# How a New Breed of Distributed Energy Services Companies can reach 500mm energy-poor customers within a decade

---

## *A commercial solution to the energy access challenge*

*Pepukaye Bardouille & Dirk Muench*

*June 2014*

*This thought-piece has largely been written in the context of growing interest in the potential of "mini-grids" to provide a solution to the energy access challenge. Taking a step back from a dogmatic view of specific systems as a panacea, it focuses on a technology-agnostic, market-driven approach to rapidly scaling-up the availability of rural energy services – the distributed energy service company, or DESCO, model – that we believe, with the right conditions, could efficiently and cost-effectively reach somewhere close to 500mm people over the coming decade. The paper outlines the characteristics of the DESCO model and discusses how it is different from the more mainstream energy access approaches. It then puts forth a series of developments that, in our view, will need to be facilitated very soon for the model to realize its potential, with a particular focus on the amount and nature of financing that will be required for broader DESCO penetration. In so doing, it is our aim to stimulate a fresh debate on energy access and help to concretely advance the agenda because, despite increasing interest in this critically important area of basic service delivery, with the current modus operandi, there is a very real risk that the goal of achieving universal coverage by 2030 will simply not be met.*

***Abstract***

*We believe that a significant proportion of the estimated 1.3bn people (about 300mm households) around the world presently living without access to basic levels of modern energy services can be reached by 2030. And we estimate that it would require much less capital than previously assumed to achieve this goal, with a very significant share of financing potentially coming from investors who recognize the commercial opportunity that is presently emerging.*

*Without suggesting that there is a one-size-fits-all solution, our aim is to focus attention on a particular, market-driven approach to rapidly scaling-up energy access – the distributed energy service company, or DESCO, model – that we believe, with the right conditions, could provide high-quality services to more than 100mm households (500mm people) over the coming decade, profitably.*

*While ambitious, there is a scenario in which millions of people in low-income, off-grid rural areas could enjoy clean lighting and power for home appliances in the same timeframe that they received access to mobile phones, which have reached 75% of sub-Saharan Africa over the past 10 years, driven almost entirely by business opportunity.*

*The DESCO model has the potential to replicate this success.*

*At the same time, there is a very real risk that this opening will be missed or unnecessarily delayed if key actors do not collectively and synergistically drive a handful of interventions to catalyze the sector and seize its latent potential.*

*In this paper, we first outline how the DESCO business model is different from most energy access approaches implemented or otherwise promoted in the development space, and discuss in detail its characteristics in the context of the market: over a billion "energy poor" people who currently spend over $20bn a year just on lighting their homes. We then put forth a series of developments that, in our view, will need to be facilitated for the model to realize its potential, focusing in particular on the volume and kinds of financing required for much broader DESCO penetration.*

*With a sense of urgency and the ultimate objective of catalyzing critical sectoral interventions to drive scale-up, we conclude with a series of recommendations to entrepreneurs, investors, donors, governments and NGOs - all of whom have recognized the challenge of energy access and are looking for solutions.*

*In writing this thought piece, it is our explicit aim to stimulate a fresh, even contrarian, debate on energy access. Without serious focus on new business models, operational approaches on the ground, financing methods and policy interventions, there is a real risk that the goal of universal coverage by 2030 will simply not be achieved.*

## CONTENTS

## 1. Introduction

In 2005, just 5% percent of sub-Saharan Africans had a cellular telephone. Less than 10 years later, mobile network operators (MNOs) boast over 250mm unique subscribers, covering 50% of the continent, employing over 3mm people and generating revenues of more than $100bn per year. This incredible growth was fueled by a total investment of around $44bn over the last 6 years alone.[1]

Over the same period, Africa's electricity connections have barely budged and currently hover at around 30%. An estimated 120mm households (590mm people[2]) are effectively left in the dark.

Energy poverty is not a new issue. The challenge has been recognized for decades and myriad initiatives, largely driven by governments and development agencies, to extend power to the poor have been launched. But success has been limited. With a handful of notable exceptions, electrification rates across sub-Saharan Africa and South Asia have only just kept up with increases in population in the past decade.

But there are clear signs that the situation *could* change in just a few years.

We believe that a new breed of distributed energy services company (DESCO) is poised to mirror the success of MNOs. With the right operating models, combination of commercial and concessional financing and broader ecosystem conditions, in ten years DESCOs could grow just as fast as telecom companies did and lift 100mm households (500mm people) out of energy poverty; attract as much capital as MNOs – serving 100mm households would require investments of around $30bn[3] - and potentially reward investors with handsome returns (20+% on equity).

In fact, we will go even further by positing that the emerging DESCO model is so attractive and has so much potential to reach scale because it offers an unparalleled '*win to the seventh (win[7])'* for stakeholders of the energy access imperative:

1. *Low-income households* in remote rural settings would receive far better electricity-based energy services – from lighting to phone charging to TV, internet and, in some cases, power for productive activities that could support everything from refrigeration to grain milling – for less money than they currently spend on kerosene, candles, batteries and diesel generators. And, they would have access to these services without having to make relatively large cash outlays[4] to buy solar home systems or similar products.

---

[1] GSMA: Sub-Saharan Africa Mobile Economy 2013; http://www.gsmamobileeconomyafrica.com

[2] "Global Tracking Framework", Sustainable Energy For All (2013) v. 3, page 38.

[3] This compares with $48bn/year that the IEA estimated in the 2011 World Energy Outlook would be required to connect 300mm households to the grid.

[4] High upfront expenses have frequently been mentioned as one of the major hurdles to the widespread adoption of solar products. See also: "Last Mile Distribution of Off-Grid Solar Products: Support Needs, Concerns, and Opportunities", German Development Cooperation Office, 2013 and

2. *Local entrepreneurs and international firms* – including the many sales and service agents required to run wide-reaching DESCO networks – would make a solid return and in some cases may even get rich from the venture.
3. *Donors, philanthropists, development finance institutions and non-governmental organizations* would see their grants, concessional investments and energy access projects much more effectively catalyze transformation in decades-long efforts to bring energy access over the last mile to target households.
4. *Financial investors* would earn attractive returns as the sector demonstrates high growth rates in markets where the poor already spend some $20bn[5] annually on lower-quality lighting services alone.
5. *Strategic investors* would benefit from a newly "empowered" customer. Consider electronics companies targeting 1bn plus new consumers globally; people who today have no use for any of those products without electricity.
6. *Governments* in developing countries could rightly claim to have facilitated energy access to a large percentage of off-grid low income households and hope to reap a reward in the next election: No light, no vote – no more!
7. And last but not least, given that renewable energy technology will be the most effective within DESCO sector, *the world's climate* could also win as the sector's development would significantly reduce $CO_2$[6] and Black Carbon[7] emissions by displacing kerosene lanterns and diesel generators.

