Miller Center
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CLOSING THE CIRCUIT

Accelerating Clean Energy Investment in India

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EXECUTIVE SUMMARY

Despite recent progress in extending the grid in India, approximately 300 million people still lack access to electricity. As shown in recent studies by Miller Center for Social Entrepreneurship[1] and GOGLA[2], access to electricity improves quality of life in many ways. Private energy enterprises can play an important role in providing affordable, reliable clean energy to the people who need it. However, these enterprises require both the knowledge and resources to develop financially viable clean energy business models. This is particularly challenging in places like India, where capital is scarce.

The Energy Access India (EAI) program, funded by USAID from 2015 to 2018, was designed to close the circuit between clean energy enterprises and investors[3] by providing access to knowledge and mentorship able to increase enterprises' investor readiness so that more capital can flow to these enterprises.

Researchers from the William Davidson Institute at the University of Michigan and Miller Center for Social Entrepreneurship at Santa Clara University studied the challenges and lessons learned from the perspectives of both enterprises and investors engaged in the program.

Based on the researchers' findings, this report:

- Analyzes the business models and strategies that EAI portfolio companies implemented
- Identifies commonalities in the trajectory that many enterprises followed as they evolved
- Identifies barriers and opportunities for investment in clean energy enterprises in India
- Provides actionable recommendations for enterprises and investors to influence the development of the overall clean energy industry

The enterprises in the EAI portfolio aim to be financially sustainable. If profitable opportunities are identified, such as in commercial and industrial rooftop solar installations, the commercial capital needed to realize those opportunities can be made available. Whether this can be achieved for any or all of the enterprises in the portfolio is not yet clear. As a result, much of the paper focuses on the grants, subsidies, and concessional capital that enterprises require to reduce this uncertainty.

In the absence of obviously profitable investments, matching the right concessional capital to the right entrepreneurial business models and enterprises is important to achieve the broader goal of increasing energy access throughout India, and beyond. Our hope is that this paper can help aggregate the collective experiences of the EAI portfolio companies, the investors engaged through the program, and the program team to highlight opportunities for greater alignment between enterprises and investors.

In so doing, the ultimate goal is to help connect enterprises providing clean energy with those that seek to support them—thereby increasing access to energy and improving the livelihoods of millions of India's poorest people.

INTRODUCTION

In addition to the 300 million people in India who lack access to electricity, 100 million more have access for less than four hours per day[4]. Together, these energy-poor Indians account for almost one-third of the entire global population that lacks access to electricity[5].

The United Nations' Sustainable Development Goal #7 (SDG7) aspires to "ensure access to affordable, reliable, sustainable, and modern energy for all"[6] by 2030. In India, the most visible progress in addressing energy poverty is in connecting greater numbers of people to electricity grids. However, even if the grid is present, it may not provide the reliability or quality of energy access that consumers demand. Off-grid solutions will therefore play a major role in providing access to usable energy, particularly for low-income communities[7]—which are predominantly rural[8] and where lack of energy access is greatest[9]. It is estimated that almost one-half of all new global energy access connections made through 2030 will be provided by off-grid or mini-grid systems, requiring investment of over US $275 billion[10]. Access to clean, reliable sources of energy can have a broader transformative effect on development through positive impacts on health, education, and economic development[11], in particular women's economic empowerment[12].

The technology exists to provide access to energy, either via grid connections, distributed renewable energy, or both; however, financially viable business models do not exist. A viable business model in emerging markets must be able to address challenges of financial and human capital constraints. In addition to building a viable business, many enterprises in emerging markets also participate in building the market environment in which they will operate—requiring a diverse set of partners across public and private sectors[13]. There have been many efforts to address these challenges. While few of these efforts have succeeded, they have provided some important lessons. Sharing these lessons will increase the probability of future success.

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To help energy enterprises in India address these constraints, USAID funded the Energy Access India (EAI) program. Operating from 2015 to 2018, the program was implemented by Miller Center for Social Entrepreneurship and New Ventures India. The program supported enterprises that aimed to increase access to energy for base of the pyramid (BoP) populations through commercially viable business models.

The EAI program matched enterprises with mentors able to provide technical assistance, coaching, and guidance. To help provide the enterprises with greater access to capital, the program also engaged with investors operating in India and that were focused on the clean energy industry. The findings discussed in this paper are the result of a series of interviews with a selection of enterprises participating in the EAI program, as well as with investors and other organizations assisting them. Organizations and individuals that participated in these interviews are recognized at the end of the paper.

ENERGY ACCESS IN INDIA

Despite the fact that so many people in India still lack access to energy, the Government of India announced in April 2018[14] that it had achieved 100% village electrification across the country. This contradiction is because 'electrification' is defined to mean that just 10% of the households in a village have access to electricity—while also ensuring that public places have electricity on demand and that basic infrastructure exists within the boundary of the village[15]. By this definition, 100% of Indian villages may, indeed, be electrified. However, the existence of grid infrastructure at the last mile doesn't necessarily equate to universal access. In practical terms, increasing access to energy for BoP populations means bringing this energy infrastructure to the last few feet: into homes, businesses, and fields. Whether or not a promise of grid extension materializes, the mere expectation can slow adoption of alternative solutions.

Typically, grid connections provide the most affordable option, and it may be difficult for private off-grid solutions to compete solely on price. Some enterprises have addressed affordability through pay-as-you-go (PAYGO) models that allow consumers the flexibility to pay for energy when they have cash available. One of the key differences from the off-grid solar market in India and some other regions, notably sub-Saharan Africa, is the relatively low penetration of PAYGO models in India. PAYGO models received 85% of all off-grid financing globally during the period 2012-2017, but only 2% of global unit sales via PAYGO models occur in Asia[16]. This may partly be due to the limited use of mobile money in India compared to other regions and the continued reliance on microfinance institutions (MFIs) for consumer financing solutions[17].

Additionally, energy access is not a binary state. Households do not move from lack of access to energy to having access in one step[18]. Energy access is a continuum with a number of attributes (See **Table 1**) that may not be satisfied by the mere presence of a physical connection. Different customer segments and communities will value specific attributes of energy access differently—maybe prioritizing reliability, quality, or hours of energy access more highly than price. This diversity of priorities creates a wide opportunity space for private enterprises to develop compelling value propositions that meet the needs of these populations, including the necessary levels of after-sales support and customer service that customers demand. These value propositions can continue to act as differentiated selling points for energy enterprises in India, despite the extension of the grid to most of the country.

Table 1: Attributes of Energy Access

ATTRIBUTE	DESCRIPTION
Capacity	The ability of a system to provide sufficient power to satisfy the desired applications in terms of watts or watt hours.
Duration and Availability	The amount of time energy is available.
Reliability	The degree of unscheduled interruptions in supply.
Quality	Whether the supply of energy stays within expected voltage ranges or provides the expected thermal or kinetic outputs.
Affordability	The cost of energy compared to the perceived utility created by its consumption.
Legality	Whether power is accessed through legal means thus providing more dependability and avoiding the risk of punishment.
Convenience	The time and effort required to source and maintain the supply of energy.
Health and Safety	The degree to which accessing energy may risk the health or safety of users.

based on Bhatia & Angelou (2015)

In many cases, private enterprise solutions can coexist with grid power access at the village level, and even at the individual household level. This concept of 'stacking' energy sources is not unusual in BoP markets, where consumers may rely on numerous sources of energy concurrently to optimize different attributes. For example[19], households that are grid connected often still use kerosene for indoor lighting. While the quality of lighting from the grid or solar is considered superior, the unreliability of the grid, coupled with the ease of access and affordability of kerosene, means that kerosene is preferred for indoor lighting. On the other hand, grid lighting is used more consistently in cases where high-quality lighting is required for outdoor tasks.

ENERGY ACCESS & POVERTY ALLEVIATION

The BoP describes the approximately 4 billion poorest people on the planet. This segment is defined as those earning less than US $3,000 per year in purchasing power parity (PPP) and represents a global consumer market worth over US $5 trillion PPP. The BoP in India includes more than 95% of the country's population and represents an annual market of over US $1.2 trillion PPP[20]. While sometimes described as a single population segment, in terms of consumer preferences and demands the BoP is heterogeneous, with significant differences in context between consumer segments[21]. Understanding these differences in context and identifying what these consumers value requires co-creating innovations with the BoP rather than designing solutions for them[22].

The BoP isn't defined just by limited income. People at the BoP transact primarily in the informal economy and are often unable to access the formal economy or benefit from its institutions and infrastructure[23]. As a result, they have unmet needs, rely on informal markets, and pay a penalty for the inefficiency of these markets[24]. Despite their exclusion from formal markets, BoP consumers are no less discerning as consumers than those further up the pyramid. In fact, given the constraints they are under, they may be more demanding that the products and services they spend their money on deliver real value[25].

While ensuring affordability is a key consideration in BoP markets, poverty is a multi-dimensional phenomenon that is characterized not just by a lack of economic well-being (income), but also by a lack of capability well-being[26] (health, self-efficacy) and relationship well-being (within family, community, environment)[27]. Energy enterprises that develop value propositions based on attributes other than affordability, such as reliability or quality, also have a poverty alleviation impact by addressing these multiple dimensions.

For example, a high-quality source of energy may have positive impacts on economic well-being when put to productive use, such as enabling farmers to add value to their crops through processing. Access to reliable energy that allows students to study more may have positive impacts on that student's capabilities and result in improved choice and future opportunity in the labor market. Access to appliances that improve convenience, safety, and quality of life, such as refrigerators or mobile phone charging, can improve people's capacity to generate income, reduce stress, and improve relationship well-being within family units.

When defining energy access, Bhatia & Angelou (2015) make the distinction between usability and use. While energy may be usable and provide the potential to do work, it doesn't result in any change to well-being without application. Therefore, an important part of ensuring energy access is to ensure the demand for energy and the means by which it can improve well-being.

The Energy Access India Program

The EAI program ran from 2015 to 2018 as an initiative to address the constraints faced by clean energy enterprises serving the BoP in India. The program provided acceleration services and investment facilitation support to a portfolio of 30 social enterprises well positioned to create commercially viable, scalable access to energy. The project was funded by USAID and implemented by Miller Center for Social Entrepreneurship and New Ventures India. Profiles of all participating enterprises are provided in Appendix A.

The EAI program addressed the lack of managerial and technical skills through mentoring support shaped by Miller Center's Global Social Benefit Institute (GSBI®) methodology and carefully tailored to the needs of each of these high-potential clean energy entrepreneurs. Mentoring engagements began with in-depth business audits conducted by New Ventures India that produced customized mentoring plans. Depending on the audit results, one of three paths was selected:

- Early-stage companies were mentored through Miller Center's GSBI Online program, which provides 6 months of virtual mentoring to prepare a business plan and growth model to use as tools for raising investment amounts (often grants) in the range of US $50,000 to US $250,000.

- Growth-stage companies that were seeking in-depth mentoring engagements across all aspects of the enterprise were assigned a Miller Center mentor who worked with the New Ventures team to provide both virtual and on-site mentoring, preparing a business plan and financial model. These enterprises were raising investments of US $250,000 to US $2 million.

- Other growth-stage companies with more specific mentoring needs that were more limited in scope and focused on funding facilitation were provided on-demand support from both the New Ventures and Miller Center teams as appropriate. These companies targeted raising funding ranging from US $2 million to US $20 million.

