO PPPs

A closer look at PPP arrangements reveals a number of different approaches within the partnership model, all of which have met with success around the world. In each case, the strategy was tailored to the specific needs of the region and the parties involved.

Tolling or energy conversion agreement: Under this approach, a geothermal steam field operator, generally a public entity, develops and operates the steam field. The steam is then converted to electricity in a power plant owned and operated by a private developer, who may or may not attain ownership of the product. The type of contractual relationship established between the steam provider and the electricity generator (and between the electricity generator and the power off-taker) will determine the specific distribution of risks. This model was used in the Leyte and Mindanao fields in the Philippines and in the Zunil I plant in Guatemala in the late 1990s, and is the model currently pursued in Kenya.

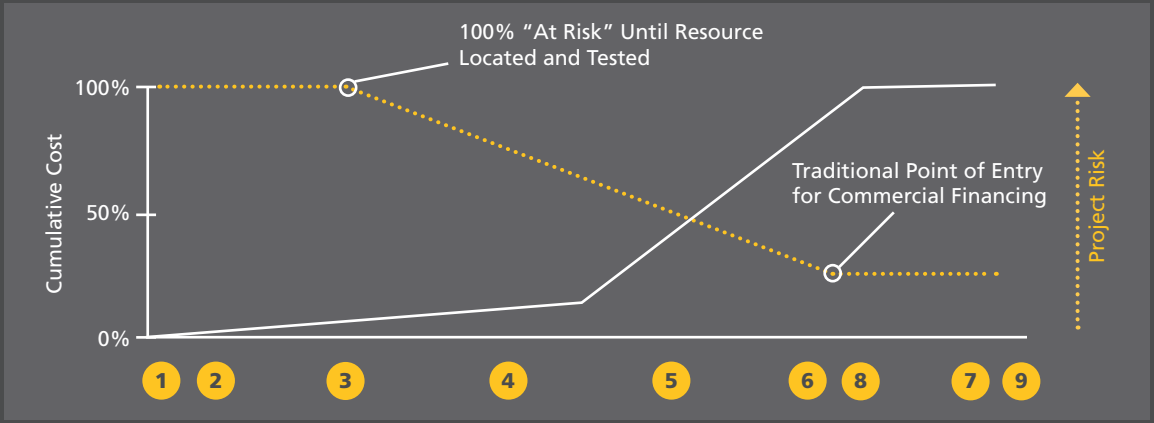
Joint venture: This entails a strategic partnership between a public entity and a competitively selected private investor. The geothermal developer is co-owned by the government and the private sector investor and all aspects of the projects are co-financed and developed (as with La-Geo, El Salvador).

Other IPP variants: Here, government may fund the surface exploration, exploratory, and confirmation drillings, offering the successful field for development and power generation. Alternatively, government performs limited exploration, then shares the risk of further exploration and power generation. The latter option is feasible only if private investors can absorb the risk associated with confirmation and production drilling.

Regardless of the approach that's used, international experience in geothermal energy shows a clear need for public-private engagement in order to exploit even a fraction of the potential of geothermal power generation. If the risks are in balance, promise can turn to potential—with power not far behind.

This article is part of The Global Geothermal Development Plan, an initiative by the World Bank Group's Energy Sector Management Assistance Program (ESMAP) and other multilateral and bilateral development partners. More information: www.esmap.org/node/3027

KEY PHASES, RISKS, AND COST PROFILE OF GEOTHERMAL DEVELOPMENT



EXPLORATORY PHASE:

1 ***Preliminary Survey:*** includes data collection, inventory, selection of areas for exploration, and pre-feasibility studies.

2 ***Surface Exploration:*** identifies the probable location and characteristics of the geothermal reservoir and establishes exploratory drilling targets.

3 ***Exploratory Drilling:*** validates surface exploration results, locates and tests the geo-thermal resource to support preparation of a feasibility study.

4 ***Confirmation Drilling:*** confirms or serves to modify the conceptual reservoir model, updates the volumetric assessment, and establishes production drilling targets.

RESOURCE/FIELD DEVELOPMENT:

5 ***Production/Capacity Drilling:*** increases geothermal resource supply by drilling the geothermal reservoir in conformance with the model.

6 ***Steam Gathering System Development & Construction:*** detailed design, engineering, procurement, and construction of the steam gathering system and related equipment, which connects the geothermal reservoir to the power plan.

7 ***Steam Gathering System Operation:*** all operating requirements of the geothermal steam field as part of the integral operation of the power generation facility.

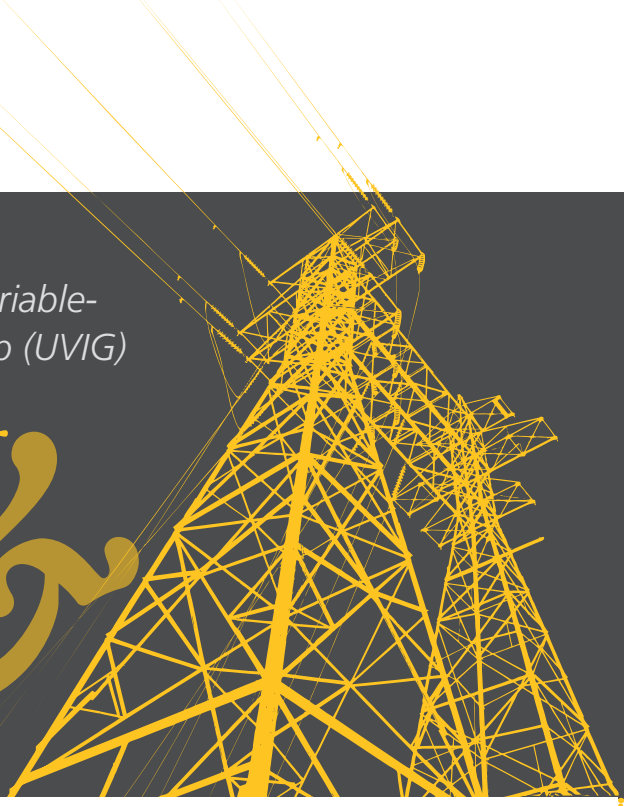
POWER PLANT DEVELOPMENT & OPERATIONS:

8 ***Power Plant Detailed Development & Construction:*** detailed design, engineering, procurement, and construction of the power plant and the electrical interconnect to the transmission grid.