## 2. Characteristics of a Distributed Energy Services Company - DESCO

There are broadly three approaches to addressing the access to energy challenge:

***Utility-based electricity grid extension***: Over the last 20 years, almost 2bn people have been connected to traditional, centralized electricity grids or island networks. While significant progress has been made in Asia and Latin America (notably Brazil, China, India and Thailand), with the exceptions of Kenya, South Africa and a perhaps a handful of others, the situation has actually deteriorated in sub-Saharan African countries, where grid extension has only slightly increased between 2000 and 2010[8]. Given the cost of stringing power lines into very remote and often very low-

---

"The Base of Pyramid distribution challenge", Centre for Development Finance, Institute for Financial and Management Research, 2011

[5] Cash spending on kerosene and candles for lighting and phone charging services alone is estimated to be $18 billion. From Gap to Opportunity: Business Models for Scaling-up Energy Access, IFC, 2012

[6] It has been estimated that in 2005 houses without electricity consume 77 billion liters of liquid fuels (mostly kerosene) to meet lighting requirements, corresponding to 190 million metric tonnes of CO2 per year. See also: *Mills E., Science. 2005, May 27; 308(5726):1263-4.*

[7] Black Carbon is a product of incomplete combustion and one of the few components of atmospheric aerosol that absorbs light and heats the atmosphere, thereby contributing to climate warming. […] During its short atmospheric lifetime, one kg of Black Carbon produces as much positive forcing as 700 kg of carbon dioxide (CO2) does during 100 years. See also: *Household Light Makes Global Heat: High Black Carbon Emissions From Kerosene Wick Lamps, Env. Scien. Tech. 2012.*

[8] "Global Tracking Framework", Sustainable Energy For All (2013) v. 3, pages 35 and 270.

income (i.e., low consumption) areas, this option is often neither economically efficient for governments to subsidize nor feasible for cash-strapped utilities.

***Government or donor funded off-grid electrification projects***: Dozens of initiatives around the world have established infrastructure, typically using renewable energy options such as hydro-powered micro-grids or solar home systems at the village level. There are several examples of successful projects designed to reach the last mile using solar home systems in Argentina, Peru, Morocco and South Africa and mini-hydro-plants in Brazil and Nepal, to name a few. But, with the notable exception of Bangladesh's government-incentivized, market-based solar home system roll-out that has reached over 2 million homes, most have been heavily subsidized (generally 70-100 percent of capital costs) and, even then, plateaued at or below 50,000 new connections per month.[9] Project design, limited funding, failure to budget sufficiently for ongoing operations and maintenance or overly complex governance structures are some of the reasons that scale-up or replication has been stifled.

***(Commercial) sales of durable energy access products***: In less than a decade, there has been a remarkable increase in cash sales of ever more sophisticated basic energy access products—*notably solar lanterns costing $10-30*—to low-income, off-grid households in peri-urban and rural areas. Initially limited to rooftop home systems that could cost a household $200-500 to light their home and run very basic appliances, there has been a dramatic shift in the use of solar energy at the household level in less than a decade. Tremendous product innovation, improvements in quality and price declines have led to almost explosive growth in solar lantern distribution in sub-Saharan Africa; after a short five years, the market penetration of solar lanterns now stands at about 3% by the most recent reliable estimates.[10] From a business perspective, $10-30 lanterns are low margin products that require high sales volume for companies to become profitable. While mastery of distribution channels remains a challenge for many companies and continues to affect profitability for some,[11] it has been interesting to observe that, in some markets, concerns about affordability for end-users of these lower-cost products are proving to be unwarranted, as cash sales have grown without credit assistance. However, what is perhaps more notable is evidence of increasing demand among low-income customers for more sophisticated products, notably high-performance

---

[9] www.sun-connect-news.org and http://goo.gl/X92qAT

[10] "Trends and Developments in the Africa Off-Grid Lighting Market", Lighting Africa, 2012

[11] Establishing strong distribution networks in rural areas is a costly business. So, when the ticket-price of the good sold is low, it is difficult to recover this investment without subsidy. This is even more the case when each customer buys only one or two products; without a "repeat business", or until such a time as sales of other products, be these home appliances, water filters or insurance, can be better integrated into the solar lantern supply chains, customer acquisition will remain extremely expensive. For example, the two largest solar product distributors, SunnyMoney and Total are not truly commercial operations: SunnyMoney uses non-commercial approaches to distribution, leveraging teachers in Tanzania as sales agents, and Total's distribution of solar lanterns is part of its CSR program selling products at or even below costs through their existing network of gas stations.

lighting devices with cellphone charger add-ons, and solar kits typically costing $50-150. It could be that access to "entry-level" solar lanterns are pushing people up the energy ladder, maybe due to increased comfort with a new technology, real productive gains as a result of longer hours of light, cost savings from reduced or eliminated kerosene consumption, or solar products simply becoming aspirational. But as even lower-end lanterns begin to reach often poorer, more rural markets, and as demand for more expensive modern lighting products increases, cash sales may start to face an affordability bottleneck. To push through this barrier, retail companies must address the asset finance question, else they may not secure sufficient sales volumes for the business to be commercially viable.

The DESCO model differs from these energy access approaches in several respects.

## *2.1 Identity of the DESCO business model*

First and foremost, the DESCO is not a project but, rather, a *business that provides a commercial return on investment*. It is fundamentally *designed to scale.*[12]

Secondly, in contrast to the product sales and distribution business model, the DESCO *builds a customer relationship* by installing assets – such as a solar home system or connection to a mini-grid – at or near dwellings and small businesses, collecting an *on-going payment for energy* (or recurring fees) from the customer.

Hence, the DESCO is comparable to a commercial utility company.

However, in contrast to typical utilities[13] – national or private – the DESCO does not focus on delivering "free-flow kWhs". Rather, it provides its market segment with desired *energy services*[14]*.* This may be sufficient electricity for lighting and cellphone charging; the ability to use a fan, TV, radio, computer; or power for a retail business.

The third key differentiating characteristic, then, is that *at scale the DESCO model does not require a subsidy* and is, in fact, highly profitable.

Before getting into the details, let us clarify that this need not be a zero-sum game. DESCOs can complement non-market based initiatives. But the advantage is that this market-driven approach can serve a portion of the population that does not actually require subsidies, thereby freeing finite concessionary resources to serve the

[12] Unlike small "backyard utilities" selling power to off-grid villagers and often also to "grid connected but intermittently served" urban dwellers using diesel-gensets around the developing world, from Nigeria to the Philippines.

[13] It may also not have been given an exclusive service area with an explicit obligation to supply.

[14] There are examples of fee-for-service off-grid businesses, for instance in the aforementioned solar home system concessions. But, these efforts have all enjoyed significant subsidies from local or national government or donors, hence are not truly commercial. Likewise, while grid extension efforts have successfully connected millions of poor people in rural areas, they often rely on cross-subsidies amongst consumer categories and do not generally recover capital costs.

poorest, most remote households. Similarly, the DESCO model can co-exist with commercial product sales. However, for a large portion of the consumer segment, we believe that DESCOs simply offer a more attractive deal. For instance, where this is an issue for households, DESCOs eliminate upfront payments and spread costs over time, thereby addressing the issue of affordability. Depending on the specific variation, DESCOs also reduce risk by eliminating end-user ownership.[15] And households may also be hesitant to invest in a system (especially rooftop ones) if the utility or politicians are making parallel promises of "the grid coming very soon", however futile the hope or unreliable any eventual ensuing networked service.

## *2.2 Variations within the DESCO identity*

The operating approach that a DESCO chooses can take many shapes.

**DESCOs can cover all market segments:** The firm can be focused on serving customers living on little more than $1 per day, rural entrepreneurs running a small business or, of course, a combination of the two.

