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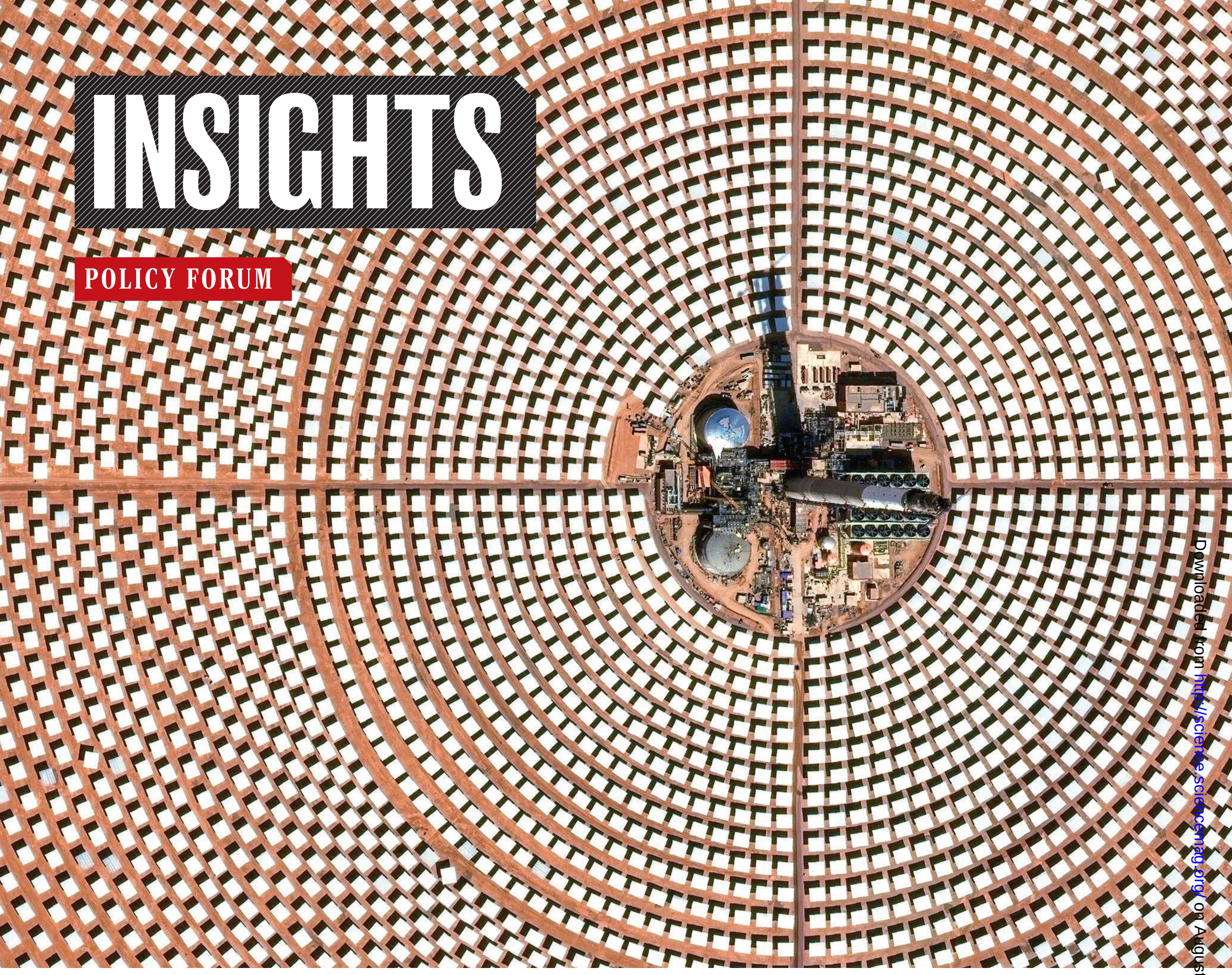
POLICY FORUM



