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**Regulating Mini-Grids: What The Energy Minister Needs  
To Know**

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*"Governments throughout the world engage in three main activities: they tax, they spend and they regulate. Regulation is the least understood..."* Scott Jacobs, OECD, 1994

*"...people deserve a regulatory systems that works for them, not against them...We do not have such a regulatory system today."* U.S. government presidential order, 2003

*"... most failures happen at delivery."* Jim Yong Kim, President,  
World Bank Group, October 2012

Suppose that you have just been appointed as the Minister of Energy in a Sub-Saharan African country. Before your swearing-in ceremony, the President made it quite clear that your performance will be judged solely on how successful you are at increasing electrification in rural areas. At present, less than 10% of your country's rural households have electricity. You are fortunate that your predecessor produced a Rural Electrification Plan. But he was sacked because he made very little progress in implementing it. The President said that the basic overall strategy is given in this plan so "you don't need to reinvent the wheel." But he emphasized that now your job is "to make it happen."

**The Two Tracks To Rural Electrification**

When you look at the plan, you see that it lays out a two-track approach to rural electrification. The centralized track is to be accomplished through extension of the national grid into rural areas. It involves a combination of efforts by the national utility, the rural energy agency and your ministry. In contrast, the decentralized track is targeted for nongovernmental entities such as cooperatives, community user associations and private entrepreneurs. The plan states that these nongovernment entities will be encouraged to build and operate mini-grids. The mini-grids should be built in rural areas that are too isolated to be supplied by the main grid or in areas that are not likely to be reached by the main grid for many years.

**Centralized Track.** You decide to call your predecessor to get his advice. Despite the embarrassment of having been fired, he is willing to talk. He says that you will need two different approaches. For the centralized track, you can directly order the national utility, the ministry and the Rural Electrification Agency to take actions to expand the grid. But he cautions that this is easier said than done. First, despite what you order, the executives at the government-owned national utility are genuinely reluctant to expand into rural areas. Even if the government pays for the capital costs of the expansion, the utility's top managers expect to lose money on almost every kWh that they sell in rural areas. This is because the national utility is forced to charge rural households the same tariffs that it charges households in urban areas even though its costs of supplying rural areas are much higher. Second, he points out that when the President fired him, the President conveniently ignored the fact the government failed to provide the Ministry with much of the grant money that it had promised for expanding the grid. Third, members of Parliament in rural areas will pressure the government to extend the grid to villages in their constituency even if these are thinly populated areas.

**Decentralized Track.** You then ask him for advice on the decentralized track. He says that the most important thing to remember is that you, as the Minister of Energy, have no direct authority to order non-government entities to do anything. Therefore, a very different approach is needed. He says that you must *incentivize* these non-government entities, whether community based or privately owned, to make the needed investments. *In particular, you will need to create a clear and credible policy and regulatory framework that convinces potential investors that their mini-grid projects will be commercially sustainable.* He says that he and his staff were going to develop that framework but just as they were getting started, the President asked for his resignation.

When the phone conversation ends, you turn to your advisor, an experienced civil servant who has served four earlier Energy Ministers, and say: "Let's talk about mini-grids. Tell me what policies and regulations are needed to get investments in mini-grids."

## **Making Sure That You Are Talking About The Same Things**

Your advisor responds: "Mr. Minister, first things first. To make sure that we don't waste time, I think that we first need to define a few terms and concepts. So let's talk about what we mean by mini-grids and regulation."

You agree so he gives the following mini-tutorial--

**What is a mini-grid?** When most people talk about a mini-grid, they are referring to an entity that owns a small generating unit and a stand-alone distribution system that is physically isolated from the national or a regional grid. This pure case is usually described as an *isolated mini-grid*. However, other cases/instances of mini-

grids exist and people often confuse mini-grids with small power producers. Let me try to clarify using Table 1, which shows the main types of mini-grids and small power producers. The cases are defined by the location of the generator and who it sells to.

**Table 1: Types of Electricity Sales Involving Mini-Grids and Small Power Producers**

		Location of generation	
		Connected to isolated mini-grid	Connected to main grid
Nature of customers	Selling retail (directly to final customers)	Case 1	Case 3
	Selling wholesale (to utility)	Case 2	Case 4

Source: "From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Rural Electrification and Renewable Energy in Africa", Chapter 2, World Bank, forthcoming 2014.

