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THE BOTTOM LINE

Although the payment models offered by off-grid energy companies are less flexible than those implemented with great success by mobile telephone companies, they may still have an important role to play in scaling up off-grid energy services for billions of people who lack access to electricity. More research is needed to assess the importance of flexible payments in attracting reliable low-income customers.

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Scaling Up Access to Electricity: Pay-as-You-Go Plans in Off-Grid Energy Services

Why is this issue important?

Flexible payment plans can make electricity accessible to more people

About 1.2 billion people worldwide lack access to electricity, most of them in rural areas. Many live in areas unlikely to be reached by foreseeable extensions of the grid and will have to obtain their electrical service from an off-grid provider (IEA 2011). Presently, households without electricity spend about $18 billion each year on kerosene and other products that substitute for electricity. Nine out of ten of those households could save by using off-grid electricity instead—if it were available (IFC 2013).

To attract substantial numbers of customers and be able to provide modern energy services to all, off-grid providers must take into account the circumstances of their customers. Because most households in rural areas have low and variable incomes, flexible payment models will be important in making off-grid energy services appealing to customers. By allowing off-grid companies to charge usage fees to recover their costs, so-called smart meters (which allow providers to switch the power supply to individual households on and off) are enabling off-grid providers to invest in the assets they need to expand electricity services. Smart meters also allow flexible consumption of electricity services and thus flexible "pay-as-you-go" payment plans.

Pay-as-you-go models have clear advantages for customers with low or variable income. Instead of regular, fixed payments, customers pay directly for the service they use, often in the form of a package of appliances and the associated power supply—they do not receive any service for which they have not first paid. As a result, payments often can be made in smaller amounts than would otherwise be possible, and customers have greater control over their consumption and thus of their spending. Both features, which mirror the pattern of consumption of nonelectrical energy products, should enable off-grid companies to reach a much broader user base than they could if they were offering constant service under conventional terms. The effectiveness of pay-as-you-go models in reaching low-income customers has been demonstrated by the success of mobile telephony—in fact, their adoption in developing countries has been linked to the spread of mobile telephones (Rouvinen 2004; Kalba 2008; World Bank 2014).

Although small payments (whether flexible or not) are probably just as important as payment flexibility for driving the expansion of off-grid energy, the focus of this note is on the mechanics of flexible payments that allow consumers maximum control over the timing and amount of their expenditures. We examine a sample of pay-as-you-go models presently being used by small-scale providers of electricity, comparing the degree of payment flexibility offered by each provider with the fully flexible models offered by mobile telephone operators. After evaluating energy companies' experiences with these models, we discuss the potential of payment flexibility to drive expansion of off-grid electricity service.[1]

[1] The comparison with mobile telephony is not intended to imply any inherent similarity between the two fields; mobile telephony simply serves as the clearest example of an industry that has implemented pay-as-you-go models with tremendous success.

"Most off-grid energy solutions have relatively high fixed costs that cannot be as easily spread across the user base. Mini-grid customers, for example, require dedicated transformers, power lines, and internal wiring specific to an individual household or small group of households."

How suitable are pay-as-you go models for electricity service?

User-specific costs associated with electricity service may limit the applicability of pay-as-you-go models

Flexible payment for off-grid electricity is a recent phenomenon, and it is not yet clear whether fully flexible options can be offered successfully. To date, pay-as-you-go plans offered by providers of off-grid electricity are less flexible than those offered by mobile phone companies, which may reduce their appeal among low-income customers.

Nevertheless, a growing number of off-grid providers operating mini-grids or offering solar home systems (or other types of individual units) has begun to offer pay-as-you-go options to attract customers with low or irregular incomes. Smart meters that allow a single customer's power unit to be remotely disabled have been a critical technology driver of flexible payment plans. Just as important, however, is better understanding among energy providers of what customers have been paying for substitutes for electricity and thus how much—and in what increments—they might be willing to pay for a cleaner and safer alternative. With this information, providers can also estimate demand for their services.

It is not clear whether energy companies can fully replicate the characteristics of the successful pay-as-you-go models used by mobile telephone operators, in particular the flexibility of customer payments. The pay-as-you-go model, as applied in mobile telephony, offers customers maximum control over the timing and the amount of their payments. Phone owners buy credit to use their phone in an amount of their choosing (with a wide range of available increments), use the phone for that particular amount of minutes or messages, and refill their credit whenever and by however much they want or can afford. Usage requirements are minimal, and purchased credits can be used over long (sometimes indefinite) periods of time. Customers are never required to pay more than they can afford at any given time.