SUSTAINABLE ENERGY

An action agenda for Africa's electricity sector

Modernization and expansion require heightened efforts

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To meet the needs of a growing population in a manner that is socially equitable, economically viable, and environmentally sustainable, Africa's electricity sector will require a major transformation (*1*). It has already undergone some important changes over the past decade. Efforts to expand access to electricity have proceeded at a slightly faster pace than anticipated 10 years ago. In parallel, the deployment of renewable energy technologies has progressed apace, despite new discoveries of natural gas across the continent and favored by the volatility of oil prices. Nonetheless, the expansion and modernization of Africa's electricity sector need heightened efforts, as evidenced by current electrification rates, generation-capacity levels, and security-of-supply indicators. We identify a suite of actions that, if implemented, would put Africa's electricity sector on track to sharply increase electrification rates across the continent while securing long-term access to affordable cleaner energy, and reducing greenhouse-gas emissions and emissions of local-air pollutants (see the figure) (*2*).

SUPPLY-SIDE INCENTIVES, DEMAND-SIDE SUBSIDIES

Despite progress with rural electrification, at least 250 million people in Africa cannot afford electricity, a gap that the COVID-19 global health pandemic has widened by about 80 million people who have fallen into extreme poverty (*3*). A combination of supply-side incentives and demand-side subsidies can go a long way toward expanding

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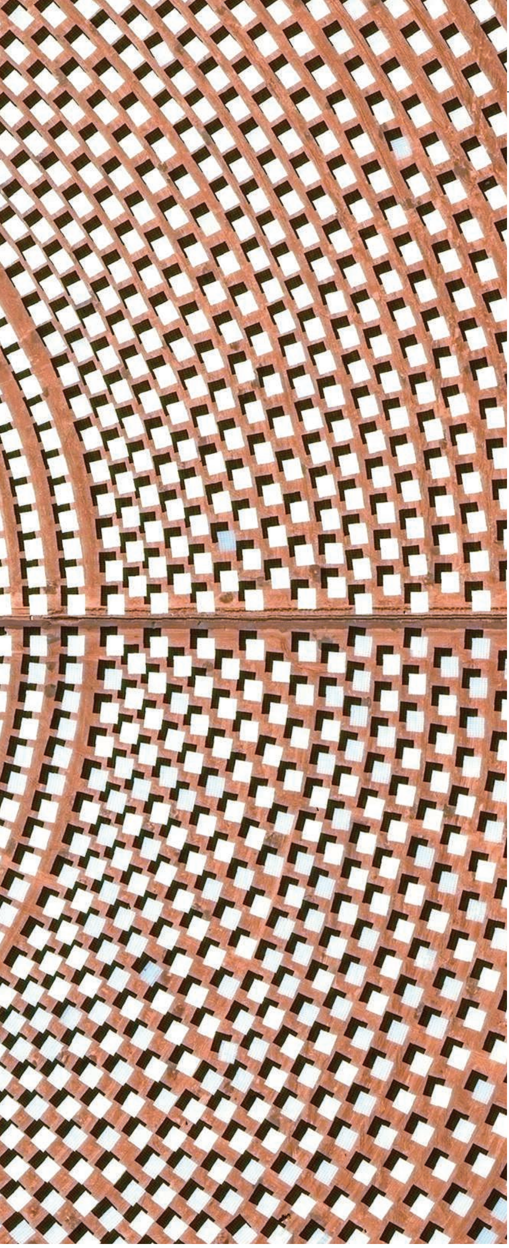

With a capacity of 580 MW, Morocco's Ouarzazate solar power station is one of the world's largest solar thermal plants.

electricity markets, by breaking down the vicious circle whereby the affordability gap limits electricity supply options.