9 ***Power Plant Operation:*** personnel training and operational requirements as part of the integral operation of the power generation facility.

By J. Charles Smith, Utility Variable-Generation Integration Group (UVIG)

integrating WIND & SOLAR



Much has been learned over the past decade from experience and research in the integration of the variable generation (VG) of energy from wind and solar power plants into an electric grid. Understanding the lessons that have emerged for transmission and network planning, along with market design and operation, is critical to future efforts to integrate higher levels of VG at lower cost.

Think of the transmission network as the glue that holds energy systems together. It connects the base load to generation, allows for large blocks of energy to be moved from where they are generated to where they need to be consumed, eliminates or reduces congestion, and improves reliability. It supports the electricity markets by covering large geographical regions, allowing access to many generation units. This ensures a deep and liquid market, and better management of the aggregate variability in VG.

Networks need to be large enough to cope with increasing generation supply. Expansion of transmission networks is justified based on:

- economics (resulting in lower cost energy);
- reliability (resulting in fewer hours of outages); and
- public policy goals (allowing for the integration of VG from renewables).

Networks also must be well and appropriately managed. Evidence shows that national networks

must be managed at the central level to achieve national objectives and fairly balance regional competing interests. A regulatory function at the national level, such as the United States Federal Energy Regulatory Commission and the Council of European Energy Regulators, can be important.

MARKET DESIGN

National market design creates a level playing field for all participants (generators, transmission companies, distribution companies) by providing the same set of bidding policies, operating policies, and payment policies. As with transmission, a strong regulatory function should also be developed in parallel to ensure fairness in market operation, discourage anticompetitive market behavior, and encourage new entrants.

MARKET OPERATION

Given the size and complexity of a well-functioning market, the complexity and expense of the software necessary to operate the market, the operation of the existing infrastructure, and the long-term goals for integrating a large share of VG, it is important to address the following issues as part of a comprehensive market operation.

Balancing Area: System balancing, done over large areas, is critical for reliable system operation. In doing this, countries can aggregate VG across broad geographical regions. This reduces the variability of the output and the cost of integration, and increases the amount of VG that can be integrated cost-effectively.

Reserve Requirements: A large balancing area and associated aggregation benefits also reduce reserve requirements because there is a reduced variability over a larger geographic area, leading to a smaller reserve capacity to manage the reduced variability. In addition, the contingency remains the same and can be covered with fewer total reserves in the footprint.

Unit Commitment and Economic Dispatch: Scheduling and dispatching generation at the market level makes a larger pool of generation available to balance the system load. This larger pool with a shorter dispatch interval provides greater flexibility, leading to efficient and economical system operation.

EXPERIENCE PAYS OFF

A range of experience has now been developed with the establishment of competitive electricity markets around the world in countries as diverse as the U.S., Chile, Great Britain, Denmark, Germany, and Australia. The experience illustrates that well-designed markets can provide an effective solution for the integration of large amounts of variable generation. But there is no one-size-fits-all solution, and the most custom tailored solutions routinely take 10 to 20 years to develop and mature. While many are still a work in progress, they provide an important guide for those who would embark on the journey.

MEXICAN ENERGY REFORM

Releasing power & renewable energy

By Eduardo Márquez & Ariel Ramos, Hans and Boone LLP

Photo © Randy Montoya/Sandia Labs

Mexico is among the world's highest-potential producers of renewable energy. It has almost double the solar radiation and photovoltaic capacity of Germany, the country with the highest installed solar capacity. The so-called "Ring of Fire" ranks Mexico fourth in the world in the production of geothermal electricity, even though it currently taps only about 10 percent of its potential. As for wind energy, while the installed capacity has grown over 600 percent in the last five years to a current 1,200 megawatts (MW), this is still only a fraction of the potential total capacity of over 40,000 MW.

Mexico has one of the world's most ambitious clean energy strategies that targets 35 percent of total power generation from renewables by 2024. As of 2012, the installed capacity for power generation through renewable energy was at 23 percent, which is still far from the targeted 35 percent. According to Mexico's Ministry of Energy, as of September 2013, the gross genera-

tion of electricity in Mexico was 22,008 gigawatt hours (GWh).

ENERGY REFORM'S NEW RULES

In December 2013, the Mexican Congress approved a constitutional amendment (the "Energy Reform") to open to foreign investment and private participation the oil, gas, and power sectors. The Energy Reform will change the rules of the game for the whole sector, including renewable energy. It provides a formal opening for the private sector to participate in the generation of power in an open market. The underlying legislation for the Energy Reform is still on the table, and the rules for such participation shall be put in place in the upcoming years.

The Energy Reform establishes that the state will reserve the right to transmit and distribute power. It provides for private participation through the finance, installation, maintenance, management, and operation of infrastructure to carry out the transmission and distribution of power.

Once the new law that regulates power is in place, the Executive Branch will have one year to create the National Center of Energy Control. The agency will regulate Mexico's electrical system, operate the wholesale market of power, and give private parties access to the transmission and distribution grid.

As for renewable energy, the transitory articles of the Energy Reform mandate the Mexican Congress to enact legislation within 120 days to regulate the survey, exploration, and exploitation of geothermal resources. By 2015, the Ministry of Energy shall include in the National Program for Sustainable Use of Energy a strategy to promote the use of clean technology and fuels.

OBLIGATIONS AND OPPORTUNITIES

The underlying legislation will establish new obligations in clean energy and reduction of pollutant emissions for players in this industry. This will spur private parties to seek the support of international organizations and government programs so they can access finance, social and environmental assistance, and other mechanisms that will help them create bankable projects.

Although new rules of the game have yet to be firmly established, PPPs will continue to play a strong role in the power sector. This is especially true for projects involving municipalities. These municipalities could become the vehicle that powers Mexico's transition to renewable energy.