**DESCOs can provide all levels of energy access:[16]** The business model is flexible when it comes to the amount of energy or, effectively, energy services it offers to customers. In theory the DESCO model can cover the entire range of services from Tier 1 - ~1W task light – to Tier 4 - ~800W for commercial appliances (Figure 1).[17]

**DESCOs are not limited to one energy source (e.g. solar photovoltaic, biomass gasification or hydro power) nor are they restricted to the technology or energy asset used to generate and distribute power (e.g. solar home system vs. solar mini-grid):** The DESCO model is essentially technology agnostic.[18,19] DESCOs install distributed energy assets at or near the locations of their customers. The same DESCO can use a plug-and-play solar kit in one market segment, a rooftop solar home system wired into the home in a second and solar mini-grids with battery back-up in a third area[20] or, for that matter, it may install biomass mini-grids in one location and solar mini-grids in another.[21]

---

[15] While there has been a notable increase in product quality and consumer awareness of quality standards, thanks in part to programs such as Lighting Africa, many poor households are (understandably) wary of tying money to a product that may just stop working with no recourse.
[16] See also SE4All publication: The Global Tracking Framework, ANNEX III.
[17] Currently DESCOs reach only about 200,000 households and small businesses globally. Most customers are using Tier 1 and 2 services. Tiers 3 and 4 are expected to increase in use as the market expands and customers more fully adopt the DESCO model for their energy needs.
[18] In reality, we expect that renewable resources will dominate the sector given low operating costs.
[19] While DESCOs may leverage a range of energy sources, the choice of energy generation technology and/or system size will ultimately influence profitability.
[20] For example, Persistent Energy Ghana.
[21] For example, DESI Power and Husk Power.

***Figure 1: Energy Service Tiers that can be covered by DESCOs[22]***

*DESCOs can provide one or more levels of energy service, from the basic (Tier 2, <200Wh per day) to "full electrification" (Tier 4, 1,600 Wh per day).*

| | | | Appliance providing energy service | Power need | Usage amount | Energy need appliance per day | Cumulative energy need per day+ | Example product |
|---|---|---|---|---|---|---|---|---|
| | | | *Unit* | *[Wp]* | *[hrs / day]* | *[Wh / day]* | *[Wh / day]* | |
| Tier 4 < 1,600Wh per day | | | Grain Mill | 750 | 4 | 3000 | 3744 | |
| | Tier 3 < 800Wh per day | | Water Pump | 150 | 2 | 300 | 744 | Sunpump SDS 128 |
| | | | Fridge | 150 | 2 | 300 | 444 | Steca PF 166, no battery |
| | | TIER 2 < 200Wh per day | TV / Tablet Comp | 12 | 6 | 72 | 144 | MacBook pro (65Wh), iPad (34Wh) |
| | | | Lighting | 10 | 6 | 60 | 72 | Fosera Lamp 200 (1.6W) |
| | | | Phone | 5 | 2 | 10 | 12 | iPhone (10Wh) |
| | | | Task Light | 0.5 | 4 | 2 | 2 | d.light s1/s2 |

*+ The 'Cumulative energy / day' - column reflects the cumulative energy need if all appliances would be used in a given day. For example, running a task light, phone, lights and TV for the hours shown above would require a total of 144Wh. Adding a fridge would require a total of 444Wh and so on.*

**DESCOs can charge customers for services (i.e., recover their investment and operating costs) in different ways:** In a *pay-per-use model*, the DESCO bills energy users only for the *services consumed* (for example, per full charge of a battery, per hour of supply of a certain service level, even per kWh). In a *rental model* the DESCO would require a periodic fee for equipment (such as daily, weekly or monthly), regardless of whether or not energy is actually consumed. Hence, in a rental model, a customer would pay a fee for time-linked *access to the asset*, be it a village micro-grid or a rooftop solar home system, even if that customer does not switch on their appliances. In a *lease finance model* the DESCO would opt to *sell its assets* to customers over time (for example, the household owns its solar home system after X months of payment).

**DESCOs may choose to extend their ability to finance assets beyond their primary energy-producing asset:** On an abstract level, the DESCO provides customers with an energy asset (i.e. micro-grid connection or solar home system) and recovers its cost over time. Once the customer relationship is established, however, a DESCO may choose to extend its offering to include either directly selling (for cash) or, alternatively, providing financing services for appliances such as a fan,

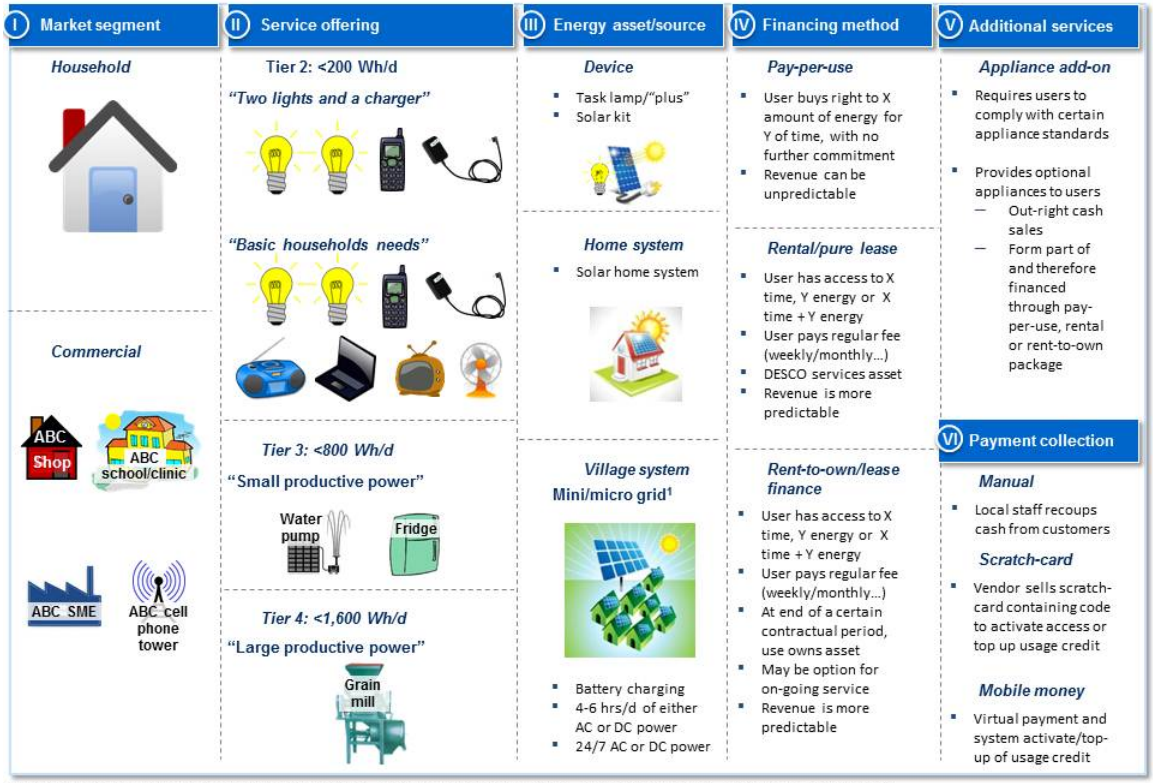
[22] See also: "Considering Access to Energy Services", white paper by Persistent Energy Partners.

tablet PC or even a refrigerator. In the most extreme scenario, it is conceivable that the DESCO would operate much like a micro-finance institution with the added feature that it can remotely control the customers' energy assets and energy access to "encourage" repayment (by locking out the energy assets if necessary).

**DESCOs can collect payment from customers in different ways:** Some DESCOs employ a local village agent to recoup fees from customers manually (they often also help to reduce the risk of delinquency though social pressure). Others require users to buy scratch cards from agents or nearby shops, containing a pin code to activate the system or to register credit for a given service level or period of time. Where available, DESCOs also opt to go virtual, using mobile payment systems like Kenya's M-PESA (Safaricom) or Airtel Money to collect monies. Almost all DESCOs require pre-payment for services, regardless of the collection method.

