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Transforming the Power Sector in Developing Countries

A Strategic Framework for Post-Paris Action

Dr. Robert F. Ichord, Jr.

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Cover photo credit: A woman tends to maintenance work on the solar street lighting in her village of Tinginaput, India, in 2009. Abbie Trayler-Smith/UK Department for International Development.

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INTRODUCTION

To achieve the goals of the 2015 Paris Agreement on Climate Change, the energy sector must be fundamentally transformed into a more efficient, lower-carbon system. Energy-related carbon dioxide (CO_2) emissions of 32.2 gigatons (Gt) accounted for two-thirds of all CO_2 emissions in 2014;[1] these emissions are projected to increase as incomes, cities, and populations—especially in developing countries—grow.

The electricity sector will be especially critical, given its importance for our digital economies, the continued significant use of coal in power, and the expanding role of renewable energy technologies. The power sector is expected to see the most rapid growth of any energy subsector, driven by electrification in the developing countries. Technological changes are radically altering the nature of the electricity sector in all four phases: generation, transmission, distribution, and end use—and these changes are forcing adoption of new policy, regulatory, institutional, and operating models. Increasingly, environmental issues are driving policy and investment decisions as countries seek to achieve the emission mitigation targets in their Paris commitments and struggle to deal with the serious pollution problems that have resulted from fossil fuel use or as the consequence of devastating storms or drought conditions.

A major global challenge in the years ahead will be meeting the electricity needs of developing countries in a clean, efficient, and affordable manner. Large investments will be needed. And major improvements in policy, regulatory, and institutional frameworks will be critical to creating a conducive "enabling environment" for investment in sustainable energy.

This report examines this challenge and proposes a strategic framework for post-Paris action. Subsequent publications will apply this framework to key countries and regions in the non-OECD (Organisation for Economic Co-operation and Development) world. Concerted international action is needed to move towards the Paris target of limiting temperature rise to two degrees centigrade or less. This series of publications will hopefully contribute to our understanding of the issues and the choices facing emerging market and developing countries.

1 International Energy Agency, *Energy and Climate Change*, World Energy Outlook Special Report, OECD/IEA, 2015, pp. 11, 17.

THE CHALLENGE

The challenge of power sector transformation comes at a turbulent time in the global energy market. Governments and companies are struggling in the low and volatile oil-price environment. Forecasts of future energy markets are highly uncertain. Despite this flux, five basic factors are at play that will shape and define the key dimensions and central questions of the challenge.

Meeting Growing Energy Demand and Changing the Fuel Mix

The role of non-OECD countries in the global economy and energy system is increasing. Their share of world primary energy demand has grown from 41 percent in 1980 to 60 percent in 2013, and is forecast to increase to 68 percent by 2040.[2] Fossil fuels supplied just over 80 percent of non-OECD primary energy demand in 2013. In terms of future growth, the International Energy Agency (IEA) projects, based on an assumed 4.6 percent average annual growth in gross domestic product, that non-OECD primary energy growth will average 1.6 percent per year under the New Policies Scenario.[3] Electricity sector demand growth is expected to be higher at 2.9 percent. China and India are anticipated to continue their dominance with over 50 percent of total electricity generation in 2030. India's share increases as economic growth in China slows. After India (4.9 percent), Africa is expected to have the most rapid growth in electricity demand (4 percent).[4] Reducing energy intensity is a critical element of the challenge and the following figure shows how more aggressive energy efficiency policies (represented in the 450 scenarios for 2020 and 2030) could significantly impact energy demand growth, especially in the non-OECD countries (see figure 1).

The role of non-OECD countries in the global economy and energy system is increasing. Their share of world primary energy demand . . . is forecast to increase to 68 percent by 2040.

Forecasts see an increasing role for renewable energy in the future global power mix (see figure 2) as costs and efficiencies continue to improve. The International Renewable Energy Agency (IRENA) notes that 164 countries have set targets for renewable energy[5] and that renewables already accounted for an estimated 58.5 percent of net power generation additions globally in 2014.[6] Among non-OECD countries, China, Brazil, India, and South Africa constituted a sizable share of these additions. These large countries are also looking to nuclear power in their future mix but market size requirements and high costs limit its broader development as a non-fossil fuel option. **Will the non-OECD countries accelerate their energy efficiency and renewable energy substitution and development efforts?**

Improving Governance and Transparency

Poor governance, corruption, and political instability are key obstacles affecting the transformation process in developing countries. The annual volume of funds generated from transactions in the electricity sector is large and the cash flows from energy sales and project procurements make tempting targets for corrupt officials. These funds are often diverted to political parties to finance election campaigns and other political activities. Donors, international financial organizations, and investors sometimes exacerbate these problems and bolster corrupt elites. Although the potential investment funds under private management in the industrial countries are substantial, the perception held by fund managers is generally that the risks in the developing markets are very high. **Will these countries improve**

2 International Energy Agency, *World Energy Outlook 2011*, Table 2.3, p. 8; International Energy Agency, World Energy Outlook 2015, Table 2.2, p. 68.