PPPs, POWER, AND RENEWABLES—THE ROLE OF MUNICIPALITIES

So far, public-private partnerships (PPPs) in power and renewables have been primarily used between municipalities and private parties for cogeneration and self-supply schemes, or through long-term off-take contracts between private parties and the Federal Electricity Commission.

PPPs have been common at the municipal level because of the municipalities' obligation to provide public services such as streetlighting. They have provided an efficient and cost-effective mechanism to ensure high quality delivery of electricity. These PPPs will continue to light the way as Mexico's Energy Reform takes hold.

Photo © Wendell/flickr

WHAT'S WORKING IN MEXICO: WHY AND WHY NOT?

Most of Mexico's successful renewable energy projects have been focused on wind, biogas, thermoelectric, and thermo-solar energy (including photovoltaic modules). Bioenergía de Nuevo León, the first biogas project in Latin America, is a good example. This project was a joint venture between the private sector and the State Government of Nuevo León through the State Ecological and Waste Management Agency. Bioenergía de Nuevo León currently serves, and is partnering with, seven municipalities. This project has been supported at different stages by the World Bank, including an emission reduction purchase agreement to buy 1 million carbon credits.

Another example is Aura Solar. The solar power plant located in Baja California was completed in 2014 and it currently is the largest solar plant in Latin America and the first large scale solar plant in Mexico. The project has as its only offtaker CFE, which will buy all the solar power generated by the plant. The current generation capacity is 30 MW. This private project received financing from IFC and the Mexican development bank NAFINSA.

Due to the geographical conditions of states such as Chiapas, Oaxaca, Baja California, Nuevo León, and Tamaulipas, municipalities have been able to provide inexpensive renewable energy. However, other states have not seen the same success. Political rifts, project risks, and the high cost of technology have all contributed to the problem. This highlights the most significant challenge in Mexico's regulatory reform: to find an appropriate balance between the public and private sector. When the private sector is empowered to provide renewable energy at a lower cost to municipalities, the potential of Mexico's vast resources and renewable energy capacity may finally reach its promise.

Photo © Graham Crouch/World Bank

let's talk TRANSMISSION

Private investment for emerging markets

By Marcelino Madrigal, World Bank

Emerging markets need the security and reliability of well-planned power transmission networks. Private sector investment in the transmission network, already proven in developed countries, is becoming more common in emerging markets.

The past is not prologue when it comes to models for the transmission of power; fresh technologies and growing needs are driving a new way of doing business. Although many developing countries fervently believed that the transmission sector needed to remain public throughout the 1980s and 1990s, a model that could accommodate private investment started to take hold after 2000. Once investment needs were evaluated—and understood to be higher than the

government could handle on its own—officials started thinking more about ways to include the private sector.

The transmission network has always been seen as a natural monopoly, but it's been misinterpreted as requiring monopoly ownership. Transmission networks need to be operated independently to ensure non-discriminatory access, but investment needs can be achieved with the involvement of many actors, public and private. The success of private investment in transmission in the U.S. led countries like Brazil—a shining example of tremendous investment need—to adapt this approach to its own requirements. In Brazil's case, the country needed to expand and reinforce its network to connect its system and facilitate the creation of new renewable energy sources. Officials there found that incorporating private investment in transmission was not only feasible, but beneficial to all parties. The operation of the network remains a monopoly, and is organized as one entity, but private investment in transmission has been a success.

MORE THAN THE SUM OF ITS PARTS

This approach works because although there is just one network, it has many discrete components, and these components can be independently developed by the private sector. The same is true for other emerging markets. Once you identify those pieces of the network, you can engage the private sector to build them. Once a private sector entity does that, it has the right to receive regulated revenue—but only in return for satisfying its obligations for maintenance of the assets and ensuring needed performance. This assures that the transmission lines or substations will always operate according to technical standards determined by system operations rules, which continue to be managed centrally, in a monopolistic manner.

More developing markets should consider this route. This is especially important as investment requirements in transmission grow alongside peoples' demands and the need to integrate into grids more renewable sources of energy.

TRANSMISSION TIPS

There are three elements critical to successful private investment in transmission. These include:

A good planning process, coordinated by an agency that is independent from all the other actors. Because the network is a monopoly, someone has to plan for it; this responsibility typically falls to a government agency, a planning agency, or a system operator. A comprehensive plan will proactively identify transmission needs and requirements to meet demand in the most reliable, cost effective manner. The agency that creates and executes this plan must do so in an integrated fashion by sensing the demands of all actors in the industry—including generators, demand centers, and renewable energy plants.

A mechanism to engage the private sector on supporting this investment. This could be a public-private partnership (PPP), whereby, the private sector develops one of those investments identified in the plan on a concession. These arrangements mean that a private participant becomes a transmission-owning entity. They are

in charge of developing and maintaining the asset—and that in turn guarantees them revenue. That revenue gives them the opportunity to recoup their investment and a fair return on their investments.

This mechanism makes participation in the sector attractive because they are selling a transmission service that is regulated, with a regulated rate of return. It's important to note, however, that transmission-owning entities do not decide which energy flows through the network; that's decided by the system operator. This way, the key principles of the network are maintained—especially transparency and open access.

A clear and stable regulatory framework that defines how these investments are going to receive revenue. This regulatory framework is, at its core, transmission pricing: very clear transmission, cost recovery, and pricing rules. In this context, cost recovery defines how an investor is going to earn revenue and how transmission pricing regulations will collect such revenue from all the users of the network.

Awarding projects to investors follows competitive rules, which makes possible the awarding of the project to those who require the lowest revenue to develop and maintain the projects. In this way, regulators will feel more confident that the costs passed to consumers are efficient and reasonable.