Flexible payments in mobile telephony were made possible by relatively low user-specific costs—that is, the costs occasioned by a specific consumer. The lack of dedicated costs associated with specific customers reduces the need for operators to recover regular payments from each user, as long as the pooled average usage (and the total revenue from the pool) remains relatively stable and sufficient. If some users do not use their phone for a period of time, the fixed costs of transmission towers will be recouped from other users of the bandwidth without creating the need for new infrastructure.

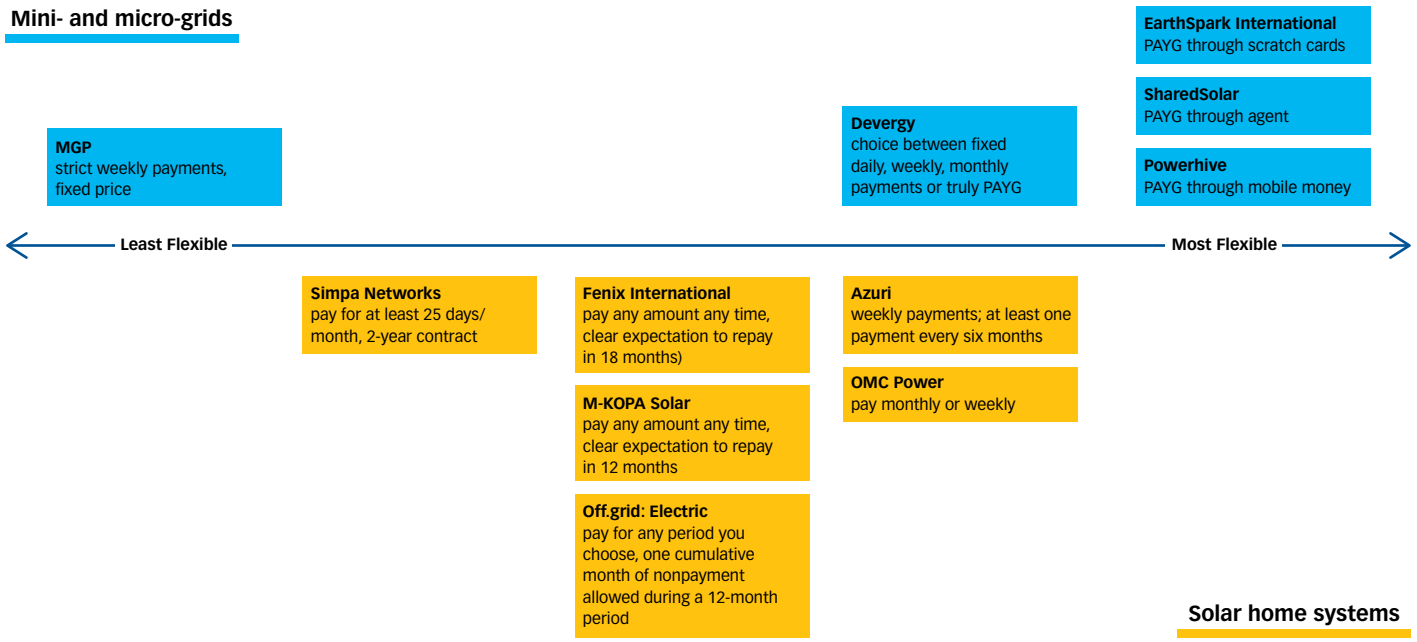
By contrast, most off-grid energy solutions have relatively high fixed costs that cannot be as easily spread across the user base. Mini-grid customers, for example, require dedicated transformers, power lines, and internal wiring specific to an individual household or small group of households. In case of solar home systems or lighting devices, the entire cost of the system is typically specific to the individual user, unless systems can be easily removed and transferred. Providers traditionally have sought to recover those costs from particular users on a regular basis. It would appear, therefore, that the cost structure of electrification technologies might compel operators to insist upon minimum fixed payments or usage requirements, thus limiting the degree of flexibility that could be offered (World Bank 2014). It is not enough, as is the case with mobile telephony, to simply add new customers to compensate for low usage of existing users, because each new user requires a new and substantial investment (connection costs).

How has the industry evolved to date?