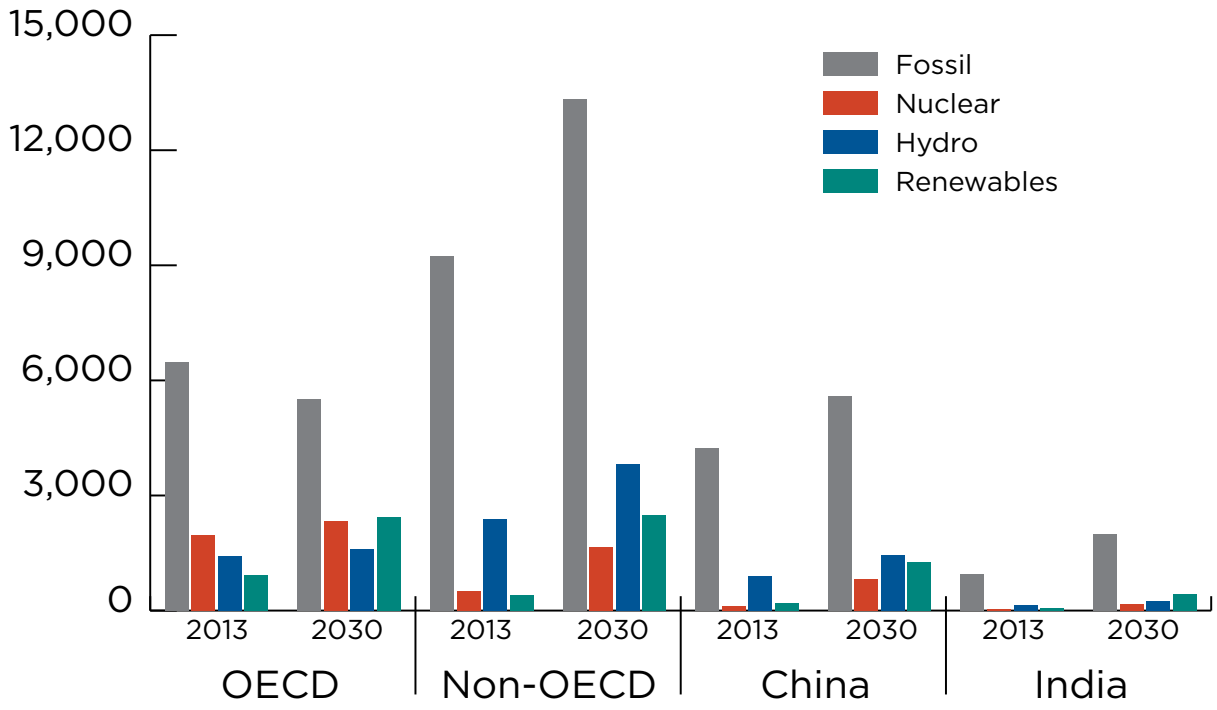
3 International Energy Agency, *World Energy Outlook 2015*, p. 616, op. cit. The New Policies Scenario serves as the International Energy Agency's baseline scenario, which takes into account country commitments and plans to reduce greenhouse gas emissions.

4 Ibid., Table 8.1, p. 307.

5 IRENA, *Renewable Energy Benefits: Measuring the Economics*, January 2016, p. 23.

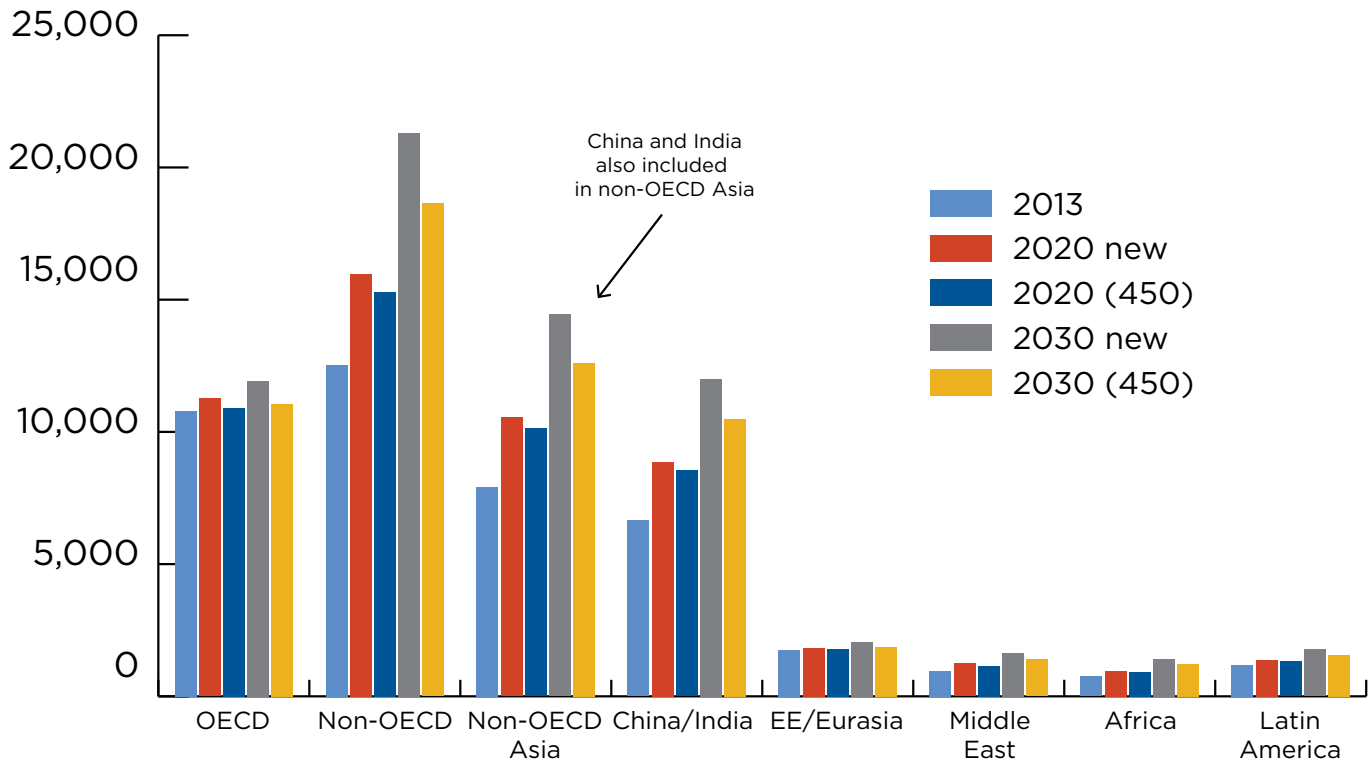
6 REN21, *Renewables 2015: Global Status Report*, p. 30.