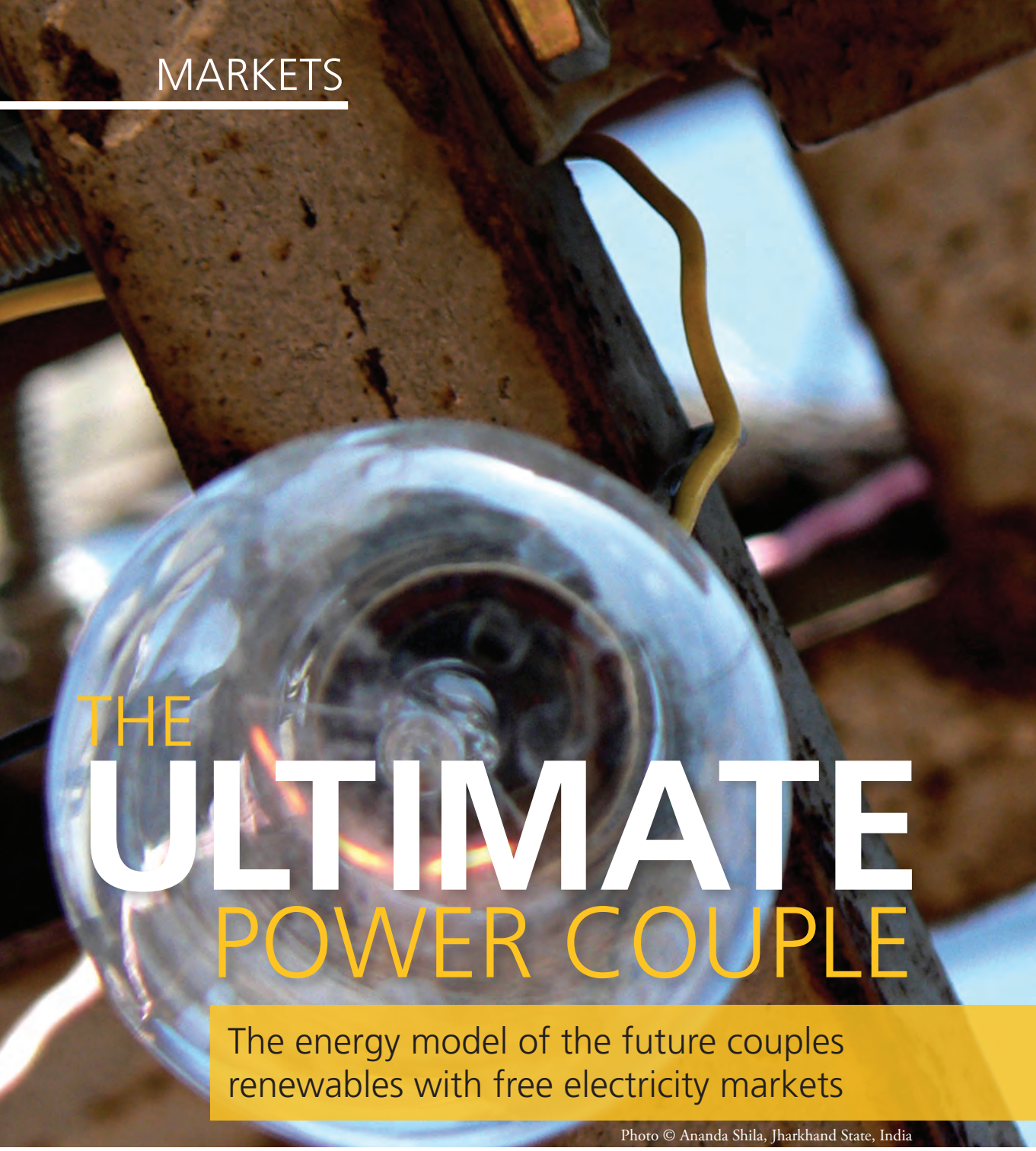
A POWERFUL DRAW

Private investment in transmission for developing countries will become more attractive as demand for transmission grows and a clear and stable institutional and regulatory framework for the transmission sector is developed. India is already considering mechanisms for private participation in transmission; Mexico recently approved a very ambitious reform plan that opens the possibility of complementing public resources with private participation. Brazil's experience has resulted in a lower cost of capital in transmission. Those are the kind of model results that other developing economies pay attention to, and more countries will move in this direction.

Brazil's experience has resulted in a lower cost of capital in transmission. Those are the kind of model results that other developing economies pay attention to.

It's especially critical for those developing markets with high investment needs in transmission driven by renewable energy programs and the need to improve the capacity and reliability of the grids required by economic growth. Strong planning abilities in the transmission sector; clear arrangements to engage the private sector through PPP models; and regulations that already take into account transmission and pricing will help pave the path to success.

As populations grow, so will demand for energy. The expanded requirements for transmission are not far behind. Private investment, done right, can meet this need.



THE ULTIMATE POWER COUPLE

The energy model of the future couples renewables with free electricity markets

Photo © Ananda Shila, Jharkhand State, India

By Aleksandar Katančević, Stratega East

The free electricity market is much younger than any of the well-known fossil fuel markets; in fact, it is the baby of the energy commodity family. It was born in Latin America in the 1980s and it reached the U.K. in 1990 with the privatization of the U.K.'s power industry. But despite its relative youth, the free electricity market is more sophisticated than the fossil fuels market. This is thanks in part to the advanced technology of electric power systems used to generate electrical energy, but also due in part to difficulties with storage.

COMPARING FORMS OF ENERGY

The transportation time for electrical energy is almost equal to the speed of light, making this product unlike any other on Earth. It is also cheap to transport: long distance distribution costs close to nothing. Together, these factors make this product incredibly easy to move. And to top it off, renewable electrical energy is environmentally-friendly and non-polluting.

Fossil fuels, the world's go-to solution, are also easy to store—they are like packets of ready energy that need only be ignited when needed. But it's no secret that they are high polluting and relatively expensive to transport.

LOOKING AHEAD

Because of this, the energy model of the future must combine free electricity markets with renewables. To compete with fossil fuels, these markets must be brought together to get the electrical energy produced from renewables to market—reliably—at a lower market price.

Renewable electrical energy is environmentally-friendly and non-polluting.

Technological energy sources (batteries and solar panels) placed locally (distributed generation), alongside additional information technology, can answer the call, connecting production with the real-time electricity market (grid). But there is no commercial marketplace to sell energy that the consumer generates and does not require;

today's electricity market environment is not yet sophisticated enough to support real-time trading of energy produced or purchased by distributed generation and households.