Supply-side incentives refers to the combination of risk-guarantee schemes and so-called blending instruments. Through international finance, risk-guarantee schemes cover private lenders against the risk of a government failing to perform its contractual obligations and, in some instances, against expropriation, civil unrest, and other imponderables. Blending instruments are public-private partnerships through which grants are used to attract larger volumes of private and, in some cases, public finance. The combination of risk-guarantee schemes and blending instruments is set to play a central role in expanding electrification in Africa (*4*). However, it is increasingly clear that coordination among the various partners is indispensable for this combination of schemes to work. Here, coordination refers to the ability of the various actors to align eligibility and implementation requisites across their respective portfolios.

Given this precondition and the magnitude of the energy access problem in Africa, a continent-wide risk-guarantee scheme should be established, ideally by a combination of African and other multilateral lending institutions. Such an integrated approach, through which overall savings can outweigh risk premia (*5*), could be articulated under the aegis of the African Single Electricity Market, launched in early February 2021 with the main goal of harmonizing regulatory and technical aspects of electricity generation, transmission, and distribution across the continent.

Demand-side subsidies refer to direct or indirect payments to secure electricity access to the poorest households in Africa. This kind of subsidy can take the form of a reduced rate, calculated by using 12-month or shorter rolling-average electricity-consumption data, for example, and may be complemented with cross-subsidies. Although the experience with these types of subsidies remains limited, initiatives such as the European Union's GET.Invest program and the World Bank's Africa Renewable Energy and Access program are putting the concept on the policy agenda. These initiatives suggest that, when combined with supply-side incentives, demand-side subsidies can help close the affordability gap referred to above by serving the poorest households. African governments and bilateral and multilateral lenders should adopt and scale up this kind of approach. In doing so, they should be mindful of the need to rely on highly disaggregated estimates of affordability to underpin the design of demand-side subsidy programs, because affordability levels can vary greatly, even within small (one square kilometer–sized) areas (*6*).

Moving from successful pilot projects to transformative off-grid rural-electrification programs at the continental scale requires a concerted effort by all types of program financiers. Such an effort would be best articulated around a set of good practice requirements, reflecting the considerations outlined above and adopted by African governments and bilateral and multilateral lenders alike.

THE GREEN ENERGY–INFORMATION TECHNOLOGY INNOVATION FRONTIER

The electricity sector is in the midst of a major transformation, as utilities' primary role is gradually becoming "the management of energy supplied by independent power producers, rather than building and owning capacity themselves" (*7*). Such transformation is driven by digitalization, which makes it possible to "identify who needs energy and deliver it at the right time, in the right place, and at the lowest cost" (*8*). Worldwide, digitalization in the power sector is forecast to become a US$ 64 billion market by 2025, with smart-meters alone accounting for US$ 26 billion in the same year (*7*).

For Africa's electricity sector, digitalization entails three main opportunities (*8*). First, reduce the need for additional investments in electricity infrastructure: Through preset financial incentives, digital monitoring and data analysis tools make it possible to adjust electricity consumption during peak-demand and off-peak periods, accommodate variability in supply, and limit network congestion. Second, reduce electricity costs for consumers, by facilitating the integration of distributed electricity generation (typically, household-level solar photovoltaic panels and storage facilities) into local grids. Third, help manage the uncertainties in supply that are inherent to the variability of renewable energy–powered electricity generation and electricity supplied by interconnected mini-grids.

To reap the full benefits of digitalization, a pan-African cross-sectoral digital road map, such as the European Union's Digital Single Market Strategy, needs to be developed, consistent with existing guidelines and mechanisms for secure data sharing (*8*). At the national level, governments would benefit from adopting policies that are conducive to the expansion of renewable energy markets, and of technological innovation, notably with regard to the development of digital startups—namely, the programmers, vendors, and certifying companies that are needed to put digitalization to work (*7*). When measured against 21 criteria related to the domestic renewable energy sector and digital business fabric, the African countries that are best placed to embrace digitalization are Nigeria, Egypt, Kenya, Ethiopia, and Ghana (*7*).