Figure 1. IEA New Policies Scenario: Projected Electricity Generation by Source (2030, TWh)



Source: IEA World Energy Outlook, 2015.

Figure 2. IEA World Energy Outlook 2015 Electricity Generation Scenarios: 2020 and 2030 by Region (TWh)



Source: IEA World Energy Outlook, 2015.

their policy and regulatory environments and build effective institutions to better manage the sector?

Increasing Affordability and Access

The non-OECD countries are trying not only to keep up with electricity demand but also to expand electricity access and keep it affordable. The United Nations (UN) Sustainable Development Goal 7 calls for universal electricity access by 2030—but providing service to the 1.1 billion people without electricity is a huge challenge. The political pressure to maintain subsidized electricity rates for the lower-income groups limits governments' ability to expand access programs. But decentralized, renewable energy options are becoming more affordable and countries are pursuing ways of facilitating commercialization of these technologies and promoting private entrepreneurial involvement. **Will countries scale-up these efforts and mobilize private capital?**

Tackling Environmental and Social Problems

The ecological systems in much of the developing world are under serious if not severe stress from pollution and land, forest, and water degradation, and climate change is exacerbating these problems. The energy sector significantly influences these processes and the well-being of various social groups within countries. Environmental considerations and vulnerabilities are becoming central to how countries view their energy sources and even national security. The choices they make with respect to their future electricity generation sources and infrastructure, given their capital intensiveness and longevity, will have long-term consequences. **Will countries elevate the role of environmental sustainability in their energy policies and strategic planning to minimize impacts and create more resilient and reliable electricity systems?**

Achieving Power Sector Financial Viability

The electric power sector is highly capital intensive, requiring millions if not billions of dollars in annual investments in most countries. Although it can be an engine of economic growth and job creation, it is often a drag and burden on developing-country governments and enterprises. A vicious cycle of inadequate tariffs, theft, and low collections; unreliable service; and poor maintenance may exist that leads to financially distressed utilities, inadequate investment, loss in business productivity, and government diversion of budget resources from other high-priority social and economic needs. These problems often stem back to poor governance and corruption. Political will is needed to turn around the sector finances and this generally takes time to achieve. But this effort is absolutely critical for countries to make the transition to cleaner, more efficient systems. **Will countries take the political and management steps needed to put their electric sectors on a sound financial footing within a reasonable period of time?**

Serious reforms are needed to address these five dimensions of the transformation challenge. Different perspectives exist on the power sector reform process, especially related to the basic political economy issue of the role of the private sector. John Besant-Jones and Robert Bacon at the World Bank suggest four main elements of the process:

1. formation and approval of a power policy by governments that provides the broad guidelines for the reform program and the heavy political commitment needed to sustain the reform process, followed by the enactment of legislation necessary for implementing this policy;

2. development of a transparent regulatory framework for the electricity market;

3. unbundling of the integrated structure of the power supply and establishing a market in which electricity is traded at arms' length; and

4. divestiture of the state's ownership at least in most of the electricity generation and distribution segments of the market.[7]

7 R. W. Bacon and J. Besant-Jones, *Global Electric Power Reform: Privatization and Liberalization of the Electric Power Industry in Developing Countries*, World Bank Energy and Mining Group Paper No. 2, June 2002, p. 4.

THE STRATEGY

The following sections present a strategic framework to address the transformation challenges. The framework should be adapted to each country and its regional circumstances. Although the strategy is directed to developing-country policy officials who must chart their own future, it is relevant for a wide range of international public and private stakeholders.

Creating a Sound Policy, Legal, and Regulatory Environment

Strategic Element #1: Developing countries should build sound policy, legal, and regulatory frameworks and institutions to attract investment in the electric power sector. High priority should be placed on energy efficiency and development of rational tariffs, standards, and incentives for deploying more efficient technologies.

Although developing a consensus among different political and sector interests on a national energy policy can be difficult, governments should seek to forge a policy for sustainable energy development based on input from the public and key stakeholders and build on policies already developed for Paris. Important issues to address in these policies include energy security and concerns over external energy and political dependencies, the role of the private sector and the scope and form of government regulation, priorities for domestic energy resource development, and the approach to meeting the energy needs of low-income groups.