***Figure 2: Principal aspects of the DESCO identity***

DESCOs can serve the household and/or commercial markets, offering Tier 2 to Tier 4 service levels that are powered using sophisticated solar devices (solar kits), roof-top solar home systems, or village-level micro-o or mini-grids that use a range of renewable resources, conventional fuel or a hybrid. They are finances on a pay-per-use basis, a pure lease (rental) basis, or through lease-finance (rent-to-own). Payment is collected manually, using scratch-cards or through mobile money. In addition to supplying customers with energy services, the DESCO may also offer conversion appliances for household use.




1 Can be powered using a range of energy sources, including solar, wind, hydro, biomass and diesel, including in combination

## 2.3 Some real-world examples[23]

There are a number of interesting DESCOs using a range of technologies to provide Tier 2 to Tier 4 energy service levels to customers across several countries.

***Figure 3: Business model overview of selected DESCOs[24]***

| | | Technology | | | Energy source | | | | | System-size | | | Service level (Wh/d) | | | Payment collection | | | How users are charged | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Business model examples | Country | Device/ Solar kit | Roof-top solar system | Micro/ mini grid | Solar PV | Bio-mass | Hydro | Wind | Diesel | <1 kW | <5 kW | 10+ kW | Tier 2 <200 | Tier 3 <800 | Tier 4 <1,600 | Manual/ cash | Scratch card | Mobile money | Pay-per-use | Lease Time/Energy/ Time + Energy | | Lease-finance |
| DESI Power | India | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | ✓ | |
| Devergy | Tanzania | | | ✓ | ✓ | | | | | | ✓ | | ✓ | | | | ✓ | | ✓ | | | |
| Enersa | Senegal | | | ✓ | ✓ | | | ✓ | ✓ | | ✓ | | ✓ | | | | ✓ | | ✓ | | | |
| Fenix | Uganda | ✓ | | | ✓ | | | | | ✓ | | | ✓ | | | | | ✓ | ✓ | | | ✓ |
| Husk Power | India, Uganda | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | | | ✓ | | | | | ✓ | |
| Mera Gao Power | India | | | ✓ | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | | ✓ | |
| Minda Nexgen | India | | | ✓ | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | | ✓ | |
| M-Kopa | Kenya | ✓ | | | ✓ | | | | | ✓ | | | ✓ | | | | | ✓ | | | | ✓ |
| Mobisol | Tanzania | | ✓ | | ✓ | | | | | ✓ | | | ✓ | ✓ | | | | ✓ | | | | ✓ |
| Naturetech | India | | | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | ✓ | | | ✓ | | |
| Offgrid Electric | Tanzania | | ✓ | | ✓ | | | | | ✓ | | | ✓ | | | | | ✓ | | ✓ | | |
| OMC Power | India | | | ✓ | ✓ | | | | | | | ✓ | ✓ | | | ✓ | | | ✓ | | | |
| Persistent Energy | Ghana | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ | | | | | ✓ | ✓ | | | |
| Powerhive | Kenya | | | ✓ | ✓ | | | | | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | |
| Rift Valley Energy | Tanzania | | | ✓ | | | ✓ | | | | | ✓ | ✓ | ✓ | | | ✓ | | | | ✓ | |
| SELCO | India | | ✓ | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | | | ✓ |

Husk Power Systems and DESI Power began operating in India several years ago. Husk initially used biomass as a fuel source in gasification systems on the order of 25-100kW, mainly serving very poor households with a fixed-price, pre-paid, Tier 2 package of "2-lights-and-a-charger" for 4-8 hours a day, while DESI opted to provide higher levels of service to both household and commercial users. Both firms have now diversified into solar photovoltaic (PV) and Husk has become one of the first mini-grid DESCOs to operate in more than one country, expanding to East Africa.

---

[23] *Note that the companies mentioned in this section – including those listed in Figure 3 – have not been chosen for their particular performance as a DESCO, or because they are paragon examples for the business model. Furthermore, this list of companies running a DESCO model is also not complete. To better analyze DESCOs and understand their key success factors, see section 2.4.*

[24] *This is an overview of some of the interesting DESCOs that we have come across in the course of our work. This list is neither complete nor does it indicate the potential of any particular DESCO to scale. It is only meant to shows how far the variations within the DESCO model currently go.*

Also in India, Minda NexGenTech and Mera Gao Power employ 240Wp PV systems to supply pre-paid Tier 2 energy packages using a rental model. SELCO, one of India's longest-operating off-grid companies, employs 10-50Wp modular solar home systems installed on individual households' rooftops to supply energy. System ownership is transferred to customers over time through a lease-to-own model.

Energy services at Tier 1 and Tier 2 level are also provided using rechargeable batteries that effectively take energy to homes "without wires". Batteries may be recharged using power from the grid and then taken by bicycle or motorbike to off-grid (for instance, EGG-energy operating in peri-urban areas of Tanzania). Recharging can also be done using PV mini-grids (OMC in rural India, whose core business is to serve cellphone towers) or, in one case, by "pedal power" (Nuru PowerCycle in Rwanda).

In Tanzania, Off-Grid:Electric rents modular 10-20Wp solar home systems that can be upgraded as user demand grows using a rental model; Devergy runs 1.5-4.5kW PV solar micro-grids to offer households Tier 2 service using a pay-per-use model; and Mobisol offers 15–200Wp solar home systems on a lease-to-own basis. In Ghana, Persistent Energy Ghana provides basic households Tier 2 energy using pay-per-use solar micro-grids in some villages and rental solar home systems in others.

In Kenya and Uganda, respectively, M-Kopa and Fenix International use lease-financing to provide Tier 2 energy, selling customers high-quality solar kits that can power 4-6 efficient light bulbs and also charge smaller appliances. Uptake has been driven by the ability to effectively 'buy down' the product on a daily basis while mimicking (and off-setting) household and small business spending on kerosene. Solar Now is also lease-financing larger systems in Uganda.

In Bangladesh, Solaric lease-finances 2.8kW PV systems to provide sufficient Tier 2 DC power for 50 households to run 3-4 lights, a charger, fan and TV for a fixed fee. In Senegal, Enersa sells power similarly – packaged as 'energy blocks' that allow users to upgrade service levels as needed – from 1.5-5.5kW hybrid solar-diesel systems.

In Kenya, Powerhive has installed 10-50kW PV systems that can supply 24/7 Tier 3 pay-per-use services to household and small commercial customers who purchase pre-paid energy units similar to cellphone airtime. These systems can be integrated into the power grid, should it come to the villages. Again in Tanzania, Rift Valley Energy[25] leverages a much larger scale 3.8MW hydro-powered facility to supply its

[25] While Rift Valley Energy has received significant long-term loans and concessional grants to cover capital costs, and is therefore a quasi-commercial venture, we include it as an example given potential applicability to other areas with similar resource and population characteristics. That said, we acknowledge that, although potential for DESCOs to provide Tier 3 service levels, the focus of DESCOs is currently on Tiers 1 and 2. This is because the upfront capital costs required to meet the increased service levels, be it through larger solar panels and batteries for storage of hydro-power plants, is significantly higher and, accordingly, extends the payback period well beyond 3 years.

own commercial agricultural agri-business needs as well as serve about 1,000 household users with up to Tier 4 services and also feed back to the national grid.

## *2.4 Success factors for a DESCO*

It is important to understand that, while we believe firmly in the potential of the fundamental DESCO model, not all companies that we have examined are created equally in terms of what we could consider their *likelihood of reaching scale*.