What's the bottom line? Even if we had a completely compatible energy source that could produce energy locally, the electricity market would have no trading mechanism for such a source.

At the intraday electricity market, electrical energy is traded one hour ahead, working within the electricity exchange.

ENTER INTRADAY TRADING

The intraday electricity market, which grew from the need for real-time price information from the electricity market, is the closest relative to a real-time market. In today's intraday electricity markets, electrical energy is traded one hour ahead, working within the electricity exchange.

In the future, the transmission system operator or market operator responsible for the market area (either the country or a coordinated region) should ideally provide the price, which should be calculated about one minute ahead of delivery, and be valid for at least one minute. Price information should be available electronically and fed directly into a device that controls the operational mode of the household.

In a successful scenario, the household would work in three modes:

1. Taking energy from the grid.
2. Feeding energy into the grid.
3. Neutral against the grid, but
   - feeding the energy into local batteries, or
   - taking the energy from batteries and the solar panel on the roof of the house (i.e., being self-sustaining).

ARE WE THERE YET?

Several hurdles must be overcome before this model can operate. For example, the electricity market would need to develop to the point where it can generate real-time market pricing. Power systems stability would need to improve, and suitable energy management technology would need to be developed.

Currently, spikes in demand are satisfied with fossil fuel energy. Thermal power plants are stable, they respond quickly, and they are readily available. In a future where fossil fuels have been phased out, this will cease to be a back-up plan. For a new energy model to work, stakeholders and consumers alike will need confidence in a real-time solution that will see us into the next century.

COMPARING SOURCES OF ENERGY

	Fossil energy (oil, coal, natural gas)	Electrical energy	Renewable energy (hydro, solar, wind)
Transportation time	Days to months	0.7 x speed of light	No need, available locally
Transportation costs	Medium to high	Extremely low	Zero
Storage availability	Stable in its natural form or easily stored using industrial storage solutions.	Limited due to the size and cost of storage.	Very limited to the size of the reservoir, battery or compressor and stored locally.
Energy type	Primary energy source	Derivative energy source	Primary energy source
Commodity application	Energy container	Energy transporta-tion medium	Energy release (infinite source)
Environmental impact	Pollution produced when burned	Extremely low	Extremely low
Usage by the end consumer in its original form	Not really, always comes with side effects (smell, pollution, CO_2 hazardous gases)	Absolutely (clean, no smell, no pollution, no hazardous gases)	Yes in some applications

GOING ONCE, GOING TWICE...

Electricity auctions deliver results

Photo © Dana Smillie/World Bank

By Luiz Maurer, IFC

Auctions are an interesting and potentially effective form of procuring electricity. If successfully designed and implemented, they may lead to far superior results than other selection methods since they increase transparency and foster competitiveness.

Bidders don't raise their paddles in an electricity auction, and there's no fast-talking man at a podium urging folks to act fast on a great deal. But the auction of electricity contracts is still an exciting event for many countries, especially for those just starting to introduce competition in the market. For governments that already use competitive procurement methods, these auctions can further enhance competition and ultimately reduce energy costs to the end-user.

BROAD BENEFITS

Auctions can be used in countries with a wide range of sophistication in institutional and regulatory frameworks; in many cases, the benefits have offset the overall implementation costs. Auctions have also been used to procure energy contracts across a wide range of technologies, such as wind, biomass, solar photovoltaic or concentrated solar power, or even site-specific hydropower plants.

Although every case is different, successful auctions have similar results. Typically, they are able to:

- increase the transparency and competitiveness of the procurement process, resulting in economically efficient outcomes that are difficult to challenge; and
- establish an objective, market-driven criterion for the thorny regulatory issue of pass-through of generation costs to a utility-franchised market.

Latin America is leading the introduction of auctions to promote competition in energy procurement and contract new capacity. Overall, about 30 energy auctions have been conducted in Brazil, Chile, Colombia, Panama, and Peru. Results have been satisfactory more often than not, in terms of attracting a large number of private players and ensuring lower costs for consumers.

FROM THEORY TO PRACTICE

Moving from auction theory to real-life implementation is, however, not an easy task. Evidence from electricity auctions over the last few years makes it clear that to ensure success energy auctions must be built for purpose—taking into account the challenges and objectives of the host country. When this is not the case, there can be drawbacks.

Under an auction-based system, for example, an incentive is created for bidders to bid as low as possible in order to increase their chances of securing a contract. Recent experience from jurisdictions such as China and Brazil suggests that underbidding is widespread, and contract failure rates remain high, leading to slower growth. This requires the establishment of strict criteria for participation and severe penalties for non-compliance. Large countries like Brazil and South Africa have the resources and skills to design effective auction mechanisms, and smaller countries need support in designing equally effective auctions. Benefits far outweigh the initial set-up costs.

On a different level, auctions significantly increase the overall risk of renewable energy investments, as there is a relatively low likelihood that any individual project will receive a contract. Bidders must therefore put up significant sums in order to mount a bid at all, adding layers of transaction costs with little assurance that this risk will be rewarded with an actual contract to build.

> Auctions for renewable power can work to expand the energy portfolio and push costs down.

This risk must then be reflected in the cost of capital, as both debt and equity providers will rightly identify increased contract and completion risks, and demand higher returns. These higher returns may well wipe out any gains derived from greater price efficiency.