Policies should be embodied in laws in a way that provides clear direction without delving into implementing regulations. A stand-alone law for the electricity sector is common practice. This would normally contain authorities for an energy or electricity regulator although this tends to vary. Energy regulatory authorities, if properly constituted, can provide a measure of continuity and stability in the constantly changing political landscape in the developing world. The role of a professional, competent regulator, although not immune from political interference, is critical as are provisions affecting the autonomy, authority, and accountability of the institution. Issues related to transparency and accountability to the public extend to the operating energy companies given the vital service they provide and the large amounts of cash they generate. The market oversight and monitoring function for the regulator is evolving, particularly as competitive markets are put in place and the possibility of market manipulation increases. The IEA has noted: "Competitive markets are an important tool, but they must be supplemented by regulation to ensure an effective transition to low-carbon power at least cost."[8]

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A sound tariff policy is vital to a financially viable power sector and there are many prices to align in moving from fuel supply to generation and from transmission to distribution and retail levels. Electricity pricing policy is often embedded in a broader system of fuel subsidies as the International Monetary Fund has analyzed.[9] Both the structure as well as the level of electricity tariffs are important, especially whether retail tariffs reflect the full costs of supply and distribution to different consumer categories. Developing-country governments often cross-subsidize electricity by charging industrial customers more than residential, even though residential customers are generally more expensive to serve on a kilowatt-hour (kWh) basis. Low tariffs (sometimes called "life-line" tariffs) for the poor are common but sometimes this block is set too high (e.g., over 200 kWh/month) and better-off customers take advantage to the detriment of system collections. Targeted subsidies for low-income consumers are often favored to better reach those in need. Governments and regulators therefore

8 International Energy Agency, *Re-powering Markets: Market design and regulation during the transition to low- carbon power systems*, OECD, Paris, 2016, p. 11.

9 International Monetary Fund, Survey: "Counting the Costs of Energy Subsidies," July 17, 2015. Over forty-two non-OECD countries in 2013 had pre-tax energy subsidies representing over 2 percent of their GDP (calculated from country tables).

Representatives of a solar energy company visiting an Uttar Pradesh village, February 2014. *Photo credit:* Asian Development Bank.

face the difficult task of balancing the interests of consumers, electric utilities, investors, and government budgets in formulating tariff policies. The high losses in distribution in many developing countries for both technical and commercial reasons (e.g., theft) complicate the process since price increases fall on the paying customers. The introduction of feed-in tariffs for alternative generation and/or a carbon price or tax as an environmental measure adds further complexity to the process.

Developing an Efficient Institutional and Market Structure

Strategic Element #2: Developing countries, in most cases, should restructure and unbundle their national electricity monopolies and design and implement electricity markets that are open to private investment and promote efficiency and competition where feasible.

The traditional model of the integrated electric utility is changing in both the OECD and non-OECD worlds. Governments have and continue to unbundle utilities into separate functional companies as well as invite investors into generation, sometimes distribution, and in a few cases transmission. The partial unbundling of the state utility, CFE, in Mexico as part of a major energy reform program of the Enrique Peña Nieto government is one of the more recent examples.

Eliminating inefficient monopolies and introducing competition have been important factors in these restructuring actions. These reforms, especially with respect to separating out transmission, are critical to bringing greater transparency to the sector and creating the foundation for non-discriminatory access for third parties on both the generation and distribution sides.

These unbundled systems, however, have faced problems in both OECD and non-OECD countries, especially when revenue collections and retail tariffs are inadequate to cover generation costs and contracts. In developing countries, power shortages can exacerbate the problem since customers do not

want to pay for unreliable service and funds are not available to pay for needed generation. This usually results in the growth of high-cost diesel generation as, for example, in Nigeria and India.

Designing the appropriate market structure, with efficient sequencing of reforms and clear and realistic market rules, is therefore basic to successful power system transformation. One developed model is that used in the European Union, which seeks to achieve competition and enhance consumer choice. It is an unbundled system with an independent regulator, a progressive retail market opening, and third-party access, so consumers can select their supplier and generators can directly or indirectly market to consumers.[10]

There are three main types of unbundling: functional, accounting, and ownership. Non-OECD countries are at various stages of implementing these unbundling forms. Although the unbundling process can move from one form to another over time, it does not have to follow this progression. A couple of years ago, Honduras unbundled its electricity system and sold off parts of generation, transmission, and distribution to private banks. This ambitious action to deal with a financially troubled system was done, however, without a clear market design and the country has been struggling to set up a new professional regulator as called for under the law.

The unbundling process does create risks and uncertainty for investors who are seeking to determine the financial viability of the off-taker, generally the transmission company. On the other hand, unbundling can provide greater transparency in terms of where cash revenues and government subsidies are going in the system and what targeted measures and tariff regimes are needed to create a viable industry.

Market rules and commercial codes define the relationships between and among entities in generation, transmission, and distribution vis-à-vis retail customers. They have both technical and commercial dimensions. They deal with how power is dispatched and sold by the generators, transmission access and wheeling procedures, eligible customers for direct contracts, metering standards and codes, settlements mechanisms, emergency and system security considerations, procedures for dealing with cut-offs and non-payment, and other operational issues. So in addition to the terms of power-purchase and other basic agreements between an investor and the local utility partner, these systemic regulations and procedures are also key to investors' assessments of whether they can operate profitably in the country.

Achieving a Cleaner and Resilient Generation Mix

Strategic Element #3: Developing countries, building on their Paris greenhouse gas commitments, should develop detailed investment strategies and action plans to diversify and transform their generation mixes and transmission and distribution systems to those that are cleaner, more efficient, reliable, and resilient.