In addition to working with the 30 portfolio companies, the program also built relationships with over 30 investors in the Indian clean energy industry, including equity investors, debt providers, and grant-making organizations. The project team sought to understand investors' areas of interest and identify issues that would be barriers to investment. The program then worked to address those issues and facilitate connections between these investors and the clean energy entrepreneurs, including setting up pitch sessions and individual meetings. Different strategies were employed for each capital type:

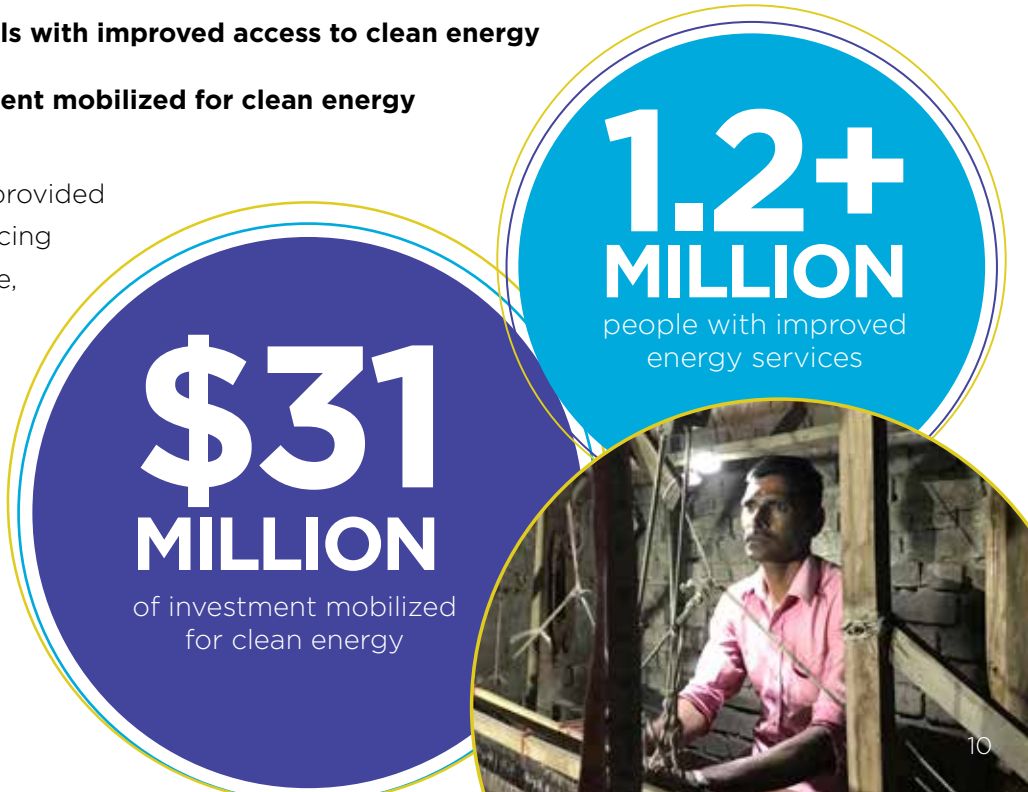
- **Grants and competitions:** New Ventures and Miller Center identified potential sources of grants and awards, then supported the entrepreneurs in the application process.
- **Debt:** The New Ventures team built relationships with top non-bank finance companies and created a standard application form that the portfolio companies could use to seek debt investment. By having trust and deep knowledge of both the entrepreneurs and the finance companies, the program was able to help entrepreneurs use debt to grow their businesses and to speed the process of sanctioning the loans.
- **Equity:** The program identified impact investors in India and globally that were actively investing in the types of companies in the portfolio. As needed, the program team provided curated recommendations, preparation, and review of investor collateral, support during negotiations, reference checks and advice to investors, and other advisory dialog with entrepreneurs.

The focus of the program was on clean energy entrepreneurs serving BoP populations in India[28] with a priority on the states with the greatest energy access challenges. Preference was given to those entrepreneurs who had already demonstrated operational success and impact. Also included in the portfolio were other enterprises that demonstrated latent potential and the ability to scale quickly when matched with the appropriate mentorship support and financing.

Success over the life of the project was measured via the growth of the portfolio enterprises, as demonstrated by:[29]

- **More than 1.2 million individuals with improved access to clean energy**
- **Over US $31 million of investment mobilized for clean energy**

These short-term achievements provided only a small contribution to reducing the overall un-electrification figure, but they offer a significant learning opportunity to help India and its leaders gain the confidence to align low-carbon and developmental goals. The work done with each portfolio company was designed to strengthen its ability to grow long after the EAI program.



Challenges Faced by Energy Enterprises in India

WORKING CAPITAL

Access to sufficient working capital at affordable rates is a key constraint for enterprises in the EAI portfolio. Access to working capital is particularly critical when implementing government tenders, which typically don't provide any payment until the end of the project.

Few providers of low-cost debt exist in the Indian market that can help overcome this constraint. While the government designates renewable energy as a priority lending sector, this priority doesn't translate to the local bank branch level, where understanding of the industry, business models, and project risk can be limited. Therefore, debt remains expensive, often requires substantial collateral, and may not be structured to match the payback period of the project.

Managing working capital is therefore a key capability for EAI enterprises. In some cases, working capital constraints have influenced major strategy decisions about which markets to target. For example, while the solar pump market has been attractive for a number of

years, Argo Solar (**www.argosolar.in**) decided that the working capital requirements of engaging in the government tendering process were too onerous and focused instead on the on-grid rooftop market. Recently, however, with the support of the EAI program, the company has gained access to a working capital facility that enabled it to compete in the solar pump market.

Some local debt providers have recognized these limitations in debt availability and are offering solutions that better match enterprises' real-world operating contexts. For example, they might base lending decisions on project cashflows rather than collateral and securing loans with assets developed by the project. This limited debt availability has also motivated some enterprises to explore off-balance-sheet financing options, where the liability is held by a separate financing partner. These more flexible options may be of even greater importance in the future as customers increasingly consider service contracts for rooftop solar that don't require them to take on the burden of capital expenditure on infrastructure.

CONSUMER FINANCING

Affordability of products is an important consideration across the spectrum of EAI enterprises, whether enterprises are increasing access for BoP populations through off-grid solutions or targeting on-grid rooftop clients further up the economic pyramid.

While early adopters of these systems may have been willing and able to directly purchase them, consumer financing is becoming a necessary component of successful business models. Many of the enterprises in the EAI portfolio have developed consumer financing schemes to enable customers to pay for their products. Some enterprises offer consumer financing facilities directly and can generate additional revenues from offering this service. However, doing so requires developing an entirely new set of capabilities to manage the associated financing, tools to mitigate risk, payment collection from customers, and asset recovery in the event of default. In essence, some of these enterprises are becoming much like MFIs and are seeking to learn from the experiences of MFIs to develop more robust approaches to this aspect of the business.

In other cases, enterprises seek to work with financing partners or to connect customers directly with sources of financing. These sources are becoming more common as banks and other financial institutions gain experience with the clean energy industry. Still, enterprises must work closely with these financial institutions to help them better understand both the technical and socioeconomic contexts and to sanction loans to clients. These partnerships lessen the enterprise's risk exposure. Enterprises no longer underwrite the financing that customers use to purchase their products, and they need not develop the associated organizational capabilities.

GOVERNMENT SUBSIDIES

Government involvement has both positive and negative implications for the market; however, uncertainty in how and when the government would intervene was a constraint faced by many of the enterprises interviewed for this research.

Low uptake of off-grid solar energy has resulted in a complex system of subsidies and incentive programs in India, at both the state and national levels. For example, the Government of India has committed to providing financial support for 2.75 million solar pumps in both on-grid and off-grid areas. But these subsidies can also undermine markets by reducing consumers' willingness to pay. For companies operating in off-grid areas, the availability of heavily subsidized electricity to farmers, for example, makes it difficult to convince people that electricity is something that should be paid for. Subsidized kerosene has the effect of anchoring consumers' perceptions of what energy should cost and creating the expectation that renewable technologies will deliver high-quality access to energy at kerosene prices. This perception ends up delaying consumers' decisions to adopt newer technologies.

POLICY UNCERTAINTY

While a number of policies and government programs support greater uptake of renewable technologies, some uncertainty remains around how the policy landscape might shift in the future. For example, the lack of a national mini-grid policy limits investment in these solutions because it's not clear how mini-grid operators will be treated when the government grid is extended into areas that they already serve. It's also not clear whether these enterprises will be allowed to provide power to the grid under these circumstances and, if so, at what rate—or even if they will be allowed to continue operating an independent parallel infrastructure. Some enterprises in the EAI portfolio have decided to avoid the mini-grid market for these reasons, while others are operating in very remote areas where the prospect of a reliable, high-quality grid connection is unlikely to become a viable alternative for some time, if ever.

Uncertainty regarding grid extension also presents a challenge for these enterprises because it can be perceived as a threat to the viability of the enterprise's business model. This might be less of a risk than some investors realize—if enterprises can develop compelling value propositions for energy access that are based on attributes other than price.

This uncertainty, however, also influences potential consumers. If consumers believe that the grid will reach their village 'soon' and that it will provide highly reliable and cost-effective power, they are less likely to see value in private-sector alternatives. Particularly in election years, the promises made by politicians about improvements in energy access, even if these promises never materialize, can delay consumers' decisions to adopt off-grid alternatives.

TALENT & ORGANIZATIONAL DEVELOPMENT

Talent—i.e., people—tends to be an extremely constrained resource for many enterprises operating in BoP markets. While many other constraints can be addressed through access to capital, that's not always true of talent. Many of the enterprises included in this study cited talent as both a constraint and a key driver of performance of the business. As enterprises seek to grow, they will need to attract, onboard, train, manage, and retain larger numbers of employees, both at the head office level and in the field.

In addition to ensuring they have the right skills and experience at different stages of development, enterprises will also need to ensure they have the right processes and structures. While enterprises are experimenting with new customer value propositions, their decision-making processes must be adaptive and focused on learning. Enterprises might experiment with numerous variations before identifying a compelling value proposition and customer segments. The goal of this type of decision-making is to reduce uncertainty about the product or service and the market the enterprise is operating within[30]. Developing the business model to deliver this value proposition at the BoP often requires an iterative experimental approach, given the lack of business infrastructure, partners, and predictability in the policy and regulatory environment.

A number of the enterprises in the EAI study are starting to move beyond this initial stage of identification and refinement of their value propositions and customer segments. This requires a leadership team that is able to evolve to a different form of decision-making, placing greater emphasis on predictability of results[31]. These enterprises can now focus on preparing for scale through the development of processes and systems that support their client acquisition and sales processes, management of partnerships, management of inventory, and resources for project implementation, etc.

It's important for enterprises to recognize these transition points as early as possible and develop or recruit the necessary talent, because they can easily disrupt the culture of the organization. These transitions can also require large investments, and they may pay dividends only when a certain level of scale has been reached. Managing these transitions is crucial for these enterprises as they move through different stages of growth of the organization and respond to shifts in the market[32].

MANAGING VARIATIONS

Enterprises in the EAI portfolio operate across multiple geographies, policy contexts, customer segments, and business lines. These variations bring trade-offs in efficiency as it becomes more difficult to standardize and lower costs. Particularly in off-grid scenarios, enterprises need to be adept at developing relationships with new communities, tailoring the design and operation of distributed energy systems to the needs of these communities. Many enterprises in the EAI portfolio manage this challenge by developing processes and systems to standardize as much as possible, such as offering a consistent value proposition across multiple geographies or customer segments. Implementing these systems is particularly challenging across various geographies in India, because contexts, policies, cost, and availability of inputs can vary widely in different states.

Variations in sales and marketing processes in business-to-consumer (B2C), business-to-business (B2B), and business-to-government (B2G) approaches present additional challenges for enterprises operating across these contexts. Time required for sales cycles can vary widely. In the case of government tendering, for example, enterprises must display a different set of skills and resources than when they sell to the private sector or directly to consumers.