The off-grid energy industry sees pay-as-you-go as a promising path to expansion

Interviews with 11 off-grid energy companies suggest that the industry views pay-as-you-go payment models as an important element in scaling up services—and particularly for attracting customers with low and irregular incomes. The companies sampled represent a range of technologies, payment plans, and geographic locations with a focus on Africa, where the energy access gap is the largest and where off-grid solutions are expected to play an important role to close this gap. Of the companies interviewed, 10 use some form of pay-as-you-go plan. The exception, India's Mera Gao Power (MGP), does not yet use smart meters and thus cannot effectively implement pay-as-you-go. MGP was included in the assessment for purposes of comparison and because it might be a candidate

Figure 1. Payment flexibility among 11 off-grid energy companies



"Pay-as-you-go means different things to different companies. Although some (micro- and mini-grids only) offer complete flexibility on when and how much customers can pay, most impose restrictions on the timing and size of payments. Some require customers to make weekly or monthly payments, and in some cases customers must pay a total amount over a predetermined period of time. "

for highly flexible payment plans if it eventually adopts the requisite technology.

Pay-as-you-go means different things to different companies. Although some (micro- and mini-grids only) offer complete flexibility on when and how much customers can pay, most impose restrictions on the timing and size of payments. Some require customers to make weekly or monthly payments, and in some cases customers must pay a total amount over a predetermined period of time. Some companies also limit the amount of energy that a customer can purchase within a particular period. And while almost all of the providers investigated offer more payment flexibility than traditional utility companies, most plans are considerably more constrained than those offered to mobile telephone customers.

Mini- and micro-grids. Of the cases studied, the most flexible payment arrangements were offered by the mini- and micro-grid providers, which did not oblige customers to buy a set number of days of service or a particular amount of energy. EarthSpark, which operates a smart-metered micro-grid in Haiti and has the most flexible model of all those studied, imposes no minimum payment requirements or service use restrictions. Customers can buy electricity credits from a local agent at any time or by using their mobile phone. EarthSpark's smart-meter technology enables the company to quickly shut off a user's electricity supply, yielding a cost structure that approaches that of mobile telephony.

In Africa, customers of SharedSolar purchase account credit in various denominations from a locally appointed vendor. Customers can purchase as much credit as they want, although their energy use is restricted by a maximum power limit and maximum daily consumption limit, both controlled by smart-metering technology.

A mixed model is offered by Devergy, which provides micro-grids in Tanzania and offers users a choice between fixed daily, weekly, or monthly payments, or a true pay-as-you-go model. However, there is a limit to the energy that can be used by each household.

"All of the providers of solar home systems imposed at least some conditions on payments, with most specifying a total payment amount over a given period of time."

MGP in India, which makes electricity from direct-current micro-grids available to the poorest segment of customers, represents the opposite end of the spectrum, expecting customers to make payments every week. The amount of energy that can be purchased is restricted. Each household receives an electricity package that is sufficient to power two light bulbs and a phone charger for seven hours a night. Customers are free to unsubscribe at any time, but they must pay regularly to maintain access to the service.

Solar home systems. The six providers of solar home systems that we examined offer flexible payments for energy systems ranging from individual solar lanterns to large, multi-household PV panels.[2] Their varied business models can be divided into two categories: (i) the lease-to-own model, in which ownership of the system passes to a household once an agreed price is paid; and (ii) a micro-utility model, in which the company provides electricity but retains ownership of the equipment that produces it. Pay-as-you-go plans under both models set fees based on users' consumption. All of the providers of solar home systems imposed at least some conditions on payments, with most specifying a total payment amount over a given period of time. Such a requirement is particularly understandable under the lease-to-own model used by M-KOPA Solar, Simpa Networks, Azuri, and Fenix International, where customer payments are applied toward purchase of the system. Under the lease-to-own model, users must pay enough to cover the cost of the system. In other words, costs are entirely user-specific (unless the unit is transferred to another user, which appears to be rare), and the company cannot recoup losses from one user through the extra usage of another.

Customers of Simpa Networks in India sign two-year contracts. Payments are calculated on a daily basis, and customers are obliged to buy at least 25 days' worth of service every month, though they can choose how they want to distribute their payments over time.

A more flexible model is offered by Fenix International, which asks their customers to pay the full cost of their device over an 18-month period. Once a payment is made for a period of use, the system is unlocked for the prepaid number of days. Customers face no restrictions on how much they must pay at any given time, as long as they pay the required total within 18 months.

Similarly, M-KOPA Solar expects customers to pay the full cost of their system in 12 months, based on daily pricing. Customers can pay any amount they choose at any time. Like Fenix International, M-KOPA offers a grace period to customers who fail to pay for their system within the agreed time.

Simpa Networks, M-KOPA Solar, and Fenix International all have the ability to switch off the device remotely as soon as the prepaid amount is used up, thus incentivizing the user to make the next payment.

A slightly different approach is offered by Off.grid:Electric, which offers solar home systems in Tanzania under the utility business model, never transferring ownership to the end user. Customers are required to pay for at least 11 months of service in any given year, but those 11 months may be split up at the customer's discretion, and payments can be made in any size and at any time. Customers who have not made a payment for a certain time are contacted to see if they have a problem or would like the system removed. If the customer persists in not paying, the system is removed and offered to another household.