LOCAL CONTENT REQUIREMENTS

In Africa, financial incentives for renewable energy–powered electricity generation have had modest success. Feed-in tariffs, through which governments set the price of an electricity-generation project, and auctions, which are based on competitive bidding by industry to determine the price, are the two main financial incentives used. Whereas feed-in tariffs are becoming less relevant given the

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fall in cost of renewable energy–powered technologies, auctions suffer from limited competition in the electricity market and the lack of domestic expertise, South Africa being the notable exception. Coherent policies that are stable over the long term, not least with regard to renewable energy targets, independent electricity-market regulators, and, as relevant, measures to reform monopolies, are indispensable for financial incentives to deliver at their fullest, as they have done in other parts of the world.

Irrespective of the type of financial incentive used, most electricity projects in Africa are undertaken by foreign developers, notably European, Chinese, and United States companies, owing to their experience and, especially, their ability to secure financing. As a result, African governments have introduced different types of so-called local-content requirements, namely obligations concerning local employment, procurement of local goods and services, and the transfer of technologies and know-how, to which foreign investors have to abide. In countries such as Kenya and Nigeria, these requirements are defined through quantitative targets, whereas in other countries, such as Uganda and Zambia, they take the form of qualitative goals.

Empirical evidence, from Africa and elsewhere (*9*), reveals that there is ample scope for improving the effectiveness of local-content requirements. Two design shortcomings are especially common in Africa: the mismatch between requirements and actual domestic capacities, which deters and delays foreign investors, and the lack of sustained demand, which limits the ability of local providers to plan and undertake capacity expansions.

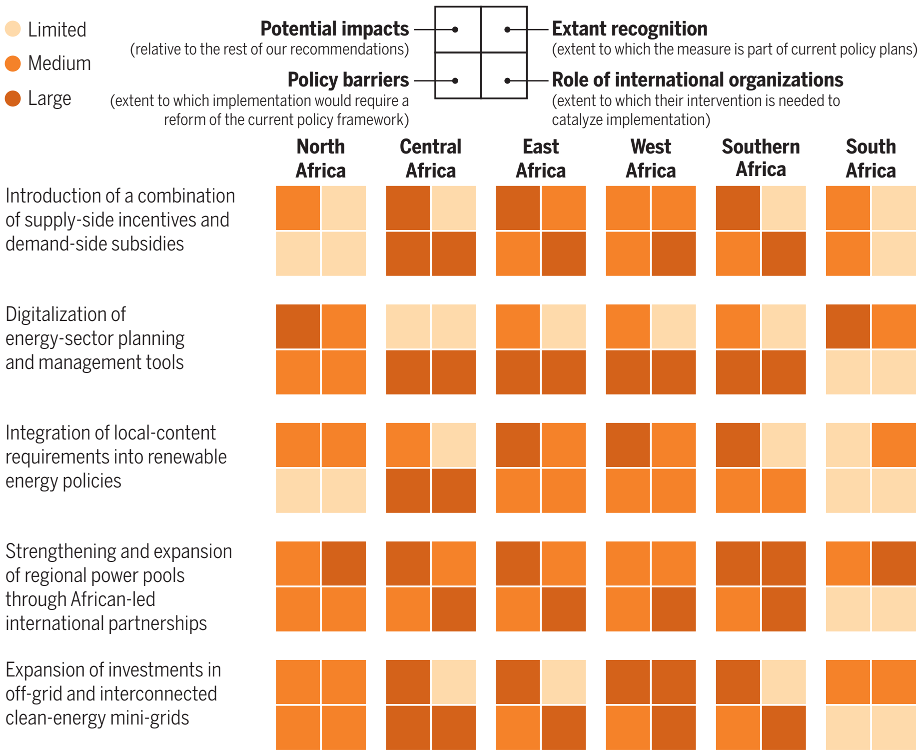
Experience from other natural-resource–based sectors shows that, to increase the effectiveness of local-content requirements, national governments in countries with limited domestic capacities can focus on a small number of promising subsectors, as opposed to a broad-based approach targeting all aspects of electricity generation, transmission, and distribution. For the subsectors chosen, a certification system can help ensure the required quality standards. National governments in countries with stronger capacities can take a more ambitious approach, structured around introducing legislative provisions and governance arrangements for local-content requirements; engaging both foreign investors and local providers in the definition of the requirements; and monitoring and reporting on the extent to which the requirements are met. For both types of countries, it is advisable to tighten requirements only gradually while continuously adjusting ambition levels to reflect technology and labor market dynamics.