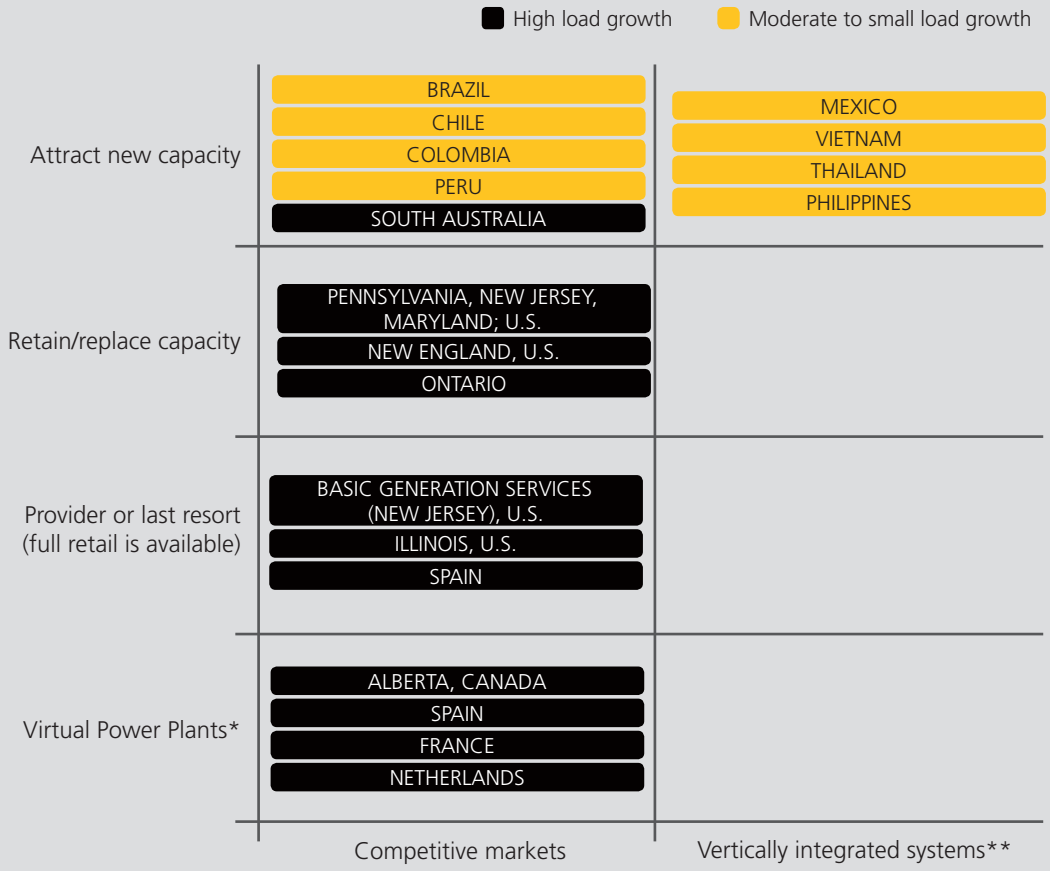
If there is confidence that auctions are there to stay, as opposed to being a once-in-a-lifetime event, manufacturers may invest with confi-

dence, even knowing that auctions may reduce margins for them. Manufacturers report that at least they know that there will be a sustainable market for them to sell their products.

NOT BIDDING ADIEU

Despite these challenges, there is a great deal of potential for furthering the use of auctions in the power sector, even in small, unsophisticated

OBJECTIVE OF PROCUREMENT AUCTIONS



**Cluster of distributed generation installations run by a central control entity.*
***When a company expands its business into areas that are at different points on the same production path.*

markets. For example, they can be used as a mechanism to grant the use of water rights, thereby enabling the development of new hydropower sites. They can also be used to select preferred projects or to allocate long-term energy contracts competitively in multi-country power pools.

Multi-product, discriminatory price auctions are also potentially applicable to select small, modular units of emergency power generation. Two-sided auctions may entertain demand response, increasing competitiveness, reducing market power, and paving the way for a more energy-efficient economy.

As these examples show, auctions can be an efficient alternative to developing non-conventional sources of energy in emerging markets, as a substitute for or complement to the traditional feed-in tariff schemes. Despite the significant initial costs to set up functioning auctions, auctions for renewable power can expand the energy portfolio and push costs down.

This article was adapted from "Electricity Auctions: An Overview of Efficient Practices," World Bank, 2011. Updated examples of electricity auctions have been included.

AUCTIONS AROUND THE WORLD

India—Between early 2010 and March 2012, the price of solar energy in India dropped to as little as INR 7.49 per kilowatt hour (kWh) or $0.15 per kWh. Much of this price decrease is due to the National Solar Mission's reverse auction bidding process, which awarded solar projects to companies with the lowest asking price. This price drop in Indian solar power means that solar could achieve price parity with coal or natural gas by 2016.

Morocco—Ouarzazate concentrated solar power project achieved $190 per megawatt hour (MWh). The lowest feed-in tariff before this tender was $375 per MWh.

Peru—Prices ranged from $69 per megawatt hour for a wind farm to $119.90 for a photovoltaic solar park. That's less than half the price of power in some countries where the government sets the rates, according to Bloomberg New Energy Finance. Wind farms get €77 per megawatt hour in Spain and €82 in France, both through feed-in tariff programs.

South Africa—In a 2013 bid, energy prices for photovoltaic have reached a record low of $95 per MWh.

Turkey—Wind generator selling on the spot ("merchant"). Not an auction for a long-term contract, but price resulting from an auction takes place every 15 minutes in the power pool.