Some enterprises overcome these variations in sales process and execution by working with channel partners that are focused on more narrow geographic regions. These channel partners might be distribution networks or implementation partners in other states or regions that have a better understanding of the local factors influencing implementation costs and schedules and achieve profitability by keeping overheads low and selling a wide range of products.

Evolving Value Propositions

Almost all the enterprises in the EAI portfolio have gone through multiple evolutions of their business models in the course of addressing the challenges outlined above. In some cases, these evolutions are responses to changes in market demand, with consumers moving up the energy ladder—for example, moving from pico-products such as solar lanterns to solar home systems. Once demand for lighting, mobile phone charging, and similar usage is satisfied, customers begin looking for solutions to satisfy greater needs, including productive loads that help directly increase their economic productivity. In other cases, evolutions in enterprise strategy may be responses to changing policies that impact market opportunities, or gaps that are encountered across the value chain.

Our analysis identified three distinct phases that enterprises undergo: **early focus, vertical integration,** and **specialization**. These phases may involve different strategies, skills, and resource requirements. While not every enterprise will go through all three phases, when investors and other organizations consider how to support these enterprises, it is helpful to understand where an individual enterprise is in this evolution and the current state of the industry around it. While the decision to specialize or vertically integrate is different for every enterprise, those operating in BoP markets often have no choice but to go through this evolution as it is often required to catalyze nascent industries[33].

EARLY FOCUS

Initially, enterprises that have developed a compelling value proposition may have found latent demand[34] from innovators and early adopters. The enterprise provides the solution these customers were looking for at a price that they were willing and able to pay. However, the innovator and early adopter market is small, and growing beyond this initial customer base may require a more complete value proposition that includes consumer financing, installation, after-sales service, etc.

VERTICAL INTEGRATION

BoP-market environments are typically underdeveloped, and partners may not exist to provide the additional components of a value proposition that an enterprise needs to appeal to a wider customer base. Because the market size is limited, the assets required to provide such inputs or supporting services are often highly specific or tailored to a limited context[35]. This means it is often more economical for an enterprise to invest in these assets themselves and provide inputs or services in-house[36]. While such vertical integration may be feasible at a small scale, it is difficult for a single enterprise to optimize on all fronts to the extent that is necessary to be efficient at scale. Each component of the customer value proposition may require different skills, resources, and organizational structure, and each may scale at a different rate.

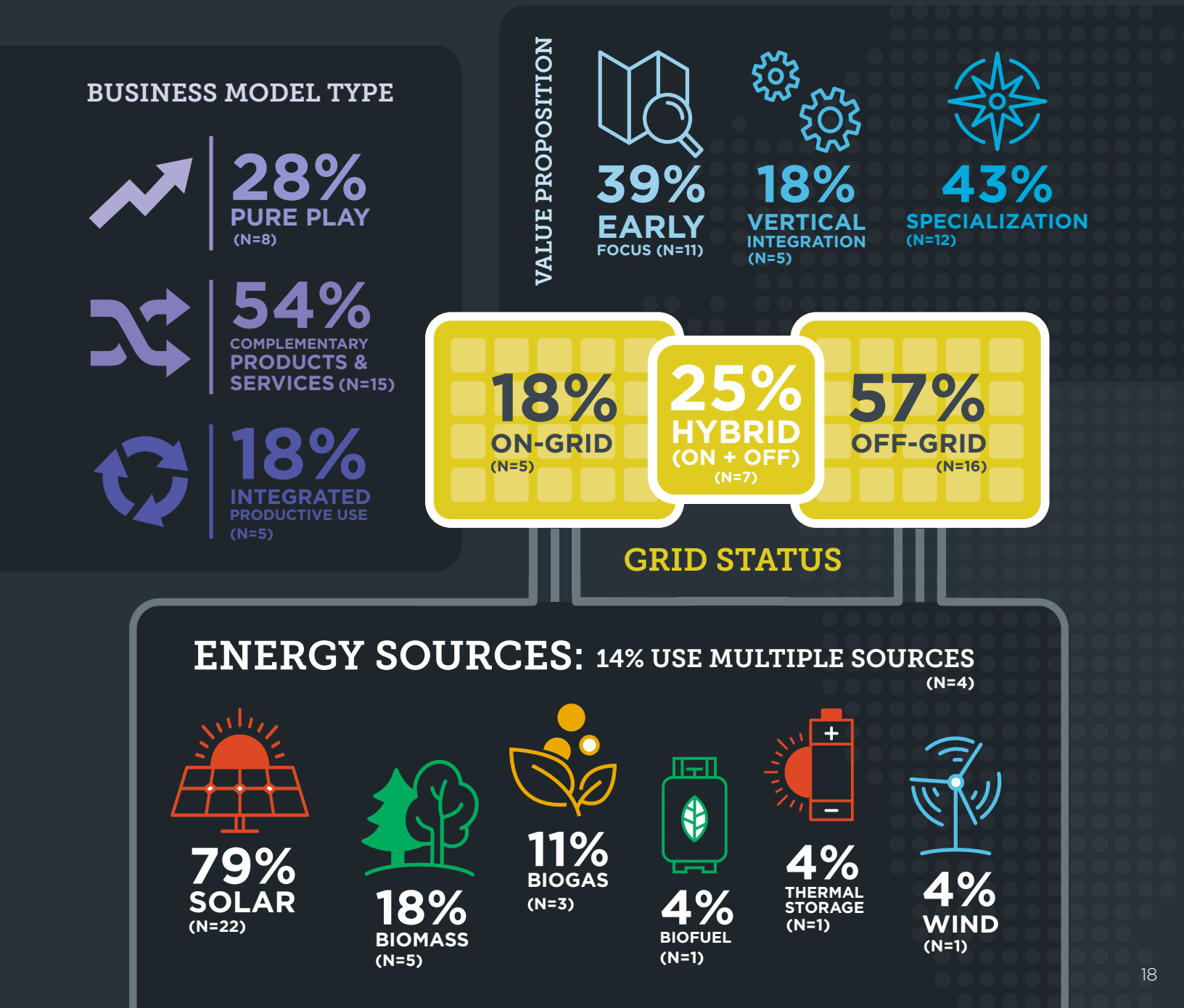
SPECIALIZATION

As these enterprises continue to grow, and the industries they operate within develop, the size of the market for inputs or supporting services may grow. The assets that provide these inputs and services become less specific and applicable to a greater number of potential buyers. This increases the likelihood that a new entrant can specialize in providing these inputs or services as a stand-alone business. The availability of such potential partners provides opportunities for existing enterprises to contract out functions that can be provided by a third party at lower cost and focus on what they do best. This may not necessarily mean a return to the enterprise's original focus.

For example, Simpa Networks (**www.simpanetworks.com**) began as a provider of solar home systems in 2013. As it was building out its distribution network, in parallel it began developing a consumer financing facility to enable customers to pay for these systems, along with a catalog of household appliances. In the process of developing this business model, Simpa has become an expert in understanding local customer requirements and developing packages of technology that meet these requirements. Simpa is currently focused on optimizing and scaling through replicating its model across India. This strategy aims to ultimately create a comparative advantage for Simpa that positions itself as a leading distributor of household appliances to the last mile across the country, regardless of how individual households access energy.

EAI PORTFOLIO APPROACHES

The EAI portfolio features a diverse set of enterprises, and the various business models that these enterprises implement arise from the evolutionary process described above. However, in analyzing the portfolio, we identified three main business model archetypes that cut across geographies and technologies. These archetypes[37] have distinct strategies for growth while also requiring different capabilities and resources. Enterprise success depends on many factors both internal and external to the enterprise, and there are no templates for success. Still, these archetypes may provide useful patterns for enterprises seeking to enter the clean energy market in India. While a single enterprise may have elements of more than one of these archetypes, typically one dominates.



COMPANY NAME	BUSINESS MODEL TYPE	VALUE PROPOSITION	ENERGY SOURCE	ON-GRID	OFF-GRID
Aga Khan Foundation	Complementary Products & Services	Early Focus	Solar		✓
Argo	Pure Play	Specialization	Solar	✓	
Avani Bioenergy	Complementary Products & Services	Specialization	Biomass	✓	
Cygni Energy Private Limited	Complementary Products & Services	Specialization	Solar	✓	✓
Cleanstar	Complementary Products & Services	Early Focus	Biofuel		
Dev Nrgee Resource Pvt. Ltd.	Integrated Productive Use	Vertical Integration	Solar	✓	✓
Ecozen Solutions Ltd.	Integrated Productive Use	Specialization	Solar		✓
E-Hands	Pure Play	Vertical Integration	Solar, Wind	✓	✓
ECCO	Complementary Products & Services	Vertical Integration	Solar		✓
Freyr	Pure Play	Specialization	Solar	✓	✓
Frontier Markets Consulting Pvt. Ltd.	Complementary Products & Services	Specialization	Solar		✓
Grass Roots Energy Inc / Emergence Bio	Complementary Products & Services	Early Focus	Biogas, Biomass, Solar		✓
G.R.I.D. (Grassroots & Rural Innovative Development Private Limited)	Complementary Products & Services	Early Focus	Solar	✓	✓
Husk Power Systems	Pure Play	Vertical Integration	Solar, Biomass		✓
Inficold India	Integrated Productive Use	Early Focus	Thermal Storage	✓	
Mangaal Sustainable Solutions	Complementary Products & Services	Specialization	Solar		✓
Mera Gao Power	Pure Play	Specialization	Solar		✓
Mlinda	Integrated Productive Use	Specialization	Solar		✓
New Leaf Dynamic Technologies	Integrated Productive Use	Early Focus	Biomass		✓
Onergy	Complementary Products & Services	Vertical Integration	Solar	✓	✓
Oorja Development Solutions	Pure Play	Early Focus	Solar, Biomass		✓
Piconergy	Complementary Products & Services	Early Focus	Solar		✓
Sistema Biobolsa	Complementary Products & Services	Specialization	Biogas		✓
Simpa Networks	Complementary Products & Services	Specialization	Solar	✓	✓
SPRE	Complementary Products & Services	Early Focus	Biogas		✓
SunMoksha	Complementary Products & Services	Early Focus	Solar		✓
Sunvest	Pure Play	Early Focus	Solar	✓	
Veddis / Gosolgen	Pure Play	Specialization	Solar	✓	

PURE PLAY

These models include on-grid rooftop solar solutions and off-grid solar home systems and solar pumps. Rooftop customers are often industrial or commercial users that pay higher tariffs for grid electricity; as such, the business case for solar rooftop installations is strong. A number of these enterprises leverage economies of scale from their rooftop solar business to also operate competitively in the solar pump market, which is experiencing significant growth due to government tendering.

These markets are often low-margin, highly competitive, and therefore cost-driven, with cost savings arising largely from economies of scale. Enterprises in these markets must focus on standardization, cost reduction, and boosting volume, making the number of installations or total installed capacity key. While increases in volume in underserved markets such as the clean energy market in India may come primarily from geographic expansion, acquisition could become a more viable future strategy as the market develops.

For example, Argo Solar (**www.argosolar.in**), established in 2013, provides solar rooftop and solar pumping solutions using both OpEx and CapEx models. Under the OpEx model the system remains the property of Argo, which is responsible for maintenance and upkeep. The customer agrees to purchase power at a set rate for a set period of time. Under the CapEx model the system is sold to the customer outright and it is the customer that incurs any future maintenance and upkeep costs. Customers include educational institutions, hospitals, hotels, warehouses, and the state or central government. Solar pumping solutions are sold mostly with government tenders. The company partners with State Bank of India and Siemens Finance, a non-banking financial company (NBFC) for end-customer financing. The OpEx projects are financed through third-party investors such as ReNew Power.