The two most common cases are Cases 1 and 4. Case 1 is the pure *isolated mini-grid*, as just described, and Case 4 is very different as it sells only to the national grid. Since it has only one customer, the national utility, and it does not need to own or operate a distribution system, it would be confusing to call it a mini-grid. Instead, it is better described as a small power producer (SPP). But that does not mean that it should be ignored because it does not operate a mini-grid. As an SPP, it can still provide benefits to the country. For example, it can supply the national utility with needed power usually in some form of renewable energy. And it can also provide a backup supply of electricity on a weakly supplied rural section of the national grid. Therefore, it can directly increase renewable energy production and indirectly increase rural electrification by providing additional electricity in national or regional systems that lack adequate generating capacity.

Combinations of cases are also possible. For example, in Tanzania, the Mwenga Hydro project sells electricity from its mini-hydro generating plant to both TANESCO (the national utility) and more than 600 households in 6 villages. Even though the Mwenga system is electrically connected to the national grid, it operates as a separate and autonomous business entity. It can be thought of as a combination of Cases 3 and 4 because it is connected to the main grid and sells at wholesale to the national utility and sells at retail to businesses, institutions and households in rural villages. Therefore, it is best described as *connected mini-grid*.

**What Is Regulation?** When a government regulates an enterprise, it imposes direct controls on some or all of the enterprise's decisions or actions. Regulation creates constraints on the actions that an unregulated enterprise might take. The three universal tasks of national electricity regulators that oversee traditional monopoly utilities are:

- Setting maximum and minimum prices
- Establishing minimum quality of service standards
- Specifying entry and exit conditions (usually through licenses, permits or concessions).

Apart from these specific tasks, you as the Minister, will also need to decide on “regulatory governance” if it is not clear in the law or you are advising on changes to the current law. That is consultant-speak for who in government approves what, when and how.

When your advisor finishes, you say: “OK, these general terms and concepts are fine, but I need some specifics. Let's talk about what looks like the hardest case: a private investor who wants to build and operate a small isolated mini-grid (Case 1) in one or more rural villages in rural areas. What specific rules and processes need to be put into place?”

## **Regulating Isolated Mini-Grids: Some Specifics**

Your advisor says: “Mr. Minister, if you want to move from theory to practice, we don't need to reinvent the wheel. Here are six specific rules that have been proposed or implemented elsewhere.”<sup>1</sup>

1. **Hybrid generators on mini-grids that use both renewable energy and some fossil fuel should be eligible to receive incentives such as government grants both for preparatory studies and for customer connections.**

*Rationale: Hybrid generators—a generating system that uses a fossil fuel and one of several forms of renewable energy—are often able to supply electricity at a lower cost and for more hours than a generator that uses just diesel, wind or solar energy alone. If a private developer were required to use solar or wind energy only to power a mini-grid, the system would require prohibitively costly amounts of battery storage to provide sufficient backup for cloudy or windless periods. Therefore, by accepting rather than prohibiting hybrid systems, we will achieve more success in ramping up both renewable generation and electrification than if we were to restrict eligible entities to generators that are 100 percent renewable. Or to paraphrase one private developer in Africa: “Look, I am not doing this because it is fashionable. The villagers just want electricity. They don't care whether the electrons are green, yellow or purple.*

*So I am using a hybrid system because it will be cheaper for my customers and I can provide them with more hours of reliable service.”<sup>2</sup>*

**2. An isolated mini-grid should be explicitly allowed to charge retail tariffs that exceed the retail tariffs charged by the national utility.**

*Rationale: The almost universal reality is that the cost of producing a kilowatt-hour of electricity on an isolated mini-grid will be higher than on a large integrated national utility. This is because it is more expensive to bring equipment, fuel and other supplies to a rural area. And since the isolated mini-grid will be a small system, it will not be able to achieve the economies of scale in operation that are available to a large national utility. So if you, as the Energy Minister, or the regulator, or the Parliament require that the mini-grid operator must charge exactly the same tariffs as the national utility, you are not going to see any private investment in mini-grids.*