Power systems are becoming more complex as the mix of generators and the growth of private power producers and small decentralized suppliers create a more operationally and institutionally diffuse system. To manage this mix and ensure system reliability, countries need strong transmission grids and modern software and control infrastructures. System planning can help assess how potential projects will affect the status and dynamic stability of the grid. Some countries have established Independent System Operators (ISOs) that are part of the national grid or separate from the transmission company. The ISO may or may not be combined with a Market Operator, who is responsible for trading and settlements.

As countries attempt to change their generation mixes and introduce cleaner energy sources, they face a number of challenges in implementing their diversification plans. In some non-OECD countries, the dominant role of fossil fuel companies in both the fuel supply and power generation stages often creates political resistance to introducing renewable energy sources and giving preference to clean energy in dispatch protocols. Political factors may also impact the financial settlements system. In cash-constrained systems, the transparency of cash distribution can be a controversial issue. The utility may also have concerns about how much renewable power can be safely added to the system and the additional transmission or backup generation costs entailed. Rooftop solar integration and net-metering issues are beginning to emerge in countries like India and pose a clear challenge to traditional utilities.

10 See the European Commission's website, www.ec.europa.eu, Energy Market Legislation, for a summary of the Third Package requirements for the electricity market. Also, the Energy Community's website, www.energy-community.org, has many documents on the legal framework and the European Union's *acquis communitaire,* including materials on unbundling.

We are seeing a strong interaction between supply-diversification decisions and environmental regulations on emissions control and monitoring. There can be tensions between the following goals: (1) introducing greater market competition and reducing prices; (2) energy security and system reliability; and (3) reducing emissions. Governments need to be aware of the implications of environmentally driven interventions on costs, prices, and jobs.[11] The good news is that the costs of large, grid-connected solar and wind systems have fallen to the point that they are often competitive with new incremental fossil fuel alternatives, especially where there is a high-quality renewable resource, fossil fuel sources are not subsidized, and transmission costs of interconnection are reasonable. Bloomberg New Energy Finance projects further decreases in costs of 41 percent for onshore wind and 60 percent for solar by 2040.[12]

The degree to which a country has a formal power expansion plan varies, but as countries seek to meet their NDCs under the recently ratified Paris Agreement, having one in place becomes increasingly important. These plans can be linked with shorter-term operational models to look more closely at reliability and the transmission implications of different capacity addition scenarios in relation to the INDC targets.

Given the strong demand for power in non-OECD countries and the political pressure that creates, some governments are welcoming power developers and foreign investment without a clear plan.

Given the strong demand for power in non-OECD countries and the political pressure that creates, some governments are welcoming power developers and foreign investment without a clear plan. They have established feed-in tariffs and other incentives to attract as much investment as they can, which can help accelerate deployment of new generation assets but can also create problems down the road.

Auctions, sometimes called "reverse auctions," are increasingly used to foster competition among developers and secure favorable prices.[13] These auctions can be specifically linked to capacity expansion plans in a more directive approach. Brazil and South Africa are interesting examples that we will consider in subsequent briefs. Competition may also be advanced by developing power exchanges or day-ahead or other bid-based markets. For most small developing countries the costs of these mechanisms generally outweigh the benefits from the limited competition.

One of the most important issues facing the non-OECD countries is the role of natural gas. As natural gas markets become more global and short term in nature and options for floating liquefied natural gas (LNG) facilities, LNG barges, and ISO containers together with lower-priced LNG become more attractive, countries such as Indonesia are seeing new potential for introducing gas in their systems. This strategy can reduce their dependence on imported oil; lower greenhouse gas emissions compared with coal or oil; deploy relatively quickly smaller but highly efficient aero-derivative gas turbines for peak, emergency, and small island power; and develop combined cycle gas plants to provide cleaner base-load power. Natural gas systems can effectively complement variable renewable energy and help "firm up" the system. Some countries, however, believe that importing gas is not a sustainable longer-term option from either an economic or climate perspective. Several Caribbean island states and the Pacific Islands are taking this position. With abundant renewable sources, including base-load geothermal in some cases, they are hesitant to replace their reliance on imported oil with a reliance on imported LNG. A key factor in the future may well be the declining costs of battery storage for grid and residential applications, especially for small systems like in the island states where it is possible to develop a mix of decentralized and larger renewable systems.

Environmental issues are becoming more influential not only in terms of emissions but also with respect to the hydrological cycle and water scarcity. Hydropower plays a key role in the power systems in most non-OECD regions and thermal power development places additional water demands on already water-stressed regions, e.g., India and China. The El Niño impacts, for example, in Brazil and Panama over the past

11 See IRENA, *Renewable Energy and Jobs: Annual Review 2016*, May 2016, for an estimate of renewable energy jobs in different countries.

12 Bloomberg New Energy Finance, *New Energy Outlook 2016*, Executive Summary, https://www.bloomberg.com/company/new-energy-outlook/.

13 See Bloomberg New Energy Finance, Slide 7, in Michael Liebreich's keynote presentation to the Bloomberg New Energy Finance Summit, April 5, 2016, for a map of the growing use of auctions.

Electric towers in Kabul, Afghanistan. *Photo credit:* Asian Development Bank.

several years and recent drought events in Southeast Asia have severely affected their power systems and economies as a whole due to shortages of supply and the need to use more expensive back-up fossil fuel plants. Desalinization requirements are expected to increase, especially in Algeria and other Middle Eastern countries, with large implications for power demand.