While PAYGO models have yet to see significant growth in India, increasing use of digital financial payments across the country may cause this to change in the near future. PAYGO models allow customers to pay for energy when they have cash available and represent a significant opportunity for pure play businesses to attract high volumes of customers and leverage technology to efficiently manage these customers.

COMPLEMENTARY PRODUCTS AND SERVICES

Another set of enterprises operates businesses where electricity generation alone is insufficient to ensure commercial viability, often due to limited demand, low willingness to pay, or both. To generate additional revenue streams, these businesses provide complementary products and services that generate additional revenue.

Complementarity can come from providing services such as consumer financing, which generates revenue through interest charged while also lowering barriers to purchasing the financed product. In other cases, additional revenue may come from by-products of energy production, for example residues from biogas production that are used as agricultural fertilizer. Other products may be developed through knowledge of and prior investment in production or consumer sales channels, such as selling solar home systems along with a range of complementary household appliances.

In all of these cases, cost reductions are driven by economies of scope—meaning that the cost of producing and/or selling one product is reduced because the enterprise is already producing and/or selling another similar or complementary product. These models aim to grow by increasing the number of sales within a given addressable market, which could be by selling more products to existing customers or developing value propositions that appeal to different customer segments. Success in these business models depends on having the range of experience and skills to develop new products and new markets.

For example, Grass Roots Energy Incorporated (GRE) (**www.grassrootsenergy.co**) develops, installs, owns, and operates biogas solutions for supplying 24x7 electricity that replaces expensive battery or diesel backup of existing solar microgrids. GRE utilizes biogas or biomass waste-to-energy generating systems along with an external combustion engine called a micro-CHP (combined heat and power). The company is able to generate electricity from the micro-CHP along with waste heat that can be used in dehydration processes. The residue from generating biogas is supplemented with additional nutrients and packaged as a retail fertilizer in both dry and liquid forms.

INTEGRATED PRODUCTIVE USE

A third set of enterprises focuses on packaging the generation of electricity along with activities that increase demand for energy. By delivering solutions that put that energy to productive use, these models increase their customers' ability to pay through additional direct income generation.

While increasing household energy access has important impacts, including economic impacts due to additional working hours, or improvements in health and well-being, enterprises in the Integrated Productive Use category are deeply involved in the development of economic opportunities that arise from greater access to energy. In these models the cost of customer acquisition can be high as a result of the investment required in these activities. For example, businesses can provide refrigerated storage solutions for agricultural produce along with a renewable energy supply to keep it running, but the economic effects will only be realized if market linkages are also created to connect farmers with buyers of that produce.

Maximizing revenue per customer and optimizing the utilization of energy generation assets are key performance indicators for these enterprises to ensure that they produce enough revenue to service their investment. Economies of learning are a key driver of cost reduction for these models, meaning that experience gained in acquiring and engaging with customers can be leveraged to increase efficiency in the future and drive down the cost of sales.

For example, Mlinda (**www.mlinda.org**) designs, installs, operates, and maintains solar microgrids for rural communities in Jharkhand, India. These microgrids are capable of providing 24x7, three-phase electricity that can power productive loads. They act as an engagement platform to work with the communities to reduce greenhouse gas (GHG) emissions, promote environmentally positive forms of production and consumption, and improve energy efficiency and the gross domestic product (GDP) of each village. Mlinda invests considerable time and effort and is developing special skills in-house to educate communities and create market linkages. It helps communities produce and market value-added products such as organic rice and mustard oil.

	PURE PLAY	COMPLEMENTARY PRODUCTS AND SERVICES	INTEGRATED PRODUCTIVE USE
Market Characteristics	Low margin, competitive, cost focused	Multiple competitors, speed to market focused	Low ability to pay, high cost of customer acquisition, relationship focused
Source of Growth	Standardization, reduce cost, increase volume (geographic expansion and/or acquisition)	Increase number of sales within existing market (new or existing customers)	Increase revenue per customer
Source of Scale	Economies of scale	Economies of scope	Economies of learning

Investing in Clean Energy in India: Challenges and Opportunities

According to the Government of India, US $100 billion in funding is required over the next six years to achieve the country's solar target of 100 GW of off-grid and grid-connected access by 2022[38]. The total energy access investment opportunity in India may be as high as US $48 billion a year by 2030[39]. The availability of funding is a key challenge not just for clean energy entrepreneurs in India, but also for investors that wish to support them. This constraint exists for all types of funding including grants, impact investments, strategic investments, and commercial investments. While impact investments describe those where investors' return expectations include social or environmental outcomes in addition to financial returns, strategic investments describe those where the investor's expectations include some knowledge about or experience of a particular technology, customer segment, or market.

Investor Challenges

POLICY UNCERTAINTY

Investment in off-grid energy enterprises is growing globally, in terms of both deal size and the number of deals. Annual investment in the off-grid solar sector has increased from US $18 million in 2013 to US $284 million in 2017. However, the percentage of off-grid investments in Asia has declined dramatically from 31% of total off-grid financing to less than 1% during the same period[40]. Some of this slowdown may be due to the perception that aggressive grid expansion policies in the region, or even the promise of such an expansion, are a threat to commercial viability of off-grid business models.

The investors interviewed for this research recognized from experience that the multi-dimensional nature of energy access still leaves room for the grid to co-exist with commercially viable models that focus on reliability, improved quality, or other attributes. However, these investors also highlighted uncertainty in the policy environment more broadly as a key barrier, emphasizing that investors should be aware of and seek to manage the associated risks.

ENTERPRISE DEPENDENCE ON SUBSIDIES

While government-supported programs may be attractive opportunities to clean energy enterprises, many investors identified over-reliance on these subsidies for revenue as a concern when assessing potential investments in India. Over-dependence on a single payer is risky in general, but especially so in situations of uncertainty about whether individual subsidies will continue to be offered. Investors are particularly conscious of diversified revenue sources, and enterprises with a high percentage of their revenues coming from the government tenders present a greater risk. This risk emanates not only from the potential for these programs to end at short notice, but also from the possibility that payments by the government are delayed, putting further pressure on the enterprise's working capital.

INDUSTRY COORDINATION

While investors continue to look for financially sustainable investment opportunities, they also seek outcomes with a catalytic effect on the industry as a whole. Investors highlighted a lack of coordination among investors and across the industry in India as a key challenge, in particular when it comes to identifying and connecting with local entrepreneurs. Investors interviewed for this research are increasingly interested in investing in intermediaries that can engage with many, often smaller and more local, enterprises as a way to achieve their energy access objectives.

Good Energies Foundation (**www.goodenergies.org**), an investor based in Switzerland, has invested in SELCO Foundation's Incubation Program. SELCO is a social enterprise that was established in 1995 to support innovation and to improve the overall clean energy industry by providing clean energy solutions and services to underserved communities in India. The Incubation Program supports local energy entrepreneurs by providing access to working capital and other forms of credit, enabling entrepreneurs to overcome workforce and supply-chain constraints and to improve understanding of the needs of low-income consumers.

Investing in such intermediaries helps investors to spread risk by diversifying across geographies, segments, and models. These investors also recognize the role they play in motivating others to enter the industry, which of course benefits not only their investees, but also the market as a whole.

Investor Opportunities

Each energy access sub-sector commands a different capital mix to finance future growth and scaling. For example, solar home system enterprises require a higher degree of debt over equity as compared to mini-grid enterprises, which require higher levels of grants and equity investment. In India, DFIs are still the largest source of capital; however, there is persistently low investment activity from impact funds. This inactivity stems from a mix of negative historical experiences and/or a desire to await outcomes from current portfolio investments. The key funding constraints in the clean energy industry in India include a lack of grants and patient capital, a need for concessional debt, and a dramatic increase from nascent levels of available equity.

GRANTS

Grant funding can be critical in the innovation process to reduce uncertainty about products or services, or to explore new customer segments. While grant funding can be particularly important in earlier stages of an enterprise's development, enterprises may iterate between phases of innovating and scaling that require more flexible models. To a large extent, enterprises in the EAI portfolio have utilized grants effectively. Uses of grants include penetrating new markets and geographies, introducing new products and services, fostering innovation, incorporating new processes, employee training, advocacy, and awareness efforts.

While grant providers have moved into other forms of concessional funding, a significant mobilization of grant/concessional funding is still needed within India and globally. Mini-grids in particular, with longer payback periods, require larger upfront catalytic grants, especially where investment is required to promote productive use applications that support commercially viable utilization levels.

Chief among grant providers' concerns is the availability of follow-on investment. To address this concern, some foundations have begun deploying recoverable grants. Stipulated within the terms of the recoverable grants are payback provisions conditional on the future commercial viability of the enterprise. Only when the enterprises actually reach break-even are repayments triggered.

Blended approaches offer an opportunity to combine grants with recoverable forms of capital from private investors and may help lower the risk of investments in the clean energy industry. Blended deal structures have various tranches (including senior, junior, or subordinated, and grant tranches) that have differentiated risk profiles and attract different levels of financial returns.

Grant funding typically occupies the most junior tranches of blended structures and acts as a first-loss guarantee that protects more senior tranche investors from any downside losses. These senior tranche investors may also receive higher upside returns since most grant tranches don't attract dividends. Shell Foundation and the Dutch Development Bank FMO recently announced a blended fund that aims to provide growth capital in the US $1 million to US $5 million range for clean energy enterprises.

Another opportunity to lower investment risk and reduce downside losses is the use of contingency funding. This approach has been pioneered by Open Road Alliance[41] and involves providing grant funding to recover from unforeseen funding shortfalls. These shortfalls might be due to additional expenses, loss events, or other unexpected scenarios. The goal of these types of grants is to protect the original investments by ensuring that the impact outcomes of the project are still achieved.

INVESTOR PROFILE: GOOD ENERGIES FOUNDATION

Good Energies Foundation (**www.goodenergies.org**) provided grant funding to Mlinda to support its activities in India to electrify rural areas through solar mini-grids and to promote low-emission economic growth[42]. Mlinda operates mini-grids in rural areas that serve low-income and marginalized populations by promoting the establishment of micro-enterprises that create demand for productive loads. While individual mini-grids reach operational break-even at a certain level of utilization, grant funding is required in early stages to understand the needs of the community and which solutions will be successful. Grant funding from Good Energies enabled Mlinda to develop these insights in an open-source model that can be shared to assist in scaling and replication, thus contributing to the development of the overall industry[43].

DEBT

Energy enterprises often require large amounts of working capital to build inventory and drive higher cash-flow levels and sales. Traditional providers of commercial debt often charge high interest rates (14% to 18%), and collateral requirements can be prohibitive. The cost of servicing high interest rate debt puts pressure on the enterprise to increase its margins, which often means pivoting to serve populations or sub-sectors that generate higher revenues, thus reducing its energy access impacts. However, some companies have been able to mitigate this effect through efficient working capital management such as short cash conversion cycles.

Some investors have developed innovative approaches to debt financing. For example, the Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) (**www.ctgsme.in**) scheme set up by the Small Industries Development Bank of India (SIDBI) (**www.sidbi.in**) and the Government of India provides collateral-free debt for micro and small enterprises. However, there is still a significant gap in the availability of low-cost, short-term debt to satisfy enterprises' working capital needs.

INVESTOR PROFILE: CASPIAN IMPACT INVESTMENTS

Caspian (**www.caspian.in**) is a domestic Indian impact fund that was established in 2005. Areas of investment focus include clean energy as well as financial inclusion, food and agriculture, affordable housing, and healthcare. A certified B Corp, with US $150 million in assets under management, Caspian's impact profile includes 9.6 million clients served within microfinance investments, 500,000 acres cultivated, 400,000 jobs created by their investees, and almost 600,000 small and marginal farmers assisted. Caspian bases its lending decisions on cash-flow projections rather than traditional collateral requirements, and it seeks to de-risk its investments by requiring improved financial controls and other company management disciplines to help strengthen growing enterprises.