*But if you announce that you are thinking of eliminating the requirement that isolated mini-grids must charge the uniform national tariff, you will probably immediately get a telephone call from the President. The President will say to you that a uniform national tariff is a “political necessity” because “we must treat all citizens equally.” And he will probably promise that the government will provide ongoing subsidies for mini-grids whose costs are higher than the revenues generated if the government requires them to charge the same tariff as the national utility. But Mr. Minister, let’s be realistic. From past experience, we both know that “subsidies promised” are not “subsidies delivered”. So at some point during the telephone call, you will have the unpleasant task of having to tell the President that if he is serious about promoting isolated mini-grids, he will need to do one of two things. Either he will have to guarantee that the subsidies promised will actually be delivered or if he cannot or will not guarantee subsidies, then he needs to allow mini-grids to charge tariffs that recover their costs.*

**3. Regulatory paperwork and processes for mini-grids and small power producers should be kept to a minimum.**

*Rationale: Complying with regulatory paperwork and processes costs time and money. This is true whether the mini-grid is privately, publicly or community owned. Isolated mini-grids operate on a “razor’s edge” of commercial viability. Unnecessary regulation, even though well intentioned, can easily destroy the commercial viability of mini-grids. Therefore, the regulator should be required by law to adopt light-handed regulation when regulating mini-grids and SPPs.*

*In general, light-handed regulation means that:*

- *The amount of information required by the regulator is minimized.*

- *The number of separate regulatory processes and decisions are as few as possible.*
- *Documents are standardized.*
- *Related decisions made by other government or community bodies are communicated to and utilized by the regulator.*

*These are general requirements. Here are three specific actions that could be taken to lighten the regulatory burden on mini-grids:*

- *Exempt them from the need to obtain a license if they are below a specified size (say, 1 MW of maximum peak demand). Instead, they should simply be required to register with the regulator for informational purposes rather than for regulatory approval.*
- *If the mini-grid is above this cut-off size, the regulator and grant-giving agency (usually, the rural energy agency) should use a simplified common application form so that the mini-grid developer does not have to complete two separate applications.*
- *Once a mini-grid becomes operational, the regulator and the rural energy agency should use a common and limited reporting form.*

*Notice that these actions are designed to simplify paperwork and processes. But light-handed regulation needs to go beyond just easing paperwork and processes. You and the regulator also need to consider deregulating the tariffs charged by mini-grids in certain circumstances. So let's talk about what that might involve.*

#### **4. Retail tariffs should be deregulated, at least for a transition period, for small mini-grid systems.**

*Rationale: Up to now, we have been talking about how to give more certainty to investors so that they will be willing to invest in isolated mini-grids. But we haven't discussed the other side of the regulatory coin: how to protect the mini-grid's customers. Remember that the traditional justification for tariff regulation is to protect captive customers from being charged high prices by a monopolist. And this usually requires that the government (whether it is a ministry or separate electricity regulator) set the maximum prices that consumers can be charged based on an analysis of the seller's projected costs.*

*But there are three problems in applying this traditional regulatory approach to mini-grids. **First**, we simply do not have the resources to do a full cost of service analysis for the 50, 100 or more isolated mini-grids that could develop if the program is successful. If we mandate a traditional full cost of service analysis with a public hearing process for each of these mini-grids, it will quickly overwhelm the administrative resources of the regulator. The regulator's limited resources would be better spent examining the tariffs and underlying costs of our national utility. **Second**, mini-grids are likely to have different business and technology models, each with its own different cost structure. So there is no standard tariff or cost template that can be easily*

applied as a shortcut. **Third**, if the regulator gets it wrong by setting a maximum tariff that is below the mini-grid's likely costs, then we will not get the private investment that we are seeking. And if the villagers fail to get access to electricity that could have been supplied by a mini-grid, have we really succeeded in protecting households and businesses in that village? As one poor Indian villager said: "...the most expensive electricity is no electricity at all."