What follows are our observations and conclusions on characteristics that would indicate a DESCO's potential to reach rural customers in meaningful numbers. These characteristics are independent of the specific type of DESCO (see Figure 2).

Highly-scalable DESCOs:

1. … **Manage AIPU** (Average Investment Per User) **against ARPU** (Average Revenue Per User) and achieve simple payback periods of under 3 years.[26],[27] The simple payback has to be so short for two reasons; first, a short simple payback on investments is an indication that there is enough cash-flow to pay for operations and remain profitable and, second, most debt maturity structures in emerging markets don't extend much beyond that point. Accordingly, to attract capital for longer is unrealistic.

2. …**Use mobile phone technology or the equivalent** to remotely control and monetize its energy assets.[28] A review of DESCOs shows that those leveraging cellphones for billing and user management are growing far more quickly than those collecting payments manually. While mobile networks may not be immediately available in all target areas, not all customers have access to a

[26] The simple payback – the ratio of AIPU over ARPU – is only an indication of a company's profitability at any given point in time. Having analyzed many variations of the business model however, we found that it is an easy litmus test to separate companies with potential from those that are unlikely to be financed and, thus, reach scale and return profits.

[27] We assume that the market is very segmented – not every customer is paying $7 per month, an amount often assumed as the average spent on kerosene per month and household. In some countries where kerosene is highly subsidized (e.g. India) outlays could be as low as $2-4 a month, reducing the DESCO price point. Some customers are wealthier, expect higher service levels and can pay much more than $7 for services. The key to success is not an absolute level of service (or system capacity) but to manage the cost relative to expected revenues – at the $3 per month end as well as the $20 per month level. The goal is to have a technological solution that can easily be horizontally (number of households) and vertically (in terms of capacity) scaled. While some solar home system DESCOs may have the option to add modules to increase capacity at the household level, we believe that this particular aspect is an advantage that mini-grid solutions have over individual home system solutions.

[28] The proliferation of mobile phone technology makes it possible for the first time to manage, control and monetize distributed energy assets in remote settings while keeping costs low. We believe that this is also the reason that DESCOs are finally developing rapidly.

cellphone and mobile payment systems are not yet universal, we believe that remote payment collection and system management will ultimately be critical to efficiently and effectively increase span of control at the long-term.

3. …**Keep costs of operation low, but allocate a substantial part of revenue** to it.[29] Like any serious venture, the operations of a DESCO are critical to its sustainability. The business model needs to be attractive after these are considered. We believe that operating costs should range between 25-35% of revenue at scale.[30] Note that at this level, the business model itself would still produce highly attractive returns on investment.

4. …**Focus on building robust distribution networks and incentivizing sales agents**. The business model and investment proposition of DESCOs is actually fairly simple. The challenge is local execution and in particular the build-up of large agent and service networks that are required to create and maintain customer relationships in regions with often poor infrastructure. In short, the DESCO's recurring revenues must provide sufficient cash flow to represent an attractive business model for agents within its network. A parallel from the mobile phone industry is the sale of airtime; this recurring revenue stream is the part of the business that attracts and motivates the customer-facing sales force. If distribution is executed effectively, the DESCO model is economically powerful enough to finance even the costly distribution required in emerging market settings.

5. …**Remain agnostic with respect to technology and technology provider.**[31] We note that there is an ongoing debate about which model is better suited to serve off-grid, low-income households. We have seen some companies using mini-grids effectively. Others are growing rapidly by installing roof-top solar home systems (SHS). And for some firms, solar kits (which we would classify as a device) suffice for their market. In many cases (notably where consumption is minimal either because users are exceedingly poor or high-efficiently appliances are installed), a 240Wp micro-grid serving 30 households could be as well suited as a 10Wp SHS on every rooftop. We believe that a superior business strategy for a DESCO would be to use both technologies within the same business model opportunistically.

6. …**Require no subsidy <u>at scale</u>**. We firmly believe that without a strong business model, any initiative will fail to reach the scale that is required.

---

[29] We include the cost of service and sales agents as well as the overhead in the cost of operations.
[30] The explanation for this range is complex and would go beyond the scope of this article. We arrive at this range by analyzing from the bottom up how much the required staff is likely to demand as pay and how much is left after all other costs – system replacement, capital, general management – have been taken care of. See also Figure 4 outlining the DESCO model at scale below.
[31] There are today many more product manufacturers entering the DESCO sector than there are DESCOs (i.e., distribution businesses installing assets and selling energy services). The product designers and manufacturers are struggling to find distribution channels for their product, regardless of the quality or cost of such product. Robust distribution channels don't yet exist.

Subsidies are often inefficiently allocated, subject to availability of funding, costly to access (from an administrative perspective) and can be accompanied by de facto and counterproductive regulation of prices as a quid pro quo or come with implied tariff restrictions, and should therefore not be relied upon. However, this does not mean that energy services companies, like almost all small and medium-sized enterprises (SMEs), will not require some form of angel financing to start, or simply to grow faster through the early life-cycle.[32]

## 3. What will it take to get to 100 mm connections?

Enthusiasm around the potential of DESCOs, and particularly those using mini-grid technologies, to close the access gap has been intensifying almost feverishly over the past year or so.

While this optimism seems justified given the economic potential of the DESCO business model, the fact is that DESCOs currently only reach some 200,000 households and small businesses globally*. Even at a growth rate of 50 percent annually, DESCOs would reach only 12 million households within 10 years.*

But with 300mm unserved households, *what will it take to be truly transformative?*

*What will it take to get to, say, 100mm DESCO connections?*

Recent analyses have estimated the financing requirements to achieve universal energy access using a combination of grid and off-grid solutions[33]. Much has been written on the enabling environment conditions that would attract more companies to serving the off-grid market.[34] Likewise, there has been exploration of the size of the market opportunity.[35] But there has been less tangible discussion on investment needed to catalyze the growth of a truly commercial energy access solution space.

Below we provide some perspectives on financing requirements of the DESCO sector, trying to be as specific as possible. The figures we show are derived from real world examples of DESCOs pursuing what we consider to be sustainable models.

[32] We note that the telecom and mobile money sectors attracted significant grants in early years.
[33] Access to Modern Energy: Assessment and Outlook for Developing and Emerging Regions. IIASA, UNIDO, GEF. 2012; World Energy Outlook 2011 Energy for all: financing access for the poor, IEA, 2011.
[34] See for example, "Tenenbaum, Bernard; Greacen, Chris; Siyambalapitiya, Tilak; Knuckles, James. 2014. From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa. Washington, DC: World Bank" (http://bit.ly/OKR_frombottomup)
[35] See "From Gap to Opportunity: Business Models for Scaling Up Energy Access, IFC 2012.

## *3.1 Going from start-up to scale*

Despite our propensity to advocate for the sector by promoting success stories, firms targeting low-income, off-grid customers are in their very early stages.

To our knowledge, no DESCO has yet reached profitability.

The largest company – by customers reached – in sub-Saharan Africa, M-Kopa, has sold systems to 65,000 households as of the time of writing. The second largest company, Off Grid:Electric, has signed up about 15,000 customers. SolarNow has reached about 5,000 customers and Mobisol has reached just about 2,500 users.

By our estimates, the total realized investment in the sector to date, including grants, is probably not more than $50mm.

This all goes to say that the sector as a whole is in its start-up phase. And like all other start-ups, it will require the right kind and amount of capital to flourish.