EQUITY

Equity is needed to build strong teams, cover operational costs, and develop the systems and processes needed to scale. But equity is in short supply, and what little is available can therefore be highly selective and is predicated on investors having a clear exit at some point in the future.

The result is that since 2012, two-thirds of equity investments in solar home system companies globally were placed in just four companies[44]. Acumen estimates that US $210 million per year in off-grid equity funding is required to meet SDG7, yet only US $16.5 million on average has been invested annually over the past 5 years.

Despite the relatively high cost of debt in India, the lack of available equity increases the possibility that enterprises become overleveraged. Once enterprises reach a high debt-to-equity ratio, it is unlikely they will be able to raise any further debt to finance growth. While much focus has been put on a lack of capital for deal sizes less than US $2 million—otherwise known as the "missing middle"—the EAI program has observed an even greater need for scaling capital in the US $2 million to US $10 million range. There are some indications that future activity will increase in the venture capital and private equity categories through funds dedicated to energy access investment, such as SunFunder's US $100 million Solar Energy Transformation (SET) fund[45], plus the increased interest from strategic investors in the clean energy industry such as Shell Technology Ventures, ENGIE, and Schneider Electric.

INVESTOR PROFILE: ACUMEN

Acumen (**www.acumen.org**) is an impact investor that takes a patient capital approach to early-stage equity investments. Acumen invests in companies that are in what it calls the "pioneer gap," which is defined as the combination of the Validate and Prepare Stages of the Blueprint to Scale framework[46]. Acumen has been investing in the clean energy industry for 10 years, and it has invested US $22.1 million in 20 companies across eight countries. These investments have been highly catalytic and have led to a total of US $219.5 million in follow-on funding raised by companies in their portfolio. This includes US $180.9 million from solar home enterprises, US $24.7 million from mini-grids, and the remainder from clean cookstove distributors. Combined, these investments have impacted over 86 million lives[47].

RECOMMENDATIONS FOR ACTION

ENTERPRISE RECOMMENDATIONS

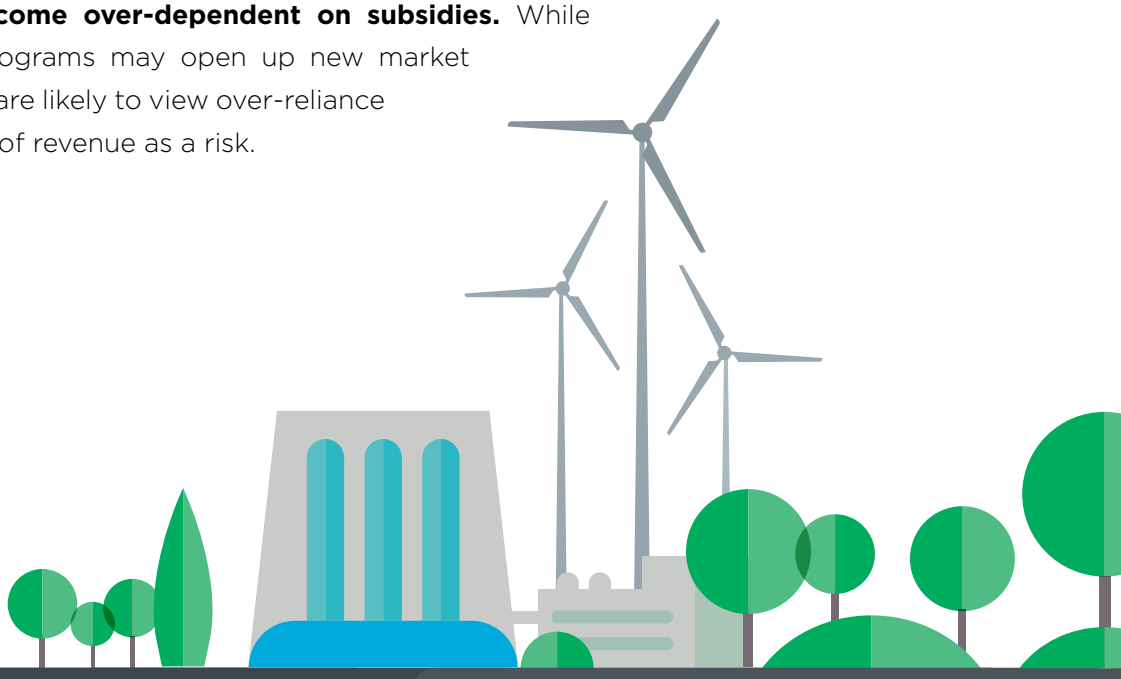
Based on the experiences of the EAI enterprises interviewed and the challenges they face, we recommend enterprises consider the following:

- **Frame the enterprise's value proposition in terms of the multiple dimensions of energy access.** This is especially true if investors don't have prior on-the-ground experience of investing in the clean energy industry in India. Enterprises should present their value propositions in terms of the multiple energy access attributes that make up the opportunity space for private energy enterprises, emphasizing how they address needs not served by the grid.

- **Supplement off-grid community-scale solutions with complementary products or integrated demand creation.** Achieving commercial viability for off-grid, community-scale models will likely necessitate identifying additional revenue streams (using the 'Complementary Products and Services' archetype) or investing in creating demand for productive load applications (the 'Integrated Productive Use' archetype).

- **Explore B2B models that specialize in specific aspects of the clean energy value chain.** Investors in the industry are increasingly interested in investing in intermediary organizations that can have a catalytic effect on the industry. New entrants in particular should explore opportunities to provide specialized services or inputs from the outset.

- **Resist the urge to become over-dependent on subsidies.** While government subsidy programs may open up new market opportunities, investors are likely to view over-reliance on a single large source of revenue as a risk.



INVESTOR RECOMMENDATIONS

The key constraint in scaling up clean energy enterprises is access to the right kind of capital at the right time. Based on discussions with enterprises, investors, and observations from the EAI project's role in facilitating investment, here are some recommendations for investors, whether they provide grants, debt, or equity:

- **Consider where enterprises are in the Focus-Integrate-Specialize cycle.** It is important for both enterprises and investors to recognize that a single enterprise cannot specialize in everything. Where enterprises are in the cycle will influence the amount and type of capital they need to grow. At a portfolio level, this may also inform strategies for investing in partners or intermediaries around these enterprises to provide inputs or supporting services.

- **Explore opportunities for greater integration and collaboration between investors across the capital continuum.** Enterprises cycle between exploring new value propositions and building systems to deliver those value propositions. Grant funding is most appropriate for the exploration stage, to reduce uncertainties about the business model or customer segment. Equity is most suitable for system building. Enterprises may have multiple overlapping innovation cycles at different stages that require both types of capital at the same time, and consequently greater collaboration between different types of investors.

- **Explore further innovation in providing affordable debt to enable enterprises to overcome working capital constraints.** Investors should consider alternatives in credit risk assessment that increase access to affordable, short-term debt without requiring collateral.

- **Direct significantly more equity to enterprises in the clean energy industry in India to enable them to reach scale.** This is particularly true in the US $2 million to US $10 million deal size range. To do this, investors need a better understanding of what constitutes a realistic risk/return spectrum for clean energy investments in India. Blended financing models that leverage grants to provide first-loss protection may help in offsetting some of the risk perceived by equity investors.

CONCLUSION

The clean energy industry in India provides challenges and opportunities for both enterprises and investors. While the challenges are plentiful, so too are the creativity and innovation necessary to overcome them. While we focus on what enterprises and investors can do, it is also important to realize that other actors can contribute to accelerating investment in the industry. Policy makers that develop and support the market infrastructure and institutions, donors, and nonprofits, such as incubators and capacity builders, all have a key role to play in supporting these enterprises in developing commercially viable models that increase access to energy.

As illustrated by the EAI portfolio we've highlighted, it's clear that developing a business model to address or avoid these challenges is not a theoretical exercise. Rather, it emerges from practice—from an iterative process of experimentation and learning.

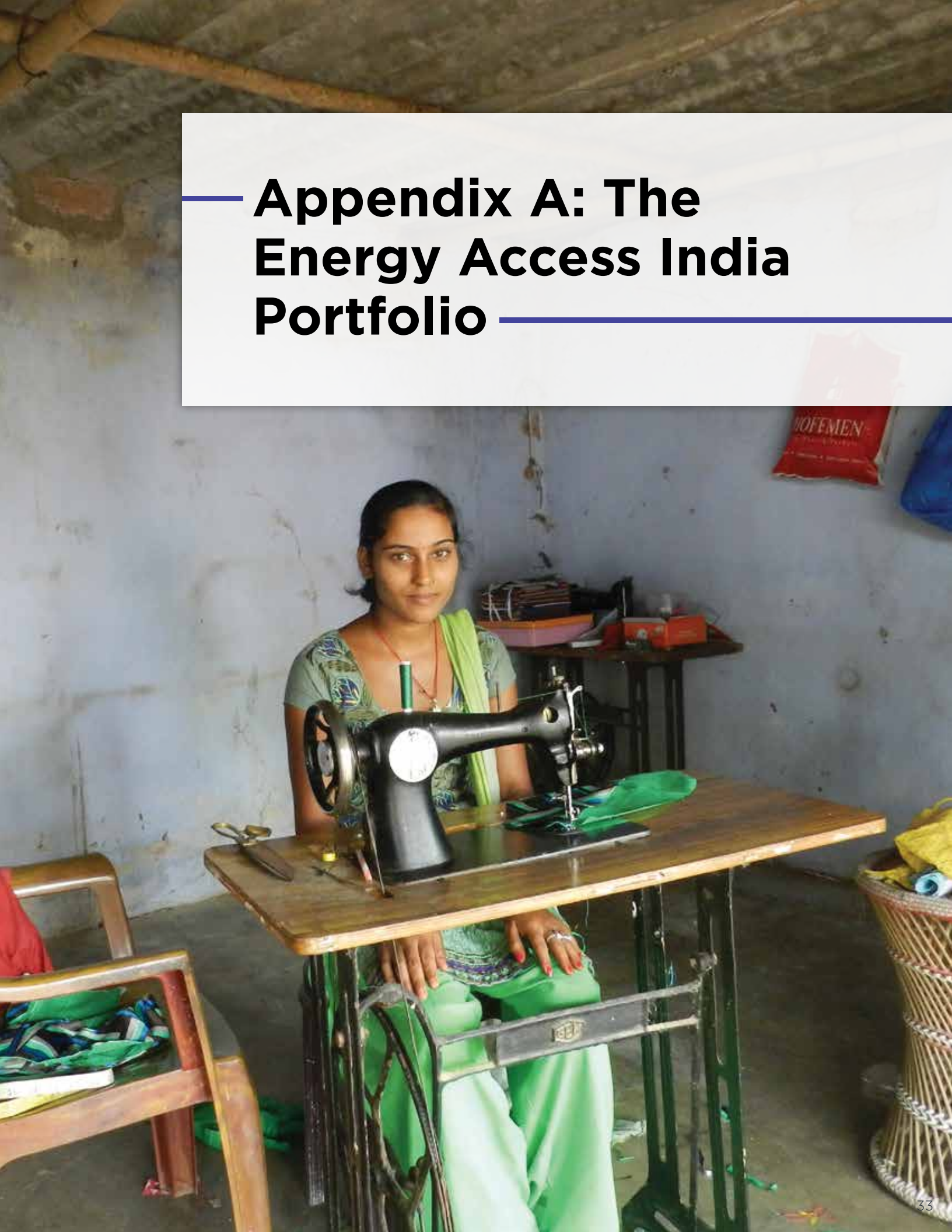
Above all, enterprises operating in underdeveloped markets require a learning orientation to increase the probability of achieving commercial viability and, ultimately, scale. As described in the Focus-Integrate-Specialize model, this experimentation and learning orientation isn't relevant just when developing a pilot; it's a capability that will continuously be called upon as the enterprise and the industry evolve.