Tanzania has already taken some initial steps in this direction. First, the staff of EWURA, the Tanzanian electricity regulator, has recently proposed that any mobile phone tower or a customer with a peak demand of 250kVa or higher be defined as an "eligible customer." Under Tanzanian law, any sales by a mini-grid to an eligible customer are exempt from tariff regulation. The rationale is that these customers have their own on-site generators. Therefore, their ability to self-supply electricity places a natural cap on the prices that the mini-grid operator can charge them. Second, the EWURA staff has also proposed that mini-grids with an installed generating capacity of 100 kW or less are not obligated to get EWURA's prior approval for their sales to households and businesses in the community. However, EWURA reserves the right to conduct an "after-the fact" review of these retail tariffs if 15 percent or more of the households in the service area complain. Finally, the EWURA staff has proposed that the mini-grid operator can take account of customers' "ability to pay" in setting tariffs. If implemented, this would allow the mini-grid operator to charge businesses (who are likely to have a greater ability to pay) a higher tariff to cross-subsidize the tariffs of poor households in the village.

In giving this pricing flexibility, the underlying presumption is that the mini-grid operator does not have unfettered monopoly power. For example, households can always go back to kerosene lanterns and batteries if the mini-grid operator charges tariffs that are too high. And more recently, other new partial substitutes for grid-supplied electricity have begun to emerge. In many African countries, if a mini-grid operator tries to charge too high a price, households can opt to get their basic energy services from low cost solar charged lanterns that can also charge mobile phones. Of course, these are not perfect substitutes but they do place competitive limits on the prices that mini-grids can charge for important basic energy services. In addition, the early evidence from Tanzania and India is that mini-grid operators, when given this pricing flexibility, will charge tariffs that lead to monthly expenditures that are 20 to 30 percent lower than what the household paid for the same services before the arrival of the mini-grid. And the light produced by a rechargeable lantern powered by electricity from a mini-grid is of much higher quality than the light by a kerosene lantern so households will spend less money and get a higher quality service. Finally, even in the absence of a regulated tariff ceiling, mini-grid operators will still have a strong incentive to keep their tariffs low because they need to maximize revenues in their early years if they are going to survive as viable commercial entities.

**5. Allow mini-grid operators to recover the administrative and interest costs of on-bill financing for connections, internal wiring, appliances and machinery.**

*Rationale: Even if you do everything listed in these first four rules, many mini-grids will still fail. The problem is that in the early years most isolated mini-grids will not generate enough revenues to cover operating costs. Revenues are likely to be insufficient for two reasons. First, not all eligible households in the village will sign up immediately. In Africa, it is well-documented that high connection charges are a major financial barrier for rural households that want to become customers.<sup>3</sup> And second, even if households do sign up as customers, they may not consume very much electricity because they cannot afford electrical appliances. The bottom line is that it makes little sense for the government to spend a lot of time and money promoting mini-grids just so villagers can have a few energy efficient light bulbs, a fan and maybe a radio.*

*A similar problem exists for businesses. Village businesses need electric powered machinery to increase their output, lower their costs or do both. This machinery will enable them to be more productive and bring more income into the village. However, these businesses are often not able to get loans that would make it possible to buy this machinery. They need some way to finance these purchases. Ideally, such financing should come from banks and micro-finance institutions. But they often do not have a working presence in newly electrified villages*

*An alternative way would be for mini-grid operators to provide on-bill financing to make it easier for household customers to buy appliances and businesses to buy machinery. On-bill financing allows customers to buy appliances or machinery and pay for them over time on their periodic electricity payments under a pre-specified payment plan. But on-bill financing will not be feasible unless the regulator has the legal authority to issue rules that state that the administrative costs and interest rate subsidies required to provide on-bill financing are deemed to be costs that can be recovered in the mini-grid's tariffs. By doing so, we will help mini-grids to increase their sales revenues and become commercially viable sooner. This general approach has also been proposed by the staff of EWURA, the Tanzanian electricity regulator, in possible "second generation" mini-grid and SPP rules.*

*Of course, this still leaves open the question of where the money will come from to provide this type of financing. As you know, donors often give grants to buy down the cost of customer connections. Now you will need to persuade donors or the government that they should also provide the seed money to mini-grid operators to create extended payment plans that can be implemented through on-bill financing to buy appliances and machinery.*



6. **When the “big grid” (the main national grid) connects to the “little grid” (an isolated mini-grid), the mini-grid operator should have the right to convert itself into a small power distributor or a combination of small power distributor and a small power producer.**

*Rationale: The basic problem here is that it is hard to predict when the “big grid” will finally reach an isolated “little grid.” Since the date of the big grid’s arrival depends on the government’s future budgets and outside donor commitments, the national utility is understandably reluctant to give anything other than a general indicative grid expansion plan. Most private investors will be hesitant to invest in isolated mini-grids if they do not know how long they will be able to operate their businesses before the big grid arrives.*