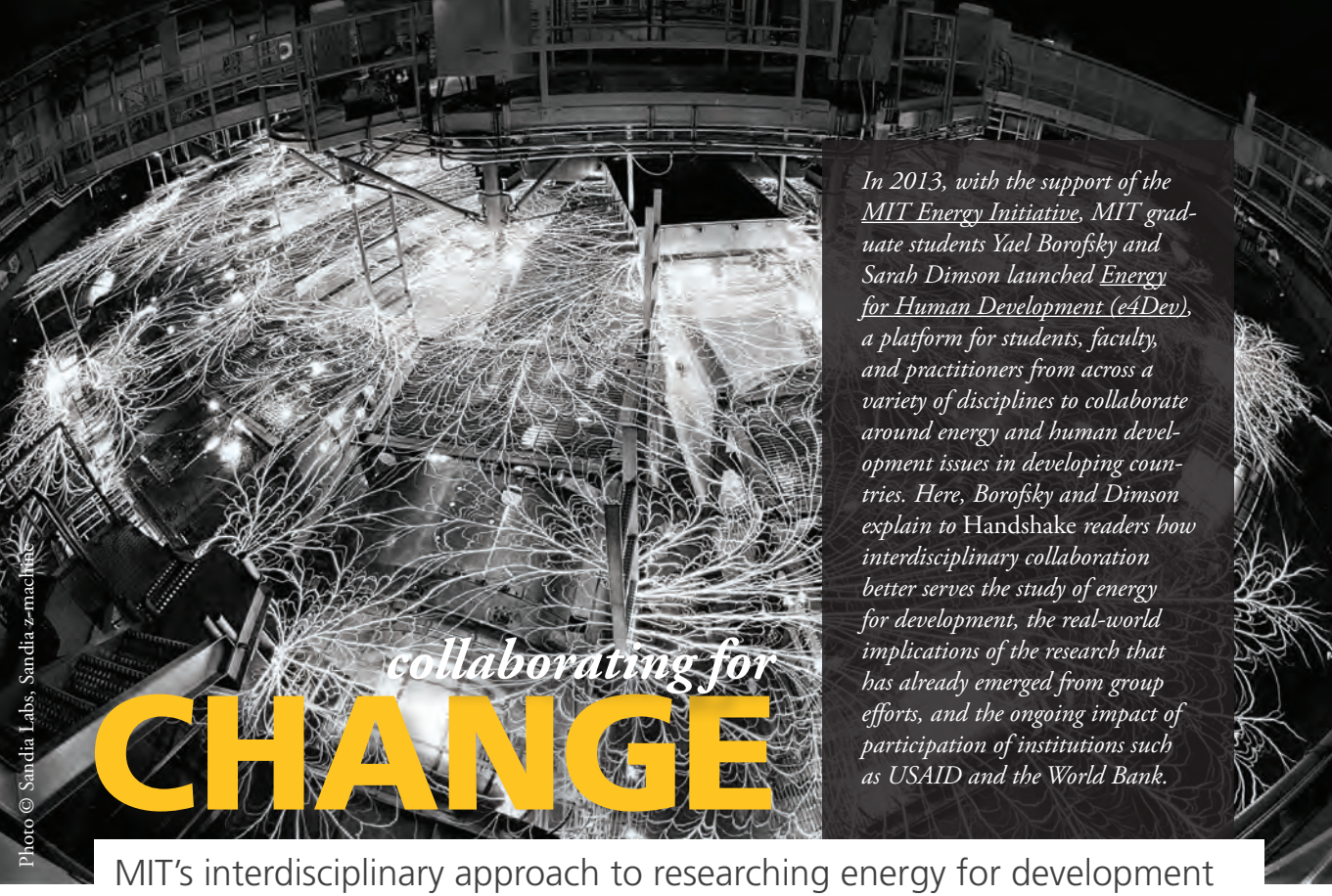


Photo © Sandia Labs, Sandia z-machine

collaborating for CHANGE

In 2013, with the support of the MIT Energy Initiative, MIT graduate students Yael Borofsky and Sarah Dimson launched Energy for Human Development (e4Dev), a platform for students, faculty, and practitioners from across a variety of disciplines to collaborate around energy and human development issues in developing countries. Here, Borofsky and Dimson explain to Handshake *readers how interdisciplinary collaboration better serves the study of energy for development, the real-world implications of the research that has already emerged from group efforts, and the ongoing impact of participation of institutions such as USAID and the World Bank.*

MIT's interdisciplinary approach to researching energy for development

e4Dev's presentations demonstrate serious interest in a range of energy issues in developing countries. Did this interest motivate the formation of the group?

Sarah Dimson: We created e4Dev for two primary reasons. First, to address an evident need for a space where those who are working at various intersections of energy and human development could discuss and debate their work. Secondly, to bring greater attention to the critical role that energy plays across various economic and human development issues—education, electricity access, climate change, health, water, and sanitation. Essentially, e4Dev provides a unique opportunity for the spread of information and original ideas.

How is the research that e4Dev seeks to promote unique?

Yael Borofsky: e4Dev is built around the notion that energy is a cross-cutting issue in most developing world research and that it can be a useful way to bring researchers together that might not otherwise find common ground or shared goals. That seems obvious, particularly at a place like MIT, which puts a premium on interdisciplinary research and happenstance connections. But

through our own personal efforts to contribute to energy and development research projects, we saw firsthand that despite good intentions, sometimes it is challenging for researchers to actively collaborate outside of their respective departments or labs. Through e4Dev, we've actually seen a diverse range of students, faculty, and outside practitioners form new partnerships or start new projects, which tells us the plan to help build these intellectual bridges is working.

e4Dev has hosted the World Bank and USAID. Do you see International Financing Institutions (IFIs) and development agencies as part of a greater energy solution?

SD: IFIs and development agencies play an important and meaningful role in advancing economic and human development. So, as we created the framework for e4Dev over the summer of 2013, we were keen to find topics of interest for the MIT community, IFIs, and aid agencies. Fortunately, our strategic planning coincided with President Obama's announcement about Power Africa. As Yael and I discussed the Power Africa initiative, we quickly realized that we had a ready starting point for a fall 2013 e4Dev event that could highlight a range of energy issues in Sub-Saharan Africa. Andrew Herscowitz, Coordinator for Power Africa, and Allen Eisendrath, USAID Energy Division Chief, accepted our invitation to share more information about the initiative and constructively engage with some of MIT's brightest minds working on electricity access, policy, and technology.

There is empirical evidence linking energy to economic growth, and this awareness is slowly starting to inspire more urgent—and hopefully more pragmatic—action in developing countries.

There has been a tremendous focus on energy issues because of trends in urbanization, but many of e4Dev's presentations are on rural communities. Why is this?

SD: Most developing country populations live in rural areas and access to modern energy services is extraordinarily low. For example, in Sub-Saharan Africa, access to electricity is approximately 32 percent and rural-dwelling residents constitute roughly 63 percent of the total population. In regions of developing Asia, a large segment of the population relies on traditional biomass for cooking and the majority of people also live in rural areas. Further, in developing Latin America and the Caribbean, access to improved water sources in rural areas is not universal at about

80 percent. Therefore, it's understandable that e4Dev's energy poverty discussions, in particular, have concentrated on designing policies, systems, and business models to meet the needs of rural populations. Our unconventional dialogue about energy poverty in rural areas is likely to continue even though contemporary conversations about development and planning tend to lean towards issues of urbanization.