Below are some broad approximations of the number of connections and amount of capital needed for the average DESCO targeting household users to reach the two major milestones towards scale: *operational breakeven* (the point where operating costs are covered by revenue) and *profitability* (the point where revenue exceeds all costs of running the business).

**To reach *operating breakeven* requires a DESCO to connect 25-50,000 households, invest ~$10mm and operate for ~2 years:** Assume, for example, that a DESCO invests $300 per household in energy assets (AIPU = $300) and expects to generate around $10 per month and household (ARPU = $10). Typically, this DESCO would reach operational breakeven once it has reached 25-50,000 households, implying annual revenue of $3-5mm per year. At such scale operations would consume about 100% of revenue (operational breakeven). At a cost of $300 per household, the investment in energy assets for 25,000 connections would amount to $7.5mm. In our experience it would take an additional $2.5mm to pay for start-up costs and R&D over the first ~1-2 years to build to that stage.

**To reach *true breakeven* (covering overhead) requires a DESCO to connect 50-75,000 households and invest more than $20mm:** To connect 50,000 households, for example, a DESCO would have to invest about $16m in energy assets alone ($300 per household). 50,000 households provide annual revenue of $6mm ($10 per month and household). Of this revenue, operations would consume 50-75% ($3 – $4.5mm). About 5-15% of this ($0.5 – $1.5mm) depending on leverage, would be used for debt service; 10-15% would be required to maintain the energy assets in the field (equivalent to a 7-year average weighted lifespan); and maybe 5% would go to product and software R&D, mainly focused on improving quality and lowering of costs. The DESCO starts to be profitable thereafter as *cost of operations grows at a slower pace than revenue*.

**To reach real scale, say 250,000 households, might take DESCOs 5 years.** But once that level is reached, the DESCO would be a very profitable business.

Below we try to graphically show these projections:

Figure 4 illustrates the relationship between funding needs and scale; Figure 5 highlights the relationship between scale and profitability; and Figure 6 presents a simplified financial model at a scale of 250,000 households.

***Figure 4: Funding needs vs. growth, scale and profitability of a prototype DESCO***

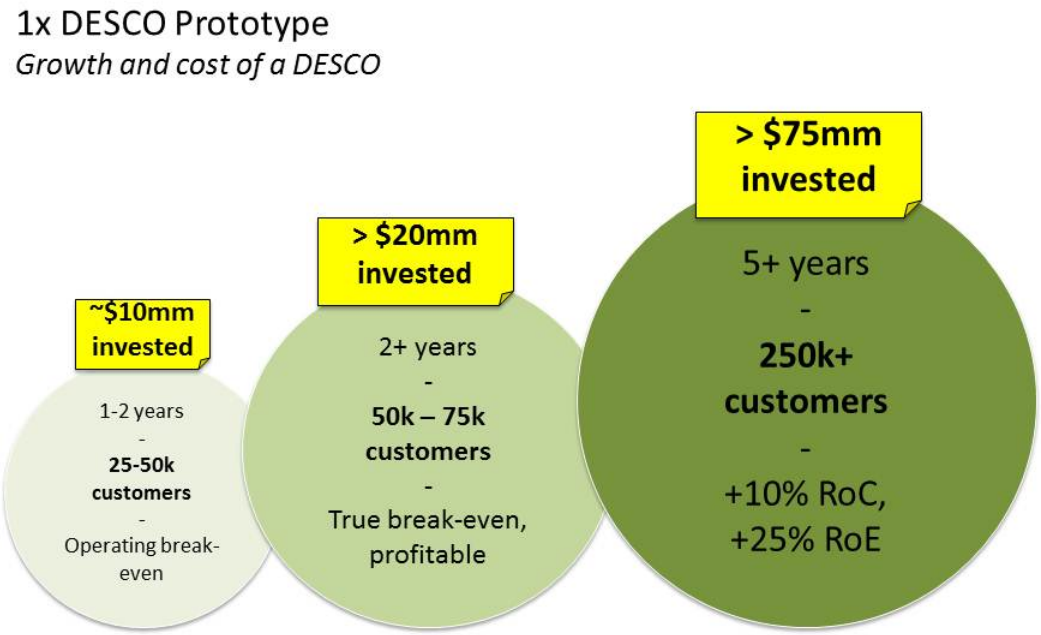


***Figure 5: Profitability vs. scale of a DESCO***

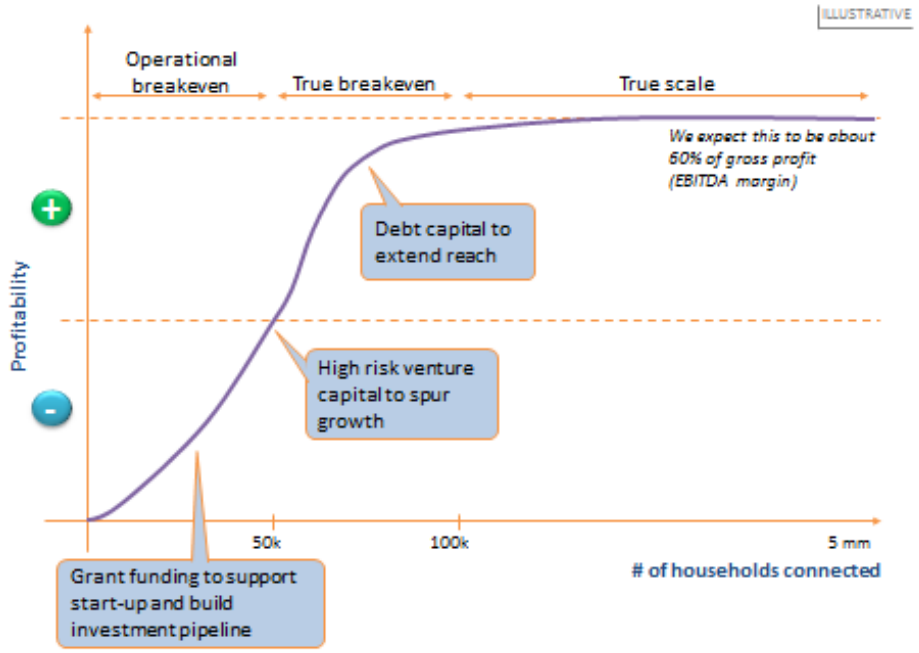



***Figure 6: Simplified financial model of a DESCO at a scale of 250,000 households***

*It is not the absolute number of average investment per user (AIPU) and average revenue per user (ARPU) that drive profitability and sustainability of the mode. Rather, it is the ratio of the AIPU over ARPU that is important to consider. A DESCO serving customers spending less than $10 per month on average can achieve the same profitability if the AIPU is accordingly lower.*

| | | | |
|---|---|---|---|
| **SCALE** | Households Connected | # | 250,000 |
| | Average Investment per household | AIPU, $ | 300 |
| | **=> Total Capital Required** | **$** | **75,000,000** |
| **REVENUE** | Average Revenue per household and month | ARPU, $ | 10 |
| | **=> Total Annual Revenue** | **$** | **30,000,000** |
| **COST** | Cost of operations[36] | $ | 7,500,000 |
| | **=> EBITDA** | **$** | **22,500,000** |
| **EXPENSES** | Depreciation / Maintenance Cost[37] | $ | 11,250,000 |
| | Leverage (% debt) | | 60% |
| | Debt financing cost | 8% | 3,600,000 |
| **INCOME** | Earnings before Taxes | $ | 7,650,000 |
| **PROFITABILITY** | ROC | | 10.20% |
| | ROE | | 25.50% |

[36] Cost of operations includes for example general management, the ongoing sales of energy credits through agents (8% of revenue), fees for mobile money transactions (1-3% of revenue) and cost of technician teams (3-5% of revenue).