*One way to reduce this uncertainty for private investors is to make it clear that they will have other business options when the big grid finally arrives. It should be stated clearly in a rule or regulation that a previously isolated mini-grid will have several available business options when the big grid arrives. It can convert itself from an isolated mini-grid to a connected mini-grid. Or it can operate as a combined connected mini-grid that continues to sell at retail in its villages and also as a renewable or hybrid generator that sells at wholesale to the national utility. However, if these are going to be commercially viable options, the regulator will have to make sure that the connected mini-grid’s distribution margin (i.e., the difference between the average bulk supply price and the average retail price) is high enough to support its distribution activities.*

*Pre-specifying the post-connection business options for isolated mini-grids can create a win-win outcome. Isolated villagers will be able to receive grid quality electricity at an earlier date. Private investors will be more willing to invest in isolated mini-grids if they know that they will not automatically go out of business when the big grid arrives. The national utility will be relieved to know that it does not have an automatic obligation to set up expensive (and difficult to manage) retail operations in rural villages previously served by a mini-grid. Finally, the country will also benefit on an ongoing basis as available evidence shows that private operators of connected mini-grids are likely to be more efficient in distribution (for example, achieving lower technical and commercial losses) than large national utilities.*

## **Is This All That Needs To Be Done?**

**The Minister:** “ OK, that’s pretty specific. Is that all I need to do?”

**The Advisor:** “No, Mr. Minister. A good regulatory system for isolated mini-grids (Case 1) is only one piece of the puzzle. But there are at least three other things that need to be done.”

1. **Determine the regulatory requirements for the other cases.** “So far we have only talked about the regulatory requirements for promoting isolated mini-grids—Case 1. But we also need to think through the regulatory requirements for the other three cases as well as combinations of cases that we are beginning to see in Africa and elsewhere. If we are going to do this exercise, we should try to be as complete as possible.”
2. **Determine if these regulations would be legal under existing statutes.** “It is fine to talk about regulatory requirements but it will be a waste of everyone’s time if these requirements are not legal under our existing laws. So after we decide what ground level regulatory requirements are needed for all types of mini-grids and SPPs, we need to get good lawyers to review whether these regulatory rules and actions are allowed under our existing energy and regulatory laws. And if not, what changes will need to be made? The ideal law needs to achieve a balance between specifying overall goals and objectives and not being so overly specific that the Minister or regulator has no flexibility to respond to unanticipated situations. Some general work has already been done elsewhere on model regulatory statutes to promote rural electrification but the work needs to go wider and deeper.”<sup>4</sup>
3. **Take action to promote sustainable financing.** “Even though we have been talking only about regulation, *it is important to recognize that good regulation by itself will not produce investments in mini-grids.* At best, good regulation can only create fertile ground. It does this by providing more certainty to (a) investors, whether private or community based, that their investments will be protected (that is, that their property rights will be created and honored), and (b) to consumers that they will get value for their money.

But if mini-grids are going to take root in this fertile ground, seeds must be planted and fertilizer must be spread. The seeds are financial capital and the fertilizer is human capital. Without both of these, the permits, licenses, and rules of a regulatory system, no matter how carefully written, are just “pretty words on pieces of paper”. So regulation is a “necessary but not sufficient” condition for private investment in mini-grids.

I am not going to try to cover financing today. That is a separate topic for another day. But let’s take a quick look at four basic financial realities.

***First, sustainability requires commercial viability.*** It is very unlikely that any mini-grid will be commercially viable if its only customers are households. And even if you add local businesses, the mini-grid operator may

still not be able to produce enough revenues to cover its costs. To become commercially viable, most mini-grids will need some significant “anchor” customer located within or near a village that has an adequate density of households and businesses to justify the expense of setting up a local distribution system.