While no templates exist for success in this or any other industry, our research has identified three distinct patterns or business model archetypes of enterprises in the EAI portfolio. Pure Play enterprises focus on standardization and driving down cost in competitive markets. Complementary Products and Services enterprises leverage economies of scope to develop value propositions that are more efficiently produced together than separately. And Integrated Productive Use enterprises develop deep relationships with customers, often helping them to develop economic uses of energy that increase both demand and ability to pay. Some enterprises represent hybrids of multiple archetypes, but typically one is dominant.

Using the collective experiences of the EAI portfolio companies, the investors engaged through the program, and the program implementation team, our research has identified areas for greater alignment between enterprises and investors. We also recommend actions that we hope motivate a productive conversation within the clean energy community in India, and beyond, on how to accelerate investment in enterprises such as those in the EAI portfolio and better understand the potential for financial sustainability.

Closing the circuit between clean energy enterprises in India and investors that seek to support them will require continued innovation, experimentation, and collaboration. But making these investments in commercially viable, scalable access to energy that meets the needs of those at the base of the pyramid has the potential to significantly improve health, education, and economic development. In doing so, these efforts can transform the lives of millions of India's poorest people.

Appendix A: The Energy Access India Portfolio



PURE PLAY

Argo Solar Private Limited (Argo)

Argo, established in 2013, provides solar rooftop and solar pumping solutions on a turnkey and an OpEx model basis. Customers include educational institutions, hospitals, hotels, warehouses, and the state or central government. Solar pumping solutions are sold mostly with government tenders. The company partners with State Bank of India and Siemens Finance, a non-banking financial company (NBFC) for end-customer financing. The OpEx projects are financed through third-party investors such as ReNew Power.

Argo has executed more than 100 projects with a total installed capacity of 4,500 kW. It operates in Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Maharashtra, Delhi, Haryana, and Uttar Pradesh. The installations benefit more than 10,000 students, reducing 4,500 tons of CO_2 emissions per year.

Over the next 5 years, Argo plans to expand operations to 10 states, installing 100 MW of solar rooftop systems and 7,000 solar pumping systems.

http://argosolar.in

E-hands Energy India Private Limited (E-hands)

E-Hands is a for-profit social enterprise providing solar photovoltaic-based energy solutions to individuals, micro-entrepreneurs, and enterprises across rural and urban India. The solutions range from portable home lighting products to solar wind hybrid microgrids and rooftop systems. E-Hands has commissioned these systems across 14 states of India. The company is deploying hybrid microgrid solutions for lighting and productive loads in rural India and high-altitude border areas. It is also providing solar rooftop solutions for powering rural bank branches.

E-hands has commissioned 300 solar installations totaling 570 kW in installed capacity and benefiting more than 12,000 households.

The company plans to install a capacity of 1,000 kW to power rural bank branches and enter the urban solar rooftop sector while continuing to build on its expertise for hybrid mini-grids in difficult-terrain, high-altitude border areas.

http://www.ehandsenergy.in

Freyr Energy Services Private Limited (Freyr)

Freyr provides turnkey solutions for distributed solar systems ranging from 1 kW to 1,000 kW. It operates primarily through two product lines: 1) rooftop systems (including fuel stations and solar water pumps) and 2) microgrids. The company is creating an extensive channel partner network that uses its proprietary SunPro™ mobile application. The channel partners select a solar product and the application integrates key functions, eliminating non-productive layers, increasing margins in the value chain, and reducing sales cycle time. Freyr is thus able to scale rapidly across geographies.

Freyr, has completed 900+ rooftop installations across 16 states and 100+ microgrid systems through government contracts, for a total of 6,000 kW of installed capacity. Based on a recent impact study, for every investment of US $1, Freyr's impact is US $5.

Freyr plans to reach 1,000+ rooftop installations, electrify 450+ villages, and execute power purchase agreement projects totaling close to 6 MW installed capacity.

http://freyrenergy.com

Husk Power Systems Private Limited (Husk Power)

Husk Power has developed a proprietary hybrid system that can generate 24x7 electricity by synchronizing solar and biomass gasification plants. The system reduces battery requirements by 75%, resulting in possible cost savings of more than 30% and a CapEx of less than US $2.40 per watt. The cost of delivering the three-phase power can be 40% cheaper than home lighting systems and is also grid-compatible. The system offers a flexible PAYGO energy service using mobile-enabled smart metering.

Husk Power has 75 microgrid sites in India and Tanzania, providing electricity to 15,000 households and businesses and reducing 95,000 tons of CO_2.

Husk Power has recently raised US $20 million and aims to add over 300 mini-grids totaling 15 MW of installed capacity in India and Tanzania. These mini-grids will serve more than 100,000 people and reduce 150,000 tons of CO_2 a year.

http://www.huskpowersystems.com

Mera Gao Microgrid Power Private Limited (MGP)

MGP builds, owns, and operates solar DC microgrids in Uttar Pradesh, India, serving off-grid hamlets with high-quality, dependable lighting and mobile phone charging services. MGP has designed a fully automated system that generates, stores, and distributes power on its own. The system can turn itself on and off each night. It takes just one day for four people to install a system that can provide services to a hamlet of 10 to 20 households. The system and distribution network together cost less than US $1,000—making this one of the lowest-cost commercially viable microgrids.

MGP has installed more than 1,500 microgrids across five districts of Uttar Pradesh, benefiting more than 100,000 people. The company has also created 140 local technical jobs.

http://meragaopower.com

Oorja Development Solutions India Private Limited (Oorja)

Oorja is a project developer of hybrid solar-biomass microgrids, deployed using a franchise model and operated by local micro-entrepreneurs. The company focuses on powering small rural businesses along the agricultural value chain, public institutions, and residential users (through cross-subsidy). It is now containerizing its solution, integrating smart meters for data monitoring, and future-proofing for grid interactivity. The founders received seed funding as Climate Fellows from Echoing Green and grant funding from institutions in the UK and France.

Oorja has successfully installed and commissioned a 10 kW smart DC solar microgrid in Sarvantara village, Uttar Pradesh. The microgrid provides energy to 100 households and powers one irrigation pump.

Oorja plans to continue scaling up within Uttar Pradesh and rollout additional microgrids each year with the goal of installing 100 hybrid AC systems and 150 solar DC systems in India within five years.

http://www.oorjasolutions.org

Sunvest Energy Private Limited (Sunvest)

Sunvest, established in 2015, is a turnkey solar rooftop solutions provider for residential and small commercial consumers in urban and semi-urban India. The target customers are individual homes, apartments, offices, educational institutions, resorts, and non-profit institutions. The company positions itself as a relationship-driven, comprehensive solutions provider supported by high referrals from existing customers. The comprehensive solutions include site audits, installation, obtaining permissions, financing, maintenance, and monitoring. The company has demonstrated execution capability by installing the first few net metered projects in the target regions.

Sunvest has completed more than 16 projects totaling 414 kW in capacity with a pipeline of 250 kW, most of them through customer referrals.

Sunvest is currently focused on the urban regions of Mumbai and Delhi with plans to expand into other urban and semi-urban locations in the future.

http://www.sunvest.in

Veddis Solars Private Limited (Veddis)

Veddis is a turnkey solar solutions provider that began by largely catering to solar projects by the Government of India, establishing a well-developed supplier management and logistics system in the process. Having successfully installed 2 MW of projects, Veddis has recently developed a solar grid-tied modular system called GoSolgen. The modular system is sold in multiples of four solar panels, in various combinations, to set up systems ranging from 1 kW to 1 MW without any change in design or cost per kW. Veddis is operating in Bihar, Uttar Pradesh. and Telangana.

Veddis has installed 220 kW of the GoSolgen systems, reaching more than 1,200 households.

Company plans call for expanding operations to Andhra Pradesh, Tamil Nadu, Karnataka, and Maharashtra.

http://www.gosolgen.com

COMPLEMENTARY PRODUCTS & SERVICES

Aga Khan Foundation/Aga Khan Rural Support Programme, India

The Aga Khan Foundation (AKF) has been implementing innovative, community-driven solutions to solve development challenges for over 50 years. The Aga Khan Rural Support Programme, India (AKRSP (I)), AKF's implementing partner, works on community-based natural resource management and livelihood improvement projects. In India, AKF and AKRSP (I) currently work in the states of Gujarat, Madhya Pradesh, Uttar Pradesh, and Bihar, reaching out to communities in more than 2,000 villages. Interventions include various renewable energy development initiatives.

Renewable energy projects using solar and biogas have benefited 61,000 households in 567 villages. Key projects apart from solar lighting include nine solar mini-grids, 28 solar-powered irrigation and drinking water supply systems, and biogas cooking systems. Special emphasis has been given to develop entrepreneurs at the village level.

Next, AKF/AKRSP (I) will integrate clean energy solutions for irrigation and education in Bihar, Madhya Pradesh, Uttar Pradesh, and Gujarat. The focus is on improving livelihood generation as well as the overall quality of life of the participating communities.

http://www.akrspindia.org.in

Avani Bioenergy Private Limited (Avani)

Avani generates energy using pine needles. The energy generated is sold to local power utilities through a 20-year Power Purchase Agreement. Local women and men collect the pine needles and are remunerated with cash and cooking charcoal. Removing the pine needles prevents forest fires and protects biodiversity in the Himalayan eco-system.

Avani has installed and is successfully operating a total capacity of 116 kW. The power plants also supply low-cost cooking charcoal and energy to more than 100 households—creating livelihood for 100 families, restoring 60 hectares of forest land, and reducing 700 tons of carbon emissions each year.

Avani aims to set up a total capacity of 2.5 MW by 2020, with village-level entrepreneurs setting up and operating the power stations. This will restore 2,500 hectares of forest land, create 2,500 rural jobs, and reduce 95,000 tons of carbon emissions per year.

http://avani-kumaon.org

Cygni Energy Private Limited (Cygni)

Cygni, in partnership with the Indian Institute of Technology Madras (IITM), has designed, developed, and commercialized controllers that integrate with solar, battery, and DC appliances without any intermediate conversions. Cygni can provide DC power up to 24 kW for homes, small offices, or commercial complexes. Power supply is at 48V within safety limits, resulting in lower cable losses and the ability to power larger productive loads. The controller can also seamlessly integrate with the grid.

The company has installed a total capacity of 8,793 kW across 800 villages, benefiting 200,000 people in eight states of India. Cygni's solar DC solution results in a much smaller solar footprint and storage capacity for the same load requirement, making it highly efficient and cost-effective.

The company plans to grow rapidly and is seeking funds for technology product development, project expansion, increasing production capacity, marketing, and working capital.

http://www.cygni.com/

CleanStar Energy Private Limited (CleanStar)

CleanStar Energy promotes sustainable biofuel production on barren/fallow land that is unsuitable for food crop cultivation and on mining waste dumps. The company was launched in 2005 based on award-winning research from Oxford University and was recognized in 2006 as one of the top 10 sustainable new ventures in India by the World Resources Institute (WRI), USAID, and the Confederation of Indian Industry (CII). CleanStar Energy has more than 10 years of field experience in biofuel plantation, maintenance, and management of biofuel trees such as Jatropha Curcas and Pongamia Pinnata.

CleanStar has a 30-acre biofuel plantation site in Beed District of rural Maharashtra. The company has also set up offices in Bangalore.