POWER POOLS

Power pooling, through cross-border trade in electric power, helps reduce electricity bills and enhances the reliability of electricity supply. Regional power pools, based increasingly on renewable energy supplies, are now possible across most of the African continent (*10*). Nonetheless, additional efforts are needed to reap the full benefits of power pooling (*11*). Notwithstanding shared challenges, notably underinvestment, the nature of the additional efforts needed varies across African regions.

Enabling the clean energy revolution in Africa

Power-sector reform, energy access, and investing in Sustainable Development Goal 7 each build economic opportunities. Color-coded assessment is based on the authors' collective judgment.



North Africa: Algeria, Egypt, Libya, Mauritania, Morocco, and Tunisia; West Africa: Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo; East Africa: Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania, and Uganda; Central Africa: Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, and Gabon; Southern Africa: Angola, Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, São Tomé and Príncipe, Zambia, and Zimbabwe; South Africa: South Africa. This regional breakdown is used by the United Nations Economic Commission for Africa. The designations employed do not imply the expression of any opinion whatsoever on the part of the authors concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its boundaries.

GRAPHIC: N. DESAI/*SCIENCE* BASED ON PUIG *ET AL.*

South Africa is the main electricity producer for the Southern African power pool, facilitated by the Southern African Development Community (SADC). Given the challenges that the country is increasingly facing to meet its domestic demand for electricity, and the sharp decreases in cost of solar, wind, and energy storage, the case for relying on solar and wind energy–powered electricity generation becomes stronger in the region. Yet, at present, for both renewable energy and electric-power transmission, many of the investment discussions in the SADC region focus on large dams, which have been the technology of choice for decades. Concentrating solar power, a technology that generates electricity from the heat obtained by concentrating solar energy (in contrast to converting solar energy directly into electricity, as photovoltaic systems do), is already being deployed in South Africa, owing to its much larger generation capacity compared to photovoltaic system–based installations and its ability to store large amounts of electricity. Concentrating solar power technology can help shift the balance away from hydropower and toward solar energy, but only to the extent that stronger financial incentives are in place, compared to those introduced thus far (*1*).

To date, the members of the Maghreb Electricity Committee (COMELEC), Northern Africa's power pool, have only engaged in cross-border trade with the Iberian Peninsula, across the Mediterranean Sea (Spain currently exports electricity to Morocco). As concentrating solar power in Morocco develops, the country plans to export electricity to Spain and possibly Portugal. Tunisia and Egypt are planning similar export arrangements (with Italy and Greece, respectively). Against this background, COMELEC has pledged to launch, in 2025, a common electricity market for its five members. A planned interconnection between Morocco and Mauritania stands as the first milestone toward that goal. At present, efforts to develop intra-regional trade are hampered by insufficiently liberalized electricity markets and limited tradition of cross-border infrastructure investments in the region, which are both issues on which COMELEC has influence.

Both the Eastern Africa Power Pool (EAPP) and the West African Power Pool (WAPP) originate from preexisting cross-border arrangements aimed at promoting cooperation on energy issues. In both regions, cooperation thus far has been limited to bilateral agreements, such as the lines linking Kenya with Ethiopia and Ghana with Burkina Faso. Nonetheless, efforts are underway in both regions to harmonize regulations, contractual terms, and tariff levels applicable to electricity transmission, with a view to expanding power pooling beyond these bilateral agreements. In the EAPP region, this goal is hampered by the lack of an updated development plan, reflecting changes in assumptions about costs and the expected impacts of newly implemented policies, because such a plan is a precondition for raising the funding required to establish a regional power pool. In the WAPP region, utility near-bankruptcy is a key hurdle to intra-regional trade, which calls for the regulated entry of foreign investment.