Yet another variant is offered by Azuri, which provides solar home systems in East Africa. Azuri does not require any fixed schedule of payments as long as at least one payment is made every six weeks. Service can be purchased in increments of one week or longer. Once the system is paid off, the customer can upgrade to a larger system.

OMC Power rents lanterns and battery boxes to their customers in India. Depleted lanterns are collected for recharge and redistributed to prepaid customers. OMC requires customers to pay a fixed monthly or weekly payment, although they can discontinue service at any time.

The surveyed companies are summarized in table 1.

2 There are important differences between services, but for the purposes of this note they are grouped into a single category as they are all individual household systems.

"All of the companies surveyed are extremely positive about the payment patterns they experienced to date. … What is now required, … is clear evidence of regular payments on a larger scale. Smart-metering could prove useful in amassing such evidence."

Table1. Characteristics of off-grid energy companies interviewed for this note

Company (location, years in operation)	Technology	Business model	Description
EarthSpark International (Haiti; since 2012)	AC micro-grid	Continuous service	Non-profit solar/diesel micro-grid provider in Les Anglais urban area using Sparkmeter technology developed in-house. Small installation fee and top-ups using prepaid scratch cards or mobile phone. www.earthsparkinternational.org
SharedSolar (Senegal, Mali; since 2011)	AC micro-grid	Continuous service	Scalable micro-grid provider using software developed at Earth Institute (Columbia University). Small installation fee. Customers prepay for service at time and in amount of their choosing. As demand grows over time, capacity can be added. sharedsolar.org
MGP (India; founded in 2010)	DC micro-grid	Continuous service	Solar DC micro-grid provider targeting the poorest customers. From a small generation point, MGP provides a fixed amount of electricity: 7 hours per night for two light-bulbs and a phone charger. No smart metering. Payments are collected weekly in cash. meragaopower.com
Powerhive (Kenya; founded in 2011)	AC micro-grid	Continuous service	AC micro-grid provider using a cloud-based software platform (HoneyComb m-Power OS) that tracks and manages power-generating assets, provides real-time data and analytics as well as prepaid billing via mobile money services, enabling remote control of the micro-grid. Several payment plans available, including pay as you go. powerhive.com
Devergy (Tanzania, Ghana; since 2010)	DC micro-grid	Continuous service	Solar DC micro-grid provider aiming to serve basic needs, such as lighting and phone charging. When connecting a new village, Devergy installs solar panels and batteries and a meter in the home or small business (usually one solar tripod for 5–10 houses). Software developed in-house allows for remote monitoring and control of electricity use in each home. Customers top up using prepaid cards. www.devergy.com
M-KOPA Solar (Kenya; established in 2011)	Solar home systems	Lease to own	Asset financing company providing solar home systems for lighting and phone charging, with a more expensive option to power a chargeable radio. Down payment and pay off within 12 months via mobile phone payments. www.m-kopa.com
Simpa Networks (India; founded in 2010)	Solar home systems	Lease to own	Solar PV system provider. Down payment followed by prepaid service, with customers topping up at their discretion via mobile phone. Full payment expected within two years. simpanetworks.com
Azuri (East Africa; founded in 2012)	Technology provider	Lease to own	Provider of solar home systems. Upfront fee followed by installation of solar panels. Customers prepay for service using scratch cards. Upon full payment, the system unlocks permanently, and ownership transfers to customer. www.azuri-technologies.com
Fenix International (Uganda; launched ReadyPay in 2013)	Solar home systems	Lease to own	Solar power system includes a solar panel, smart battery, and a range of lights and phone-charging accessories. Larger kits include radio or TV. Customers pay via mobile phone and receive secure code to unlock access to power until another payment is due. Pay-off expected within 18 months. www.fenixintl.com
OMC Power (India; founded in 2011)	Solar lanterns	Continuous service	Company charges lanterns and power boxes that can run a few lights and appliances. Solar lanterns delivered to paying customers' homes twice a day. Company also operates mini-grid powering mobile phone towers connected by cable. www.omcpower.com
Off.Grid: Electric (Tanzania; founded in 2012)	Solar home systems	Continuous service	Operates like an electricity utility. A small solar system, complete with appliances, is installed in customer's home. Customers prepay weekly for service via mobile phone. Choice of electrical services, from basic lights and mobile charger to radio or TV. Ownership of solar systems remains with company. offgrid-electric.com

"Ultimately, few energy companies can offer payment plans that afford customers complete control over the size and timing of their expenditures. But customers may not require full flexibility."