What are some of the potential ways that public-private partnerships (PPPs) can contribute to energy-related development issues?

YB: Improving energy systems in developing countries requires more serious focus on planning and regulation in order to create a stable environment where PPPs can succeed. Expanding central grids and installing off-grid systems for millions are daunting tasks and incredibly risky endeavors. Long-term strategic planning and clear regulation are critical, especially in the context of creating successful PPPs on energy projects.

SD: PPPs allow for tremendous opportunities to invest in education and training in developing countries. For example, with respect to regulators, PPPs can help facilitate regular training regimes for current and future regulators, for instance through the Florence School of Regulation. On a local level, PPP schemes can potentially help design and scale effective education and vocational training programs for youth and adults.

You've seen firsthand that interest in energy for development is growing. Why is this, and how will it change the way people talk about energy in the future?

YB: There is empirical evidence linking energy to economic growth, and this awareness is slowly starting to inspire more urgent—and hopefully more pragmatic—action in developing countries. For example, the Millennium Development Goals do not explicitly include energy, but the UN's Sustainable Energy for All Initiative emphasizes the need to make energy issues a development priority. Building on this, Power Africa and other influential new initiatives have drawn more attention to the need for universal energy access predicated on the development of reliable and affordable power.

e4Dev
energy for human development

For more information or to participate in an e4Dev event at MIT please contact: e4dev-request@mit.edu.

Yael Borofsky

Sarah Dimson

2013-2014 e4DEV PRESENTATIONS

- Energy for Human Development: Why Is Energy Critical for Human Development? A Multi-Disciplinary Discussion
- Prospects for Grid-Connected Solar PV in Kenya
- Solar Powered DC Microgrids in Rural India
- Power Africa: Presented by USAID
- Reliable Alternative Energy Options for Access: Lessons from China's Countryside
- Electrifying Rural India with Solar Microgrids: Adoption and Impact
- How Can We Make Water Desalination Less Energy-Intensive?
- Tackling Tanzania's Drinking Water Crisis Through the Integration of Water Filtration Technology and Information Communication Technology
- Architecting Large Desalination Projects for the Developing World
- Sanitation in Urban Slums in Kenya, Presented by Sanergy
- Solid Fuels from Biomass
- Water in Ghana
- Waste Gas-to-Liquid Domestic Fuels in India
- Biogas in Nigeria, Presented by NovGen
- Sustainable Charcoal Fuels in Uganda
- Investigating Opportunities for Microgrids in India
- Concentrating Solar Power in India
- Mini-grids for Energy Access in India: Impressions and Reporting on Early Research
- Developing an Innovation Ecosystem for Solar Energy in Chile
- Solar-Based Energy Service Delivery: Africa's Next Tech Revolution? Presented by the World Bank Africa Energy Group
- Creating Waste Management Systems with the Informal Sector in Low-Income Countries

Photo © U.S. Army Corps of Engineers

THE GLOBAL CHALLENGE

of the 7 billion people on Earth today

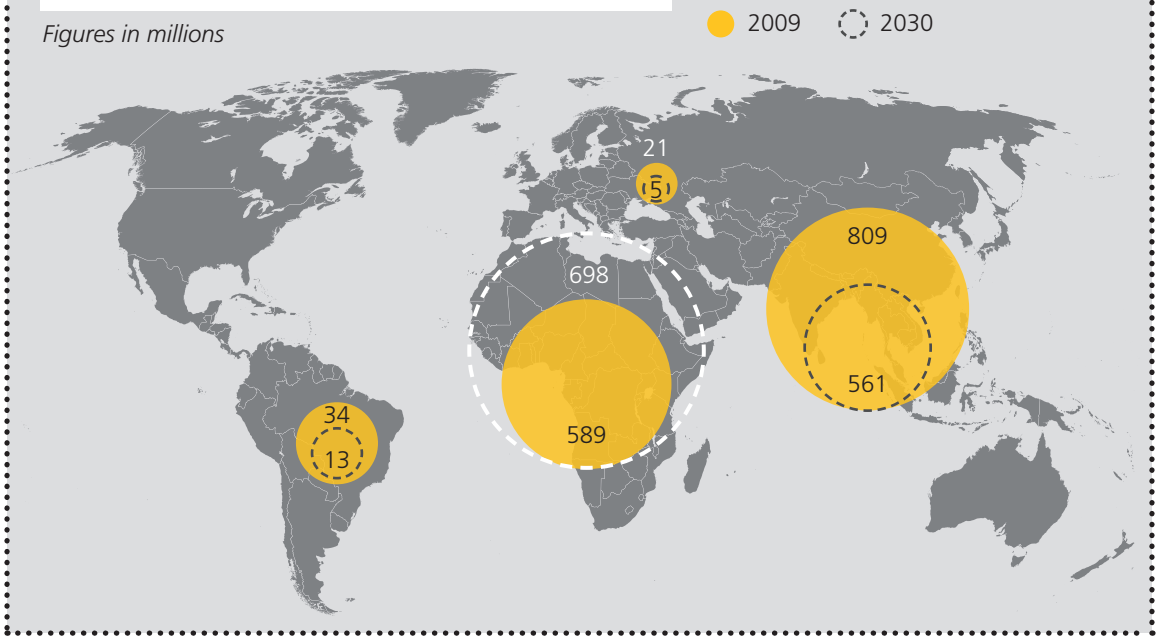
1.2 billion
people are without access to electricity worldwide.

2.8 billion
rely on solid fuels for cooking, which resulted in

3.5 million
premature deaths in 2010 due to indoor air pollution.

UN-ELECTRIFIED POPULATIONS ACROSS THE WORLD

Figures in millions



Sources: Electricity Access Database (International Energy Agency); Dalberg analysis & the World Bank

“No electricity... that’s why we are always moving backwards.”

—A Ghanaian villager’s comments in “Life Without Lights,” a multimedia project about global energy poverty.

EXPERIENCE LIFE WITHOUT LIGHTS

For villagers in northern Ghana, living without electricity means living half their lives in the dark.

Photo © Chad Skeers, Ghana

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