Another important factor affecting system requirements and reliability is the growing spikes in electricity demand from increasing use of air conditioners and growing urban building construction. Examples in China as well as in countries like Morocco, Saudi Arabia, Algeria, and Panama clearly show this rapid change in the daily load curves. This trend reinforces the need to give greater attention to energy efficiency in buildings, regulations on air conditioner efficiency, and demand side management.

Expanding Electricity Access to the Poor and Rural Areas

Strategic Element #4: Developing countries should strive to achieve the UN Sustainable Development Goal #7 of universal electricity access by 2030 through the creation or expansion of dedicated, national programs with high-level political support that can mobilize public and private finance and deploy an appropriate mix of decentralized, renewable energy systems (including mini-grids) and central grid expansion.

The World Bank–coordinated Global Tracking Report shows that the lack of electricity is greatest in South Asia and Sub-Saharan Africa.[14] The UN/World Bank's Sustainable Energy for All (SE4All) Finance Committee estimates that $49 billion per year is needed to achieve the Sustainable Development Goal of universal electricity access by 2030, and current funding is only about $9 billion per year.[15]

The availability of concessional finance to help low-income countries improve access is quite limited, so increased attention should be given to public-private partnership models for introducing renewable energy systems. The combination of renewable energy cost

14 See Sustainable Energy For All, *Progress Toward Sustainable Energy, Global Tracking Framework 2015 Summary Report*, World Bank, 2015, p. 2. Full report available at http:/trackingenergy4all.worldbank.org.

15 Sustainable Energy For All, *Scaling Up Finance for Sustainable Energy Investments: Report of SE4ALL Advisory Board Finance Committee*, 2015, www.se4all.org>content>financecommittee, p. 1.

reductions, particularly for solar photovoltaic and more efficient appliances and lighting, including direct current fans and TVS and LED lights, has made the decentralized approach very economically attractive for rural electrification. Given consumers' strong willingness to pay for LED lights and cell phone charging and other applications, new business models for home solar and mini-grid systems are emerging to meet not only household demands but also larger productive uses, e.g., water pumping, grain grinding, and refrigeration. A recent study estimates that $27 billion per year is spent on kerosene lighting and mobile phone charging[16] and this sizeable market is dwarfed by the diesel generator market.

The key issue is how best to scale up these systems and provide a common framework for aggregation to facilitate financing. Bangladesh provides an important model in which the government, with the help of international donors, established a corporation, IDCOL, that partners with domestic nongovernmental organizations (NGOs) and private companies to provide services and financing within a clearly defined legal and technical framework. Several dozen providers are now involved and over three million solar home systems have been installed. Innovative entrepreneurs such as Solaric are moving now to larger community nano- and mini-grids; some have been able to obtain financing from commercial banks based on successful demonstrations and a proven legal and commercial model.

Grid extension will continue to have a role depending on the economics, especially in growing peri-urban areas, and the experiences in China, Vietnam, and Morocco clearly show that with strong, high-level political support, universal electricity can be achieved this way. But the dominant model for much of South Asia and Sub-Saharan Africa will likely be a decentralized, private sector–driven one given infrastructure capital requirements and government financial stringencies. Recent work by the World Bank and the United States Department of State in Myanmar, a country that is only 20 percent electrified, resulted in a national rural electrification plan and a $400 million loan with both centralized and decentralized components. This plan recognizes that a large portion of the non-electrified areas were reasonably close to the current and planned north-south backbone grid, and at the same time seeks to tap the potential for decentralized systems like small hydro or solar photovoltaic systems to serve more isolated areas and allow earlier access to electricity while the grid expands to meet their universal access target of 2030.[17]

Collaborating with Neighbors on Regional Electricity Networks and Markets

Strategic Element #5: Developing countries should work together to build regional transmission networks and commercially viable regulatory frameworks for cross-border trade and exploitation of diverse, renewable energy resources and low-cost natural gas supplies.

Governments, utilities, and international and donor organizations are establishing regional transmission systems that will allow greater intercountry electricity trade and take advantage of price differentials as well as the variability of resources. Examples exist in almost every region: SIEPAC (Central American Electricity Connection System); the Andean SINE regional system; the well-established Energy Community in the Balkans; the CASA-1000 interconnection under development among Central Asia, Afghanistan, and Pakistan; the South, West, and East Power Pools in Sub-Saharan Africa; the ASEAN efforts in Southeast Asia; the Gulf Cooperation Council in the Middle East; and the emerging interaction among India, Bangladesh, Nepal, and Bhutan.

Interconnection itself does not make a market or increase trade. Here the development of regional regulatory organizations and frameworks for cross-border trade and market coupling are essential but politically challenging to establish. A strong interdependence exists between regional market development and the openness and reciprocity of domestic markets. Negotiated trade between transmission companies or state utilities is one thing; the ability to export to consumers in another country in a non-constrained way is another.

Attracting Domestic and International Investment and Financing

Strategic Element #6: Developing countries should increase the capacity of their local banking systems to undertake energy project finance; make use of risk-mitigation instruments and increase leveraging of funds from international financial institutions; reduce barriers to the inflow of clean energy goods, capital, and technology; and improve the transparency and predictability of their legal and regulatory systems.