What have we learned so far?

The degree of payment flexibility offered by off-grid energy providers reflects their circumstances

The pay-as-you go payment plans offered by off-grid energy providers are not as flexible as those that spurred the spread of mobile telephones, possibly because mini-grids and solar home systems nearly always have higher user-specific costs than do mobile phone operators. Instead, companies often limit the degree of payment flexibility they offer based on their individual circumstances and business model.

EarthSpark, which services a densely populated town in Haiti and is able to minimize the user-specific costs of its network, offers the most flexible payment option of the companies we investigated. Most of the lease-to-own providers of solar home systems can offer a good deal of flexibility in the timing of payments as long a specified total payment is made within a set period of time. (The company must be able to predict when it will recover the cost of the asset.) OMC Power, which does not provide an asset to finance, can offer household customers a certain degree of payment flexibility thanks to a power purchase agreement with an anchor customer that guarantees a minimum steady revenue stream. MGP, on the other hand, is severely constrained in the flexibility it can offer because it does not use smart meters and thus cannot switch its customers' power on or off at will. MGP has opted for a DC wiring system, however, which results in much lower user-specific costs than traditional AC wiring; once it moves to smart meters, it will be in a good position to offer very flexible payments.

Ultimately, few energy companies can offer payment plans that afford customers complete control over the size and timing of their expenditures. But customers may not require full flexibility. Unlike in the case of mobile phones, customers do not need to set aside additional funds to purchase the new service, because most are converting existing kerosene expenditures to pay for off-grid electricity. Small payments and some flexibility to account for unforeseen circumstances may be sufficient to attract their interest.

For companies that allow some flexibility in their payment models, a key risk is that they will not be able to ensure a revenue stream that is large and steady enough to attract long-term financing. Proving the security of future cash flows is critical to any capital-intense business, and fully flexible payment models may not be able to guarantee the continuous cash flow that financiers like to see. For flexible payment models to be a viable business option for energy companies, companies must be able to demonstrate a reliable revenue stream that is sufficient to cover their costs, including those specific to individual users.

The emerging experience in this regard is promising. All of the companies surveyed are extremely positive about the payment patterns they experienced to date. All report very low rates of default, and none identified payment recovery as a primary area of concern.

Box 1. Steps to improve the reliability of the customer base

Off-grid energy companies can increase customer reliability through educational marketing, prescreening, customer monitoring, and down payments.

- *Educational marketing.* Customers who understand the benefits of modern energy services (including cost savings over candles or kerosene) are more likely to make the switch from their existing energy sources.
- *Prescreening.* Many providers pre-screen customers for payment risk. Simpa Networks has a rigorous customer screening process that involves an extensive questionnaire and a scoring system. The company is working on a model that will be able to predict good, reliable customers.
- *Customer monitoring.* Technology is enabling companies to analyze individual customers' consumption patterns. Once the sample reaches a significant size and covers a long enough period, companies will be able to hone their ability to identify good customers. Data that provides an understanding of customers' behavior builds confidence in the financial sector.
- *Down payments.* Customers of solar home systems are required to provide a down payment. In the mini-grid business, customers pay an installation fee. Customers who make an upfront payment are making an investment and are more likely to make future payments.

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For example, Simpa Networks estimates that true default (when the customer no longer wants to use the solar home system) occurs in less than one in a hundred cases. Fenix Technologies reports very strong portfolio performance. Azuri, which does not impose a period within which the system must be repaid, nonetheless sees very regular payments. EarthSpark, which has the most flexible payment model of all companies investigated, reports continuous payments from its customers.

Because much of the off-grid industry is new and may have built their initial customer base from those customers most able to pay, it is too early to conclude that companies will be able to reach significant numbers of new low-income customers without increasing the flexibility of their payment models. One of the key benefits of flexible payment models in mobile telephony is that new customers can try the service at very little cost, and many who might otherwise not have qualified (or not have considered a large expenditure on an unknown service) became reliable customers. By contrast, some of the steps that energy companies are using to increase the reliability of payments—particularly the prescreening of customers (box 1)—may exclude the very low-income users that flexible payments were designed to attract.

If customers do continue to sign up and make regular payments, however, energy service providers will be able to demonstrate their viability. What is now required, in order to secure long-term financing at competitive rates, is clear evidence of regular payments on a larger scale. Smart-metering could prove useful in amassing such evidence, as many off-grid companies maintain detailed records of customer usage and payments that could be analyzed to assess payment reliability for different technologies and business models. This is a rich topic for future investigation.

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