The company has long-term plans to build decentralized 200-acre clusters of bioenergy value chains around Elite Pongamia and to locally produce a slew of bio-products such biodiesel, biocoal, bioCNG, and biofertilizers.

https://www.cleanstarenergy.in

ECCO Electronics Private Limited (ECCO)

ECCO is an innovative renewable energy company that is leveraging design and technology to manufacture affordable and serviceable solar products. ECCO has developed and patented a charge controller and drive technology in which three critical functions—the solar charge control, battery management, and drive—are integrated into a single microcontroller circuit. ECCO solar lamps and solar hybrid DC power packs using this patented technology are sold through the Tamil Nadu government and distributed through microfinance partners in Uttar Pradesh, Madhya Pradesh, and Maharashtra.

More than 150,000 individuals from 30,000 households have benefited from the systems designed and manufactured by ECCO. A total capacity of 900 kW has been installed so far.

ECCO is broadening its customer base and introducing new product lines such as power packs and solar home systems that come with a fan and color television.

http://ecco.in

Frontier Markets Consulting Private Limited (Frontier Markets)

Frontier Markets is a last-mile sales and distribution company for affordable clean energy products. The customers of Frontier Markets are farmers, women, and households at the bottom of the pyramid in Rajasthan. The company has a robust after-sales service model that trains and employs women to repair products on-site. Frontier Markets has developed mobile application technology for placing and tracking orders, customized hardware for remote monitoring, and a back-end cloud platform to fast-track service and promote accountability.

Frontier Markets has 2,000 retailers, four service centers, 1,000 trained women entrepreneurs, and has distributed more than 423,000 products, benefiting 2.3 million people.

The company is expanding to Bihar, Jharkhand, Odisha, Maharashtra, Madhya Pradesh, and Uttar Pradesh with plans to create 15,000 retailers, train 10,000 women entrepreneurs, and sell more than 3 million products to benefit an additional 2.1 million people. New products are solar milk curd perculators, TVs, agri-appliances, mobile phones, and digital connectivity.

http://www.frontiermkts.com

GrassRoots Energy Incorporated (GRE)

GRE develops, installs, owns, and operates microgrid solutions for supplying 24x7 electricity by replacing expensive battery or diesel backup of existing solar microgrids. GRE utilizes biogas or biomass waste-to-energy generating systems along with an external combustion engine called a micro-CHP (combined heat and power). The company is able to generate electricity and waste heat from the micro-CHP as well as fertilizer from the biogas/biomass plant.

GRE implemented its first project in Bheldi, Bihar, to replace a diesel generator backup with an existing solar microgrid. By providing primary veterinary services, training marginal dairy farmers, and exchanging cattle feed for dung, GRE is creating a reliable supply chain of feed stock for its biogas/biomass plant.

Expanding on two stand-alone microgrids based on the waste heat recovery system, the company plans to set up 1,000 microgrids in five years after the commercial launch. These systems will reach 200,000 people.

http://www.grassrootsenergy.co/

Grassroots and Rural Innovative Development Private Limited (GRID)

GRID is a social enterprise providing energy and water to rural communities by setting up stand-alone solar-based water purification systems, microgrids, and home lighting systems. For water purification, a 10 kW to 15 kW solar microgrid powers a RO-UV filtration process, producing 20,000 to 30,000 liters of clean drinking water every day. The solar microgrid has a battery bank ensuring that the plant runs continuously for 10 to 12 hours. A village-level entrepreneur operates the plant, and three to four additional people help in operations, awareness, and demand generation.

The system produces 20,000 liters of purified water, sold at a rate of US $0.004 in 10 liter cans, and serves approximately 1,000 households. Customers collect water from the plant or pay extra for home delivery.

GRID is setting up two water purification systems in Madhya Pradesh and Punjab and aims to commission 80 to 100 such systems across 10 states of India in the next two years.

http://www.gridindia.co.in

Mangaal Sustainable Solutions Private Limited (Mangaal)

Mangaal is a system integrator incubated at the SELCO Incubation Centre providing customized solar energy solutions in Manipur, India. The products and services provided include solar home lighting systems, water heaters, street lights, microgrids, grid-connected rooftop systems, and solar-powered appliances such as sewing machines. The company also distributes solar lanterns from Greenlight Planet. Mangaal has worked with rural banks and MFIs to provide end-user financing, and they also work through local NGOs and entrepreneurs.

Mangaal has installed 4,900 systems benefiting 24,500 people, despite working in an area with frequent curfews and a poor law-and-order situation.

Mangaal is working toward expanding to other parts of the North Eastern Region, in particular Assam. The company is targeting the solar rooftop sector, installing larger-sized systems and working on solar technology solutions for weaving looms and creating rural livelihoods.

https://mangaal.com

Punam Energy Private Limited (ONergy)

ONergy is an award-winning energy access enterprise providing complete solar energy solutions in rural West Bengal, Odisha, Jharkhand, and northeast India. ONergy establishes renewable energy centers (RECs) that train rural entrepreneurs who enable last-mile energy distribution and provide the service infrastructure. The company has been successful in leveraging existing networks of local NGOs, self-help groups, and MFIs to develop an ecosystem that promotes a complete range of customized solar solutions including lights, home lighting systems, televisions, fans, irrigation pumps, water heaters, microgrids, and rooftop systems. It also facilitates consumer finance.

ONergy has established 20 RECs, covered more than 3,000 villages, and trained more than 3,500 rural entrepreneurs affecting more than 350,000 lives.

ONergy is setting up a solar module manufacturing unit. The company is also developing PAYGO solar lighting, solar rooftop leasing, and community-centric microgrids and irrigation pump solutions.

http://onergy.in

Piconergy Private Limited (Piconergy)

Piconergy has successfully designed and deployed a solar home lighting system called 'Helios' comprising a sturdy power box, a 6V 4.5 Ah Absorbent Glass Mat (AGM) maintenance-free battery, three powerful LED lights, and a USB port for mobile charging. The company actively provides energy services in the urban underserved pockets of Mumbai city and Rajasthan. Local entrepreneurs recruited and trained by the company distribute the systems, as do rural women entrepreneurs trained by partner NGOs and MFIs. Piconergy complements its system with a range of services such as providing consumer financing, warranties, and reliable after-sales service.

Piconergy has distributed 275 Helios systems reaching close to 1,100 people.

In the next three years, Piconergy aims to sell 20,000 systems, create 200 local job opportunities, improve the education of 40,000 children, and impact more than 100,000 lives.

http://www.piconergy.com

Simpa Energy India Private Limited (Simpa)

Simpa provides solar solutions (lighting, phone charging, TV, fans, power backup) with point-of-sale finance to energy-poor households and micro-enterprises. The company acquires and serves customers in a cost-effective manner, using both direct sales and mass distribution through retail stores and dealers. Simpa has developed and deployed proprietary remote monitoring and smart-panel control technology, as well as prepaid metering to reduce transaction costs and mitigate risks. The customers of Simpa are daily wage earners, farmers, and small commercial establishments.

Simpa has installed a cumulative 2.4 MW, benefiting 44,049 households and 220,245 people.

Simpa plans to expand to 160 districts across six states: Uttar Pradesh, Bihar, Jharkhand, Orrisa, West Bengal, and Assam. Over the next 18 months the company intends to expand to 60 districts of Uttar Pradesh and Bihar, identified using a rigorous analysis framework drilled down further to the block and village level.

http://simpanetworks.com

Buen Manejo Del Campo India Private Limited/ Sistema India (Sistema.bio)

Sistema.bio manufactures and installs hybrid reactor bio-digesters that can efficiently transform cattle manure into biogas and bio-fertilizer. Biogas replaces fossil fuels and biomass as a fuel for clean cooking or to generate electricity. Bio-fertilizer by-products replace chemical fertilizers and increase crop yield in a sustainable manner. The bio-digesters also help in managing waste by reducing water contamination, greenhouse gas emissions, insects, and odor. The company works with small and medium farmers across the world.

Sistema.bio recently commenced operations in India. It has partnered with Tata Trust and other NGOs for turnkey execution and commissioning of bio-digestors in the tribal belt of Gujarat. The company has successfully installed 70 digesters that benefit 60 households and 630 people.

Over the next three years, the company plans to expand primarily in the states of Gujarat, Karnataka, and Maharashtra, with a target of installing 1,000+ bio-digestors. The company has plans to manufacture their bio-digesters in India.

http://sistema.bio

SP Renewable Energy Sources Private Limited (SPRE)

SPRE designs and provides turnkey energy-efficient biogas solutions that produce energy from solid organic waste, agricultural and industrial waste water, and biomass. The biogas solutions developed in collaboration with German and Dutch biogas companies come with a data logging and remote monitoring system. The containers are made of pre-fabricated fiberglass, do not require any civil engineering work, and may be one of the lowest-cost solutions available. SPRE provides solutions in the states of Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, Uttar Pradesh, Orissa, and Punjab.

The company has installed 500 systems impacting approximately 3,750 people and has also trained and employed 25 women in production.

SPRE plans to install more than 228,000 ‘flexi biogas’ plants in the next five years, targeting small dairy farmers, milk producers, highway restaurants, and school canteens. Distribution will be through women self-help groups acting as independent agents.

http://www.spre.co.in

SunMoksha Power Private Limited (SunMoksha)

SunMoksha is a turnkey microgrid solutions provider with its proprietary Smart Nanogrid™ smart grid and remote management solution. It designs, develops, installs, and integrates hardware and software controlling the generation and distribution of electricity. Power generated from hybrid-renewable resources is remotely controlled with communication and networking over diverse protocols, to deliver the right amount of energy, to the right location, at the right time and at the right price.

SunMoksha validated its technology in a remote village in Odisha, where a 30 kW solar microgrid electrifies 140 households, streetlights, a temple, and three community centers. 10 kW is set aside for productive uses. The company won the Millennium Alliance Award and has successfully launched and implemented a smart solar pump system.

SunMoksha has plans to expand into Rwanda through the India-Rwanda Innovation Growth Program. The company is in the process of implementing more smart microgrids and pump systems in Odisha.

http://www.sunmoksha.com

INTEGRATED PRODUCTIVE USE

Dev Nrgee Resources Private Limited (NRG)

NRG is a social impact organization that is successfully integrating the entire yarn-to-fabric-to-market value chain, improving livelihoods in the handloom weaving and rural silk yarn industry. NRG has patented the 'Unnati' and 'Buniyaad' micro-machines for silk yarn reeling and spinning and the 'Sun Kargha', a solar-plus-manual loom making the weaving process twice as productive.

NRG has installed more than 10,000 machines across 350 villages in Bihar, Chhattisgarh, Jharkhand, Odisha, and North East India, impacting more than 40,000 people. Family income has doubled to US $160 per month, and an additional 50 people are employed to service the machines.

NRG is showcasing its machines at Rural Experience Centers and partnering with MFIs to target 200,000 plus households in India that produce silk yarn and handwoven fabrics using primitive tools. It is innovating technologies like micro-spinning mills and promoting natural fiber.

http://nrgresource.co.in

Ecozen Solutions Private Limited (Ecozen)

Ecozen, founded in 2010, provides agricultural supply-chain solutions based on solar technology. The company has two key proprietary products. Ecofrost is a portable solar cold room, based on thermal energy storage, that can maintain a constant temperature for 30 hours without a battery. Ecotron is a solar pump controller with an intelligent monitoring system and a battery that is removed and used by the customer when the pump is not running. The company has won two global innovation challenges for students and one Indian business competition, and it has seven patents pending.

The company has installed 60 solar cold rooms and more than 3,000 solar pump controllers.