16 Bloomberg New Energy Finance, Lighting Global, The World Bank, and Global Off-Grid Lighting Association, *Off-Grid Solar Market Trends Report 2016*, February 2016, p. 3.

17 The World Bank, "Electricity to Transform Rural Myanmar," September 16, 2015, http://www.worldbank.org/en/news/feature/2015/09/16/electricity-to-transform-rural-myanmar.

Windfarm in the Sindh province of Pakistan. *Photo credit:* Asian Development Bank.

The IEA projects that the non-OECD power sector will require $12.877 trillion over the period 2015-2040, or about $500 billion per year. Generation would need $7.025 trillion and transmission and distribution another $5.852 trillion.[18] At present there is a fundamental disconnect between where assets are deployed and where energy infrastructure financing needs are greatest and growing most rapidly. A McKinsey study estimates overall global sustainable infrastructure financing needs will be on the order of $6 trillion per year from 2015 to 2030 compared with a current expenditure of $3 trillion. Although assets under management by private institutions total around $120 trillion, 70 percent of these are concentrated in North America and Europe and most of the rest in upper-middle-income countries. To stimulate greater flows of these funds to developing-country electricity markets, a significant improvement in the investment and business environment is needed.[19]

Although overall political risk and instability are basic factors, a key obstacle is also the financial weakness of many electric utilities in the non-OECD world. The existence of a financially viable off-taker is recognized as one of the principal factors influencing private sector investors. Some countries like Bangladesh have done well in honoring their PPAs (power purchase agreements) with private generators despite the large differential between generation costs, in this case the difference between expensive generation based on imported oil and subsidized retail electricity tariffs. Other countries have not been so reliable.

The electricity distribution sector is especially starved for capital since rates and collections often do not cover costs. Urbanization and income growth are increasing demands and overloading distribution networks. Utilities are struggling to serve these loads and consequently have little cash available to expand the grid system to rural areas with low loads and limited ability to pay.

Various mitigation instruments have been developed to address financial off-taker and other risks. The US Overseas Private Investment Corporation offers insurance for political and PPA risks and the World

18 IEA, *World Energy Outlook 2015*, op. cit., Table 8.5, p. 321.

19 McKinsey and Company, *Financing Change: How to Mobilize Private Sector Financing for Sustainable Infrastructure*, McKinsey Center for Business and the Environment, January 2016, pp. 14, 19.

Bank and Multilateral Investment Guarantee Agency provide partial risk guarantees that give some confidence to investors about the government's commitment to honoring the regulatory terms of the investment or privatization.

The case of Nigeria is especially interesting since it implemented one of the largest power restructuring and privatization programs in the non-OECD world in the past three years. Distribution and generation were sold mainly to local companies and banks. The World Bank established a $500 million Credit Facility with the Ministry of Finance for the Wholesale Market Trader, which continues in its role as a "single buyer" in a system in which collections by distribution companies were low, losses were as high as 50 percent, tariffs were subsidized, and generators had difficulty obtaining gas supplies and getting paid for the power they generated. Although the credit line does not solve these problems, it has bought some time for the Muhammadu Buhari government to improve the sector's finances.[20]

One important financing trend is the growth of "green bonds." These bonds are regular debt obligations issued by banks, public entities, and private companies that focus funds on environmentally beneficial projects. India and China in particular have promoted issuing green bonds for energy infrastructure, energy efficiency, and renewable energy. The People's Bank of China has established a Green Finance Committee and has released guidelines for financial institutions; they expect to issue as much as $46 billion in green bonds in 2016.[21] With its mandate to leverage funds contributed by governments, the new Green Climate Fund—a financial mechanism under the UN Framework Convention on Climate Change—collaborated with the Inter-American Development Bank on a $217 million green bond for energy efficiency in Latin America and the Caribbean for one of its first projects in late 2015.[22] The leveraging of private capital by international financial institutions, including the new Asia Infrastructure Development Bank, will be critical to mobilizing funds for the non-OECD power sector transformation. China's expanding role in non-OECD power financing will be especially important. A new IEA study estimates that Chinese power capacity additions in Sub-Saharan Africa during 2010-2015 totaled seven gigawatts (GW) or 30 percent of new additions.[23] Although thermal- and hydropower plants have been the major focus, a key question is whether the Chinese will move towards a greater emphasis on renewables.

20 World Bank, "Nigeria—Electricity Sector Credit Facility Project," October 2015, project information document.

21 Vincent Shaw, "China aiming for $46 billion green bonds in 2016," *pv magazine*, march 29, 2016, http://www.pv-magazine.com/news/details/beitrag/china-aiming-for-46bn-green-bonds-market-in-2016_100023915/#axzz4J2WqR6me.

22 Green Climate Fund, "Green Climate Fund approves first 8 investments," newsroom, November 6, 2015, http://www.greenclimate.fund/-/green-climate-fund-approves-first-8-investmen-1.

23 International Energy Agency, *Boosting the Power Sector in Sub-Saharan Africa: China's Involvement*, OECD/IEA, 2016, pp. 12-14.