The Central African Power Pool (CAPP) remains underdeveloped. Poverty and other developmental challenges in the region limit the size of the electricity market, thus inflating prices. Compounding this challenge, weak governance arrangements result in insufficient competition in the sector, leading to underinvestment and ultimately thwarting any intra-regional power-pooling ambitions in the short term. In light of these challenges, progress with regional power pooling should build on gradually expanding bilateral electricity-trade agreements involving the Democratic Republic of Congo, owing to its high hydropower potential, drawing on support by international lenders.

MINI-GRIDS

In moderately populated areas, where both grid extension and deployment of a relatively large number of stand-alone electricity-generation systems would be prohibitively expensive, off-grid mini-grids are the most economical electrification option in most cases (*12*). In light of strained public-sector budgets, scaled-up deployment of off-grid mini-grids depends on expanded and sustained private-sector investment. Two approaches to mobilizing private-sector finance can bolster off-grid mini-grid deployment rates, as evidenced by the financial model used to set up the latest generation of off-grid mini-grids.

First, so-called third-generation mini-grids, which combine photovoltaic solar systems and batteries with or without a back-up diesel-powered electricity generator, require less than 2 weeks of scheduled maintenance per year. Such a high level of reliability makes it possible to incentivize off-grid mini-grid deployment through performance-based subsidies (*13*). For example, with World Bank backing, Nigeria's rural electrification agency pays off-grid mini-grid developers US$ 350 per connection, provided that the customer has had a steady supply of power for at least 3 months. Similarly, the reliability of third-generation mini-grids allows developers to offer customers a contract that includes, in addition to the electricity connection, the option to purchase income-generating appliances, such as machines for welding, milling, and rice hulling, thus increasing deployment rates (*13*).

Second, interconnected mini-grids can generate and distribute electricity to customers that are not connected to the main grid, while selling excess power to the main grid, as found in Nigeria, or they can choose to sell to the main grid all the electricity generated, as do some mini-grids in Tanzania. Electricity consumers benefit from interconnected mini-grids through increased reliability of supply and, in most instances, lower prices (*14*). Interconnected mini-grid development is hampered by both regulation, which is unclear at best and in some cases acts as a deterrent to interconnections, and technical standards, which may differ between mini-grids and the main grid. Overcoming the barriers to interconnected mini-grid development requires national governments to clarify licensing procedures and tariff regulations and ultimately establish unambiguous tariff levels for the various interconnection options, a set of tasks that can be facilitated by the International Renewable Energy Agency.

A PIVOTAL ROLE

Implementing our recommendations requires careful consideration of the policy options that may be most appropriate in each situation. As is the case with most aspects of public policy, power, agency, and politics will have an impact on the extent to which the policy options chosen are compatible with societal goals related to environmental quality, employment, and equity, among others (*15*). Specifically, the choice of policy options will be influenced by two sets of policy drivers that, in a developmental context, are especially powerful. The first is prevailing national-level incumbency issues (namely, resistance to change by incumbents in the energy sector) and information asymmetries among different stakeholders in a country, which invariably punish prospective new entrants in the energy sector. The second is unduly rigid priorities and procedures on the part of bilateral and multilateral lenders.

Against this background, we contend that the Sustainable Energy for All initiative has a pivotal role to play in ensuring that the policy choices that will shape the future of Africa's electricity sector are not captured by the two sets of policy drivers referred to above. As an international organization that is independent from, but works in partnership with, both the United Nations and its member countries, the Sustainable Energy for All initiative can act as the watchdog that upholds environmental and developmental concerns, notably with regard to promoting renewable energy technologies and championing local employment. It can play this role under the aegis of the newly launched African Single Electricity Market and by capitalizing on United Nations–sponsored high-level consultations, such as the High-level Dialogue on Energy 2021, which will take place in New York in September of this year. The opportunity is ripe, and leadership has to be up to the mark. ■

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