[37] We assume an average weighted life of the energy asset of 7-years. The maintenance can therefore be estimate to be equivalent to 15% of total assets in the field, or $75mm/7years.

It is very hard to say how long it will take for the sector to collectively reach a substantial part of the 200-300mm households living without access to basic energy services. The point is that we believe the sector will emerge, as its business model is so strong. We also think that the DESCO model has the highest potential yet to end energy poverty. And we know that if a business makes sense and the circumstances are right, its growth can be explosive. The telecom sector's development from less than 5mm customers in 2004 to more than 500mm in 2014 is the prime example of a service centered business model that reached true scale in little time.

## *3.2 Sector financing needs – how much and what kind of capital*

As mentioned previously, none of the 15-20 DESCOs we have analyzed have reached profitability and the largest company has 50,000 customers. In other words, the business model is still more theory than practice. Hence, the energy services sector is still a high-risk sector and will likely remain so for the next several years.

Typically, as with any new small business undertaking, we would expect companies to be mainly funded by a mix of grants and equity (Figure 6).

Grants are needed at this stage to accelerate the inflow of venture and impact capital. Even risk tolerant investors who appreciate the economic potential of a DESCO recognize the parallel to the telecom sector and note the first signs of explosive growth, struggle with the lack of a track record of this nascent sector. Without philanthropic capital the sector may still develop, but it would certainly take much longer to reach its potential. It is important to emphasize here that grants are not needed to subsidize business models that are not otherwise financially sustainable. They are needed to catalyze and accelerate the inflow of commercial capital into a new sector by financing the proof of sustainable business models.

Taking into account the assumptions discussed in the previous section, we project the following financing needs for the sector as a whole.

**The distributed energy services sector requires around $200mm in total investment over the next 1-2 years to get 20 companies to operational breakeven, positioning them for scalable growth:** We presently know of 10-12 DESCOs that we would consider to have high-potential models. Consider that there could be 5-10 more DESCOs emerging in 2014/15, for a total of 20 companies. Take into account that, aside from maybe 3-4, these companies are all near the beginning of the path of investing $10mm each to achieve operational breakeven over the course of the next 1-2 years. Therefore, we estimate the DESCO sector needs a total of around $200mm in capital to get out of the starting block with about 20 companies.

**$50mm in grant capital and $150mm in high risk venture equity should enable 20 DESCOs to reach operating breakeven:** Assume that the healthy ratio of grants to equity for a business is close to 1:3 until the DESCO has achieved

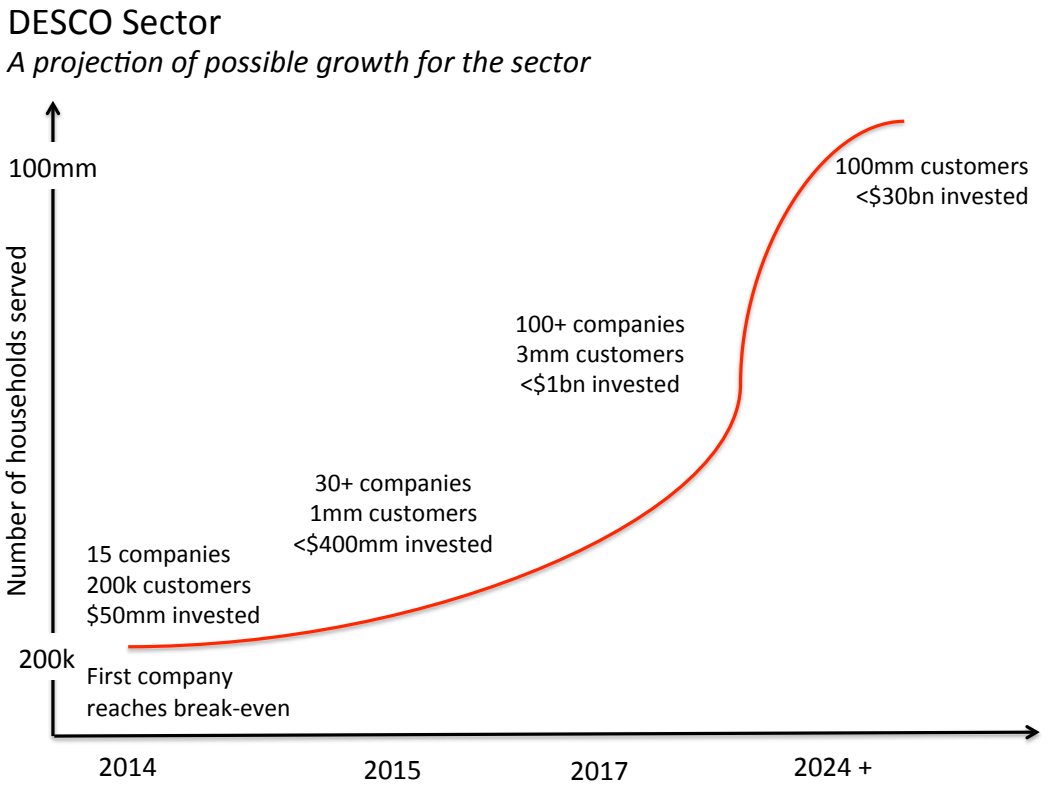
operating breakeven. Given our estimate above that it would take about $10mm for a DESCO to get to this point, we can deduce that such DESCO should have access to $2.5mm in grant capital and $7.5mm in risk-tolerant equity. Put differently, $25mm in grant capital could comfortably seed 10 DESCOs that collectively reach 250,000 households or potentially 1.25mm people after 1-2 years of operation. At that point (assuming venture equity also invests), those DESCOs can cover ongoing operations from their own revenue.

**By 2016, DESCOs collectively have the potential to add 500,000 households to their customer base and would then require an additional $150mm in capital; $100mm of this could come in the form of debt.** Once DESCOs generate stable cash flows from customers, they should be able to attract increasing amounts of debt. Given the interest in the sector and its prerequisite for social and economic development, this may happen even before companies reach operational breakeven. In fact, we see impact oriented crowd-funding platforms such as KIVA (non-profit model) or Sunfunder (for-profit model) providing the first loans already, despite the early stage of the sector. That said, the bulk of debt might only enter the sector 2-3 years from now as more and more companies come closer to profitability. At that point we could imagine DESCOs raising debt at a ratio of 2:1 to equity. If we assume that the sector will start to add around 500,000 customers per year starting in 2016, the need for capital increases to $150mm per year (500,000 households x $300 average investment per household) and we can estimate that the need for debt is around $100mm per year and increasing with the overall growth rate.

**After 2016 the need for capital will depend on the ability of the sector to connect households.** We estimate the cost of a connection to be an average of $300 and we simplify by assuming that the capital need is simply the product of average cost per connection and connections made. We further assume that debt is raised at a ratio of 2:1 to equity once the sector meaningfully begins to scale.

**To reach 100mm households will require a total investment of about $30bn; $20bn in debt and $10bn in equity.** While this is certainly a big number, and 100mm households is only about 30% of the total amount of global off-grid households, it is interesting to consider this amount in the context of sub-Saharan Africa and the mobile phone industry. According to some estimates, the mobile phone industry invested almost twice that amount over the course of just a decade. If nothing else, this goes to show that if there is the belief in a commercial business model – in this case providing phone services – capital is available and will flow fast enough to make a difference.