CONCLUSION: PRIORITIES FOR GLOBAL ACTION

The challenge of transforming the power sector in developing countries is huge and the post-Paris process needs to give special attention to this issue—these countries will constitute most of the future growth in electricity use with large consequences for greenhouse gas emissions. Reforms to electricity system structures and operating models will require adapting to each country's environment in a way that optimizes reliability, affordability, and transparency while reducing investment risks and improving environmental performance. The economic feasibility of a significant shift away from oil and coal in developing countries' energy generation mixes has considerably improved. Renewable- and gas-powered systems are poised to expand in all regions. This strategic combination, when coupled with aggressive end-use efficiency improvement, offers the fastest, most economic route to lowering emissions in the near and medium terms. Concerted efforts to change the coal power trajectories in South, Southeast, and East Asia, through greater investment in renewables and gas, will be decisive to progress in mitigating global CO_2 emissions.

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The strategy presented here will be applied to different countries and regions in subsequent briefs and specific empirical and policy conclusions will be developed. The strategy, however, requires global actions and the following section outlines some important measures that should be taken by key stakeholders.

Developing Country Governments

The developing countries in most cases need to translate their emissions targets and INDC commitments at Paris into concrete strategies that include road maps for detailed reform of the legal, regulatory, commercial, and governance aspects of their power systems as well as investment action plans.

In particular, governments must take strong steps to reduce commercial losses, improve the financial viability of their power sectors, and create the regulatory and business environments needed to mobilize private and commercial investment to meet growing demands, improve energy efficiency, and move toward cleaner energy mixes.

Governments should also take a greater leadership role in promoting coordination among external donors and investors to ensure that investment and assistance resources are productive.

OECD Country Governments

These governments should ensure that the difficult power sector reform issues facing developing countries are given greater attention in the post-Paris process and in the monitoring and reporting systems that are established.

They should continue to support the global Sustainable Energy for All initiative; press for priority action to expand electricity access for the poor, as the United States and European Union (EU) have done in their Africa initiatives; and create a regulatory environment that encourages business investment and innovation in distributed, renewable energy systems for developing-country applications.

Special efforts should be directed to supporting regulatory development through partnership and twinning programs like those of the US National Association of Regulatory Commissioners and the EU's Council of European Regulators and Agency for the Cooperation of Energy Regulators. They should work with the financial sector to reduce investor risks through regulatory reforms.

The United States has a special role to play and, as Atlantic Council's David Koranyi has argued, should "build global and regional alliances to promote energy security and liberalized energy markets" that advance climate goals.[24]

24 David Koranyi, *A US Strategy for Sustainable Energy* Security, Atlantic Council, 2016, p. 29.

International Financial Institutions and International Organizations

International financial institutions should give greater focus to electric utility reform, corporate governance, and sound financial accounting in their energy-lending programs.

They should help create more project-bundling and financial-aggregation vehicles for funding small energy efficiency and renewable energy ventures and cutting-edge entrepreneurs.

Their role in providing guarantees and risk-mitigation facilities is critical to mobilizing private finance and should be expanded, including through the Green Climate Fund.

International organizations like IRENA should expand their efforts to improve data and assessments on renewable energy and energy efficiency costs and benefits, and help countries in their transition planning.

Investors and Energy Companies

Although investors are justifiably wary about the political and governance risks in developing countries, they need to work on better understanding the opportunities of these rapidly growing markets.

International banks and institutional investors should do more to help local banking sectors develop and become more knowledgeable about and comfortable with lending to support clean energy projects.

They need to enhance efforts to provide reliable information to organizations in developing countries on the costs and implications of greater renewable energy deployment and the status of these rapidly changing technologies.

Active participation by utilities and energy companies in partnership programs, such as the utility and energy industry partnership programs run by the US Energy Association, and sponsorship of national and regional investment events and policy discussions on commercial and development issues would have mutual benefits.

Technology Companies

The expanded private and public funding and cooperation announced at Paris for technological development is an important initiative that should pay special attention to the needs and conditions in developing countries. To help these countries develop their technological infrastructures, leading technology companies should help developing countries design agendas for clean technology development and demonstration. Improved testing of technologies, e.g., for improved battery storage systems, in these extreme heat and tropical environments and giving advice on standards are critical to ensuring appropriate and efficient technologies are deployed.

NGOS and Foundations

Nongovernmental organizations and foundations, such as the World Resources Institute, which often have on-the-ground networks with civil society groups in developing countries, should continue to play a central role in assessing and advocating for environmentally sustainable energy solutions for developing countries and ensuring attention is focused on the social implications of electricity strategies and projects.

ABOUT THE AUTHOR

Dr. Robert F. Ichord, Jr. is currently a nonresident senior fellow at the Atlantic Council Global Energy Center and is CEO of Ichord Ventures LLC, a consulting company providing energy advisory services to both the private and public sectors. He has a distinguished forty-year career in the US government working on international energy security, development, and climate change issues. He served from 2011 to 2015 as deputy assistant secretary for energy transformation in the State Department's Energy Resources Bureau, where he advanced US interests in sustainable energy development, electricity sector and market reform, nuclear safety, and renewable energy and energy efficiency. Prior to State, he managed and supported large energy assistance programs in Asia, Near East, Europe, and Eurasia for the US Agency for International Development, pioneering many innovative regulatory reform, utility and energy industry partnerships, and energy efficiency activities. He also served at the Energy Research and Development Administration and the Department of Energy from 1976 to 1979 as point person for energy and developing countries, representing the Department on several initiatives with the International Energy Agency. He holds a BA from Denison University, an MALD from the Fletcher School of Law and Diplomacy at Tufts University, and a PhD in Political Science from the University of Hawaii, under a fellowship from the East-West Center Technology and Development Institute.

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