In India and elsewhere, we have some projects that use rural telecomm towers as the anchor customer. The mini-grid operator comes in and “hybridizes” existing diesel or LPG generating systems used by the tower owner or operator. And by having these towers as anchor customers, it becomes possible to get financing to provide new electricity services (whether through a traditional poles-and-wires distribution system, energy kiosks or rechargeable battery boxes or lanterns) to nearby villages that either had no electricity, very poor quality grid electricity or self-supplied at very high cost. So it is “win-win” because the mini-grid promotes both electrification and renewable energy.<sup>5</sup>

***Second, in Africa today the principal source of financing comes from bilateral or multilateral donors.*** But donors are notoriously fickle. While mini-grids may be today’s “fashion of the day”, we have to recognize that donors’ interests and priorities can change overnight for reasons that have nothing to do with the merits of mini-grids. Equally important is the fact that donor grants are rarely sufficient to cover full capital costs. So if mini-grids are going to ramp up from just being pilot projects that provide “photo-ops” for the President and donor ambassadors, mini-grids must be able to obtain loans from domestic and external banks and raise equity from local developers and international sources. But this is never going to happen “if the numbers don’t compute”.

***Third, lenders and investors will not show up unless they see a viable business case.*** We need to educate our developers and their consultants on how to prepare credible business cases. No serious investor, whether it is a bank or external investor, is going to provide financing if the basic data are missing or the assumptions are not believable. When all is said and done, the numbers must show that the mini-grid will be able to cover its costs and earn a profit.

***Fourth, even if our banks become comfortable giving loans to mini-grid operators, this, in itself, does not mean the financing problem has been solved.*** Local banks must find it in their commercial interest to make loans to mini-grid developers for longer terms and at lower interest rates. We are not going to see much mini-grid development if the only loans offered are 2 to 3 years with high interest rates and high collateral requirements. One way to “jumpstart” lending by local banks on more viable terms is to establish a donor financed line of credit or liquidity for banks that will lend to mini-grids and small power producers. Once our local banks are comfortable giving

loans for mini-grids, we are likely to see equity from both domestic and external sources.

**The Minister:** This is a lot for one day. I'll need some time to absorb this information. When all is said and done, I think that my job will be to find a workable path between economics, regulation and politics.

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## NOTES

<sup>1</sup> These recommendations are discussed in more detail in a forthcoming book titled *From The Bottom Up: How Mini-Grids and Small Power Producers Can Deliver Electrification and Renewable Energy in Africa* by Bernard Tenenbaum, Chris Greacen, Tilak Siyambalapitya, and James Knuckles. The book will be published by the World Bank in early 2014. Variants of these recommendations are also under active consideration by EWURA, the Tanzanian electricity regulator, in "second generation" rules that may be adopted in 2014.

<sup>2</sup> The key question then is: how much of the small power producer's electricity can be produced from fossil fuels like diesel oil and still be eligible for grants and regulatory benefits? In Tanzania, it has been proposed that up to 25 percent of an SPP's annual electricity production can be produced from fossil fuels.

<sup>3</sup> See Raluca Golumbeanu and Douglas Barnes, *Connection Charges and Electricity Access in Sub-Saharan Africa*, The World Bank, Policy Research Working Paper No. 6511, June 2013.

<sup>4</sup> For example, see Kilian Reiche, Bernard Tenenbaum and Clemenica Torres de Mastle, *Electrification and Regulation: Principles and a Model Law*, The World Bank, Energy and Mining Sector Board Discussion Paper No.18, July 2006. (Available at <http://siteresources.worldbank.org/EXTENERGY/Resources/336805-1156971270190/EnergyElecRegulationFinal.pdf>). One level down from laws are regulations and rules. In India, proposed model rules have been proposed by India's national electricity regulator for use by state-level electricity regulatory bodies. See Forum

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of Regulators, “Model Draft Regulations for Off-Grid RECs for Community Level Off-Grid Projects”, undated ([www.forumofregulators.gov.in](http://www.forumofregulators.gov.in)). In Tanzania, the staff of EWURA, the national electricity regulator, has convened several public conferences to discuss “second generation” rules for small power producers, mini-grids and small power distributors. The final version of these rules is expected to be issued in early 2014.

<sup>5</sup> This particular business model is described as the A-B-C model. See Mohua Mukerjee, *“Private Sector Led Off-Grid Energy Access: The A-B-C Business Model and How Third Parties Can Support The Development of Mini-Grids.”* Presentation at the Incubating Innovation for Off-Grid Electrification, London’s Investor’s Conference, London, United Kingdom, March 21, 2013.