***Figure 7: Growth projection for the DESCO sector – households served vs. # of companies, time and total capital needs***




The foregoing analysis of capital required is not intended to underemphasize the other significant challenges that DESCOs will face in order to build to scale. These challenges, including building management teams in regions that have a shortage of "human capital" (talented, trained and/or entrepreneurial individuals who can become senior, middle and lower management of DESCOs), poor infrastructure, regulatory barriers and government corruption, will slow many DESCOs and, for some, will be insurmountable, causing businesses to fail.

Our objective is not to underplay the "reality of doing business", but to paint a picture of the scale and types of financial resources that would need to be marshaled for DESCOs to become significant. Otherwise, "transformation" is actually a non-starter.

## 4. So what now? Suggestions for key actors

The sector is in its infancy. To get to where we need to go, entrepreneurs, donors, investors and policy makers need to come together first in understanding the DESCO models potential and then in doing their part in realizing such potential.

**Our suggestions are as follows:**

**To entrepreneurs:** Test your business model against the DESCO characteristics outlined above. The more you match, the better your chances to succeed.

**To financial investors:** Invest in companies that match the profile outlined above. This opportunity is real. Return on equity capital can be higher than 20%. Yes, these are still early days but there is a tendency towards frenzy as soon as the first company in a new sector proves its model. We are already seeing this happen. So don't wait too long on the sidelines or else the opportunity may slip by.

**To strategic investors:** Partner with and invest in DESCOs. The proliferation of mobile phones at base of the pyramid opened a commercial path for many businesses, from banking to, yes, even gaming, to 1bn+ consumers. Given that successful DESCOs will likely develop strong customer relationships and, moreover, have a physical presence in last-mile areas by virtue of their assets and staff being on the ground, this could serve as a channel for all kinds of energy dependent follow-on products. Imagine a new market for 100mm tablet computers, or 500mm LED light bulbs or 20mm 20W super-efficient DC refrigerators.

**To donors, philanthropic investors and non-governmental organizations (NGOs):** Understand the difference between fundamentally profitable business models and those intended to serve portions of the energy poor that are just not financially viable. We are the first to acknowledge that there will always be a portion of those without access to modern energy who cannot be served through market-oriented solutions. These people, like any other people, deserve energy access. The question is how best to intervene, providing appropriate support to two very different economic categories of people. This is simply and necessarily a question of segmentation. If you are consciously aiming to back market-based initiatives, design interventions so as not to subsidize commercially-viable segments of the market (hence spoiling it for commercial scalability, no doubt inadvertently). Support only those businesses that have a potential to be commercial. And help them scale. Here, consider using grants to leverage commercial capital, e.g. by improving its risk/return profile.

**To donors and development finance institutions (DFIs):** Show a higher tolerance for risk. If, given high transaction costs or prohibitive governance structures, you are not set up to make direct investments in smaller, riskier businesses, then consider catalyzing the emergence of a DESCO venture capital (VC) industry. As it has done in other sectors, VC – the combination of early stage equity investment and diligently executed business-building support – will be an important instrument for spurring the sector's development. Be prepared to provide technical assistance (TA) grants to support these deals. And be prepared to see some companies fail. Finally, streamline investment processes - more than 6 months is too long for many young companies to wait; we have seen several struggle, even run the risk of giving up, because of lengthy timeframes to be considered for investment.

**To governments, regulators and development partners that support them:** Re-think energy access.[38] People really do not want kWhs or the grid per se. They want to surf the web, charge their phones, light their homes. While it is certainly not our intention to suggest that two-lights-and-a-charger type services are "enough" and should be the end game, please take into account that Tier 2 of the SE4ALL access scale[39] is sufficient to power a tablet computer and that such a device would connect 1bn people to every last bit of information that is online today. Hence, analyze the extent to which you can realistically afford grid connections over the coming decade; seriously consider making DESCOs part of the connection solution space, for whatever period of time you are comfortable with; communicate this clearly to help buoy the nascent market; and adopt regulatory frameworks that allow DESCOs to expand to fill the gap (by, for example, simplifying micro-utility regulation, removing universal tariffs and enabling business to compete with kerosene prices). We recognize that, as the sector develops, a greater degree of oversight will be important to make sure that it is delivering on promises. But that will take time. So, for now, focus on enabling rather than stifling the potential. And rethink your off-grid financing modalities to make sure that subsidies are not crowding out scalable commercial solutions, benefitting a few at the expense of many.

**To development agencies:** Create and share tools and services, which could benefit everyone, such as (currently publicly available, but prohibitively expensive for start-up DESCOs) satellite imagery and complex GIS maps (electronic maps that link non-geographical data such as census information or economic activity to geographic coordinates). Together with DFIs and philanthropic investors, create lines of credit or dedicated lending instruments, and help training local banks on how to identify bankable DESCOs, so that they begin to provide debt to the sector.

## 5. Conclusion

This thought-piece has largely been written in response to growing interest in the potential for mini-grids to provide a solution to the energy access challenge. Rather than supporting a dogmatic view of specific systems as panacea, we have chosen to take a step back and apply a technology-agnostic, market-oriented lens to the issue.

While we certainly do not claim to have a full recipe for success and, if examined with a fine toothed comb some parts of the analysis contained herein will have flaws, we feel that it is important to use big numbers and make firm statements. This is in equal measure because we believe them, and because we are convinced that it is time to be bold.

[38] See also: *Considering Energy Access,* Muench and Aidun, Persistent Energy Partners (2014).
[39] http://documents.worldbank.org/curated/en/2013/05/17765643/global-tracking-framework-vol-3-3-main-report

Accordingly, we have focused on describing in as great detail as possible a model – the DESCO – that is already in existence and could rapidly further reach a significant portion of the commercially-viable market for a range of electricity-based energy services, and present our view on what it will take for this model to truly flourish.

In so doing, it is our intention to stimulate discussion and deliberation (in fact, we very much welcome this) and our hope that the ideas presented help to concretely advance what has been a very long-standing debate.

What is clear is that unless action is taken, DESCOs – be their businesses based on mini-grid technology or not – will fail to achieve relevant scale, frankly putting at risk the ultimate objective of achieving universal energy access.

**About the authors:**

***Pepukaye Bardouille**, Senior Operations Officer with the International Finance Cooperation (IFC), part of the World Bank Group. As part of the Clean Energy Team, Pepukaye leads much of IFC's global advisory activities on energy access, focusing on innovative, commercially-viable models to base of the pyramid markets; and provides strategic support to the regional advisory portfolio across Africa and Asia, which also includes grid-connected renewables. The views contained herein are her own.*
*pbardouille@ifc.org*

***Dirk Muench**, Co-founder and Managing Partner of Persistent Energy Partners (PEP). PEP invests in,[40] incubates and advises businesses providing clean energy to off-grid households and small businesses in sub-Saharan Africa. The firm's focus is on developing the emerging DESCO sector, but PEP also manages funds with investments in the wider energy access sector. The firm has offices in Accra, Dar es Salaam and New York.*
*dirk.muench@persistentenergypartners.com*

*The authors would like to acknowledge the contributions in content and writing of this article by Chris Aidun (Co-founder and Managing Partner of PEP); business model data input by Anjali Garg, Richa Goyal and Edlira Mita (IFC); and peer review by Dana Rysankova (World Bank) and Bernard Tenenbaum (Consultant to the World Bank); and, all the entrepreneurs that have worked with us, have facilitated visits and shared information about their business models.*

[40] *See a list of PEP's investments at* http://www.persistentenergypartners.com/current-investments/