Ecozen has raised two rounds of funding and is in the process of raising additional funds to continue developing the Ecofrost product, while at the same time increasing sales of the Ecotron solar pump controller.

http://www.ecozensolutions.com

Inficold India Private Limited (Inficold)

Inficold has designed and successfully developed a plug-and-play thermal energy storage solution for refrigeration applications. The patented unit, 'ColdVault', is low-cost and retrofitted to both existing and new refrigeration and air conditioning systems. Electricity storage is in a phase-change material in the ColdVault unit. When electricity is available, ColdVault is bypassed to provide direct cooling; when there is an outage, the unit provides the cooling. The system is automatic, displays a charge level, and claims to provide cooling quality at par with traditional systems.

Inficold has successfully piloted five units, with the oldest in operation since November 2016. The technology claims to reduce cooling expenses by 3 to 5 times compared to diesel.

Initial market focus is thermal storage for bulk milk coolers, and target customers are private and co-operative dairies. ColdVault meets the ISO 5708 Class2All milk cooling standard.

http://inficold.com

Mlinda Sustainable Environment Private Limited (Mlinda)

Mlinda designs, installs, operates, and maintains solar microgrids for rural communities in Jharkhand. These microgrids are capable of providing 24x7, three-phase electricity that can power productive loads. They act as an engagement platform to work with the communities to reduce greenhouse gas emissions, promote environmentally positive forms of production and consumption, and improve energy efficiency and the GDP of each village. Mlinda invests considerable time and effort to develop special skills in-house to educate communities and create market linkages. They help communities produce value-added products such as organic rice and mustard oil.

Mlinda has installed 18 microgrids totaling 312 kW of installed capacity and impacting more than 23,000 lives. Value-added products are sold to urban markets in Kolkata and New Delhi- NCR.

Mlinda is expanding to 500 productive anchor-load-based systems spread across South Jharkhand, North Chhattisgarh, and North Orisa.

http://www.mlinda.org

New Leaf Dynamic Technologies Private Limited (New Leaf)

New Leaf has successfully designed, developed, manufactured, and installed 'GreenCHILL', an off-grid, compressor-free, renewables-based refrigeration system, powered by farm waste such as biogas, cow dung cakes, biomass pellets, wood, and hay. One unit can cool 1,500 liters of milk and 15 metric tons of perishables (fish, fruit, vegetables, and flowers) at the village or farm level. It does not need grid power or diesel generator backup.

New Leaf has installed and commissioned nine units in Gujarat and North East India. In Gujarat, the units are sold to individual farmers for cold storage and ripening of agricultural produce and fruits. In the North East they are sold through government channels, mainly for fisheries.

The company aims to install 250 units that can store 2 million tons of agricultural produce, help a farmer earn an extra INR 0.45 million (US $7,000), and reduce emissions of 5,000 metric tons of CO_2 per year.

http://www.newleafdynamic.com/

ENDNOTES

1. Gray, L., Boyle, A. & Yu, V. (2017). Turning On The Lights: Transcending Energy Poverty Through the Power of Women Entrepreneurs. Miller Center for Social Entrepreneurship.
2. Global Off-Grid Lighting Association. (2018). Powering Opportunity: The Economic Impact of Off-Grid Solar. Global Off-Grid Lighting Association.
3. For the purposes of this paper, the term 'investors' is used to describe funders that aim to make investments in financially sustainable enterprises. This includes providers of grants, debt, and equity regardless of return expectations.
4. The Climate Group. (2015). The Business Case for Off-Grid Energy in India. The Climate Group.
5. World Bank. (2017). State of Electricity Access Report 2017. World Bank.
6. "SDG 7: Sustainable Development Knowledge Platform," United Nations, accessed July 17, 2018, https://sustainabledevelopment.un.org/sdg7.
7. Previous research by Miller Center for Social Entrepreneurship (https://www.scu-social-entrepreneurship.org/s/Universal-Energy-Access-Miller-Center-White-Paper-Edited-United-Nations-pg11.pdf) has proposed that these BoP customers will best be served by a large number of smaller enterprises, or units of a large enterprise, that can bring the most appropriate technology, market-building strategies, and business models to local segments of the highly fragmented energy access market.
8. World Economic Forum. (2013). Scaling Up Energy Access through Cross-Sector Partnerships. World Economic Forum.
9. World Economic Forum. (2013). Scaling Up Energy Access through Cross-Sector Partnerships. World Economic Forum.
10. "Access2017," International Energy Agency, accessed July 18, 2018, https://www.iea.org/access2017/.
11. Global Off-Grid Lighting Association. (2018). Powering Opportunity: The Economic Impact of Off-Grid Solar. Global Off-Grid Lighting Association.
12. Gray, L., Boyle, A. & Yu, V. (2017). Turning On The Lights: Transcending Energy Poverty Through the Power of Women Entrepreneurs. Miller Center for Social Entrepreneurship.
13. London, Ted. (2016). The Base of the Pyramid Promise: Building Businesses with Impact and Scale. The Stanford University Press.
14. "Modi Announces 100% Electrification – But That Doesn't Mean Everyone Has Power," The Wire, accessed June 10, 2018, https://thewire.in/government/narendra-modi-government-rural-electrification-power.
15. Ministry of Power. (2006). Rural Electrification Policy No. 44/26/05-RE (Vol-II). The Gazette of India.
16. Global Off-Grid Lighting Association. (2018). Off-Grid Solar Trends Report 2018. Global Off-Grid Lighting Association.
17. Global Off-Grid Lighting Association. (2018). Off-Grid Solar Trends Report 2018. Global Off-Grid Lighting Association.
18. Bhatia, Mikul; Angelou, Niki. (2015). Beyond Connections: Energy Access Redefined. ESMAP Technical Report;008/15. World Bank.
19. Agarwal, R., Das, C. & Koh, Harvey. (2018). Energy Portfolios of the Rural Poor: Findings From a Pilot Study in India. FSG.
20. Hammond, A.L., Kramer, W.J., Katz, R.S., Tran J.T. & Walker, C. (2007). The Next Four Billion: Market Size and Business Strategy at the Base of the Pyramid. World Resources Institute and International Finance Corporation.
21. Diehl, Jan Carel. (2009). BoP market segmentation and proposing proper value proposition for the electronics industry: How to do so? International Conference on Impact of Base of the Pyramid Ventures, at Delft.
22. London, T. & Hart, S. (2010). Next Generation Business Strategies for the Base of the Pyramid: New Approaches for Building Mutual Value. Pearson FT Press.
23. Soto, Hernando de. (2000). The mystery of capital: why capitalism triumphs in the West and fails everywhere else. Basic Books.
24. Hammond, A.L., Kramer, W.J., Katz, R.S., Tran J.T. & Walker, C. (2007). The Next Four Billion: Market Size and Business Strategy at the Base of the Pyramid. World Resources Institute and International Finance Corporation.

ENDNOTES

25. C. K. Prahalad. (2005). The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits. Wharton School Publishing.

26. Sen, Amartya. (2000). Development as Freedom. Anchor Books

27. London, Ted. (2016). The Base of the Pyramid Promise: Building Businesses with Impact and Scale. The Stanford University Press.

28. While the focus of the program was on increasing energy access for underserved populations, several of the companies in the portfolio also targeted grid-connected populations that were generally not considered BoP. Most notably this includes rooftop-solar solutions for grid-connected commercial and industrial users that reduce costs and carbon emissions, while improving reliability. However, serving these segments creates a platform for these enterprises to be commercially viable and scalable, allowing them to achieve economies of learning and scale that better enable them to serve BoP customers with solutions such as solar pumps or solar home systems.

29. Given that this paper is being written before the final project report has been completed, the actual project impact numbers will be greater than the figures cited here.

30. Reyman, I., Berends, H., Oudehand, R. & Stultiëns, R. (2016). Decision Making for Business Model Development: a process study of effectuation and causation in new technology-based ventures. RADMA and John Wiley & Sons Ltd.

31. Reyman, I., Berends, H., Oudehand, R. & Stultiëns, R. (2016). Decision Making for Business Model Development: a process study of effectuation and causation in new technology-based ventures. RADMA and John Wiley & Sons Ltd.

32. Greiner, L. (1997). Evolution and Revolution as Organizations Grow: A company's past has clues for management that are critical to future success. Family Business Review.

33. Stigler, G. (1951). The Division of Labor is Limited by the Extent of the Market. Journal of Political Economy, 59(3), 185-193.

34. Rogers, Everett M. (2003). Diffusion of Innovations. Free Press.

35. Klein, B., Crawford, R. G. & Alchian, A. A. (1978). Vertical integration, Appropriable Rents, and the Competitive Contracting Process. The University of Chicago Press for The Booth School of Business, University of Chicago, and the University of Chicago Law School.

36. For further discussion and review of the literature on decision making related to vertical integration see Lafontaine, F. & Slade, M. (2007). Vertical Integration and Firm Boundaries: The Evidence. Journal of Economic Literature Vol. XLV. Pp. 629 – 685.

37. The archetypes discussed share some similarities with business types discussed in Hagel, J & Singer, M. (1999). Unbundling the Corporation. Harvard Business Review.

38. "Unlocking Finance to Achieve India's Clean Energy Goals," Natural Resources Defense Council, accessed July 16, 2018, https://www.nrdc.org/experts/nehmat-kaur/unlocking-finance-achieve-indias-climate-energy-goals.

39. "India energy access sector makes headway, also faces headwinds: CLEAN report," Power for All, accessed July 16, 2018, https://medium.com/energy-access-india/india-energy-access-sector-makes-headway-also-faces-headwinds-clean-report-744005fe9cf.

40. Global Off-Grid Lighting Association. (2018). Off-Grid Solar Trends Report 2018. Global Off-Grid Lighting Association.

41. "Open Road Alliance," Open Road Alliance, accessed July 16, 2018, https://openroadalliance.org

42. "Good Energies: Mlinda," Good Energies, accessed July 16, 2018, https://www.goodenergies.org/what-we-do/energy/mlinda/

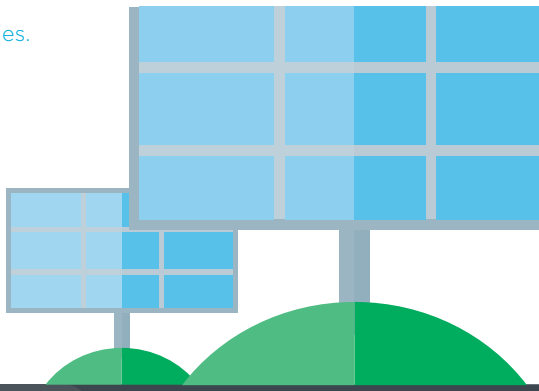
43. "Good Energies: Mlinda," Good Energies, accessed July 16, 2018, https://www.goodenergies.org/what-we-do/energy/mlinda/

44. Acumen. (2018). Accelerating Energy Access: The Role of Patient Capital. Acumen.

45. "Invest - SunFunder," SunFunder, accessed August 9, 2018, https://sunfunder.com/invest/

46. Koh, H., Karamchandani, A., & Katz, R. (2012). From Blueprint to Scale: The Case for Philanthropy in Impact Investing. Monitor Group.

47. Acumen. (2018). Accelerating Energy Access: The Role of Patient Capital. Acumen.



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ADDITIONAL RESOURCES

- **Acumen. (2018). Accelerating Energy Access: The Role of Patient Capital.**
- **GOGLA. (2018). Powering Opportunity: The Economic Impact of Off-Grid Solar.**
- **Miller Center for Social Entrepreneurship. (2017). Turning On The Lights: Transcending Energy Poverty Through the Power of Women Entrepreneurs.**
- **Miller Center for Social Entrepreneurship. (2015). Universal Energy Access: An Enterprise System Approach.**
- **NextBillion.net. (2015). Going Off Grid: Building a New Energy Future at the Base of the Pyramid.**

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