

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

171,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



## Chapter

# Innovation and Entrepreneurship to Address the UN Sustainable Development Goals

*Pritpal Singh*

## Abstract

The UN Sustainable Development Goals (UN SDGs) were developed in 2015 to address many global development challenges. Some of these goals include bringing affordable and clean energy to all (UN SDG7), provide clean water and sanitation for all (UN SDG6), providing quality education from early childhood to adults (UN SDG4), and decent work and economic growth (UN SDG 8). Technology has been advancing and can be deployed to address these challenges through entrepreneurial ways. In this chapter we will describe how technology-enabled innovative and entrepreneurial solutions are being brought to address these goals. The specific research questions to be addressed are: What types of Innovation and Entrepreneurship models are most effective in addressing the UN Sustainable Development Goals? This book chapter reviews different innovations in technologies and business models in the energy sector, particularly off-grid renewable energy, health care, water and sanitation, agriculture, and education sectors. The common themes of innovations in business models and technologies will be drawn from these case study reviews to guide researchers in developing new entrepreneurial approaches to addressing the UN SDGs.

**Keywords:** UN sustainable development goals, business models, information and communication technologies for development (ICT4D), electricity access, clean water and sanitation, good health and well-being

## 1. Introduction

The UN Sustainable Development Goals address many development challenges. The 17 UN SDGs and corresponding 169 targets cover a range of challenges including no poverty, ending hunger, quality education, access to clean and affordable energy, access to clean water and sanitation, etc. [1] **Figure 1** shows all seventeen goals.

To address these global development challenges, a variety of models have been used. These include donor aid models, development bank lending models, and entrepreneurial models. Looking at the history of success of these different approaches, the donor aid models, and development bank lending models have had some limited measure of success. However, the aid and loan models have been strongly criticized for creating a dependency on aid, particularly in African countries [2]. The entrepreneurial approach



**Figure 1.**  
UN sustainable development goals [1].

has been promoted by several authors, primarily by Paul Polack [3] and C.K. Prahalad [4]. Entrepreneurial models require strong consideration of both sustainability and scalability which are somewhat limited in the other two approaches. In the donor aid models and bank loan models, the money donated or loaned for a specific project tends to support the development activity for a limited time or scope. This is useful for some infrastructure types of projects and certainly have their role to play. However, given the scale and urgency of the needs in this space, more entrepreneurial venture approaches are required. The entrepreneurial approaches also offer opportunities for new revenue streams, as well as long term growth and sustainability. In this chapter, we will present case study examples of entrepreneurial ventures that are addressing various UN development challenges. The original research project for finding common business models for successful ventures in emerging economies was the Monitor Group’s report titled “Emerging Models, Emerging Markets” [5]. It described seven business model types that work well in emerging markets. While this report considered successful business models within the context of LMICs, it did not explicitly link the models to the UN SDGs. A more recent report that did focus on the UN SDGs is the book titled “Entrepreneurship and the UN Sustainable Development Goals” [6]. This edited volume is a collection of papers that focuses on research in this field but is focused on theoretical frameworks offering only a few case studies. The goal of this chapter is to build on these reports and describe innovations in technologies and business models that are having significant impact on addressing the UN SDGs. In particular, the common themes that appear among successful business models from research in the field will be described. By identifying these successful models, the opportunity to apply them to other UN SDGs may be explored.

## 2. Clean and affordable energy

The Institute of Electrical and Electronic Engineers (IEEE) is the professional body of electrical, computer and electronic engineers. It is the largest professional

organization in the world with over 450,000 members worldwide. One of the signature programs of the IEEE Foundation (the charitable arm of IEEE) is the IEEE Smart Village program. This program supports entrepreneurs to bring technology-based solutions to development challenges in the field, particularly around bringing electricity access to the approximately 800 million people worldwide who do not have access to electricity. The program starts with initial seed funding to pilot a solution and then provides matching funds to grow and scale the program with the aim of trying to bring electricity access to a million people.

One of the recipients of the IEEE Smart Village funding who has gone on to scale his entrepreneurial venture is Paras Loomba, Managing Director of Global Himalayan Expeditions (GHE). With an initial grant to light up five remote villages in Ladakh, India, the program has grown to electrify 131 villages to date [7]. Systems are being deployed by volunteers who go on trekking expeditions in the Himalayan mountains. An outgrowth of the program has been to increase impact tourism in the region of Ladakh in India. New revenue streams that have come out from GHE's initiative, in addition to providing lighting for villages, include high quality homestays for Himalayan Mountain trekkers, astronomy tourism, and cultural events produced by the residents who live in the Himalayan communities. The business model here has expanded income revenue streams for the communities in this region. As a result of this work, not only is the UN SDG goal 7 of Affordable and Clean Energy addressed, but so are goals UN SDG goal 3 Good Health and Well-Being, UN SDG goal 8 Decent Work and Economic Growth, and UN SDG goal 13 Climate Action. GHE has been recognized with many prestigious awards for its work including the G20 Sustainable Tourism award for the work that they have been doing to combine new forms of tourism with bringing electricity access in a sustainable and scalable way to the communities in this region.

A second business model approach is to use a hybrid model where renewable energy enterprises use revenues from installing solar electric systems in cities to subsidize installations in rural areas. An example of such a model is that of Ifeanyi Orajaka, Managing Director of the GVE group in Nigeria. The electric grid in Nigeria is relatively unreliable resulting in power shortages and blackouts even in the main cities in the country. The GVE group provides a range of services in the energy engineering space including commercial and industrial solar/generator set systems, energy efficiency/audit services for commercial customers, as well as rural electrification services ranging from individual solar home systems to village-level mini-grids [8]. An example of a 40 kW mini-grid project is shown in **Figure 2**. Installed in 2015, this project was financed by a combination of funding from the Bank of Industry (BOI) in Nigeria, the UN Development Program (UNDP) and the IEEE Smart Village program. The GVE group has continued to grow dramatically attracting foreign investment to further expand. Like GHE, the GVE group has received many prestigious awards for its work including being recognized by the London Stock Exchange as one of the fastest growing private companies in Africa in 2019 (see **Figure 3**).

Through major programs including the Sustainable Energy for All [11], an initiative launched by the UN Secretary General, Ban Ki-moon in 2011, and the emergence of green bank financing organizations that provide low interest loans for businesses deploying clean energy systems, there is growing financing support for enterprises working to address UN SDG 7. The Energy Sector Management Assistance Program (ESMAP), a global knowledge and technical assistance program administered by the World Bank, provides analytical and advisory services to low- and middle-income countries (LMICs) in the clean energy space. ESMAP released a technical report in



**Figure 2.**  
40 kW Mini-grid deployed by GVE group in Bisanti Village, Nigeria [9].



**Figure 3.**  
GVE Group being recognized by the London Stock Exchange as one of the Fastest Growing Private companies in Africa in 2019 [10].

September 2022 titled “Mini Grids for Half a Billion People” in which they outlined how investments in renewable energy could lead to significant economic growth in LMICs [12]. An Executive Summary of this report was published in 2019 and emphasizes business models using efficient appliances and productive uses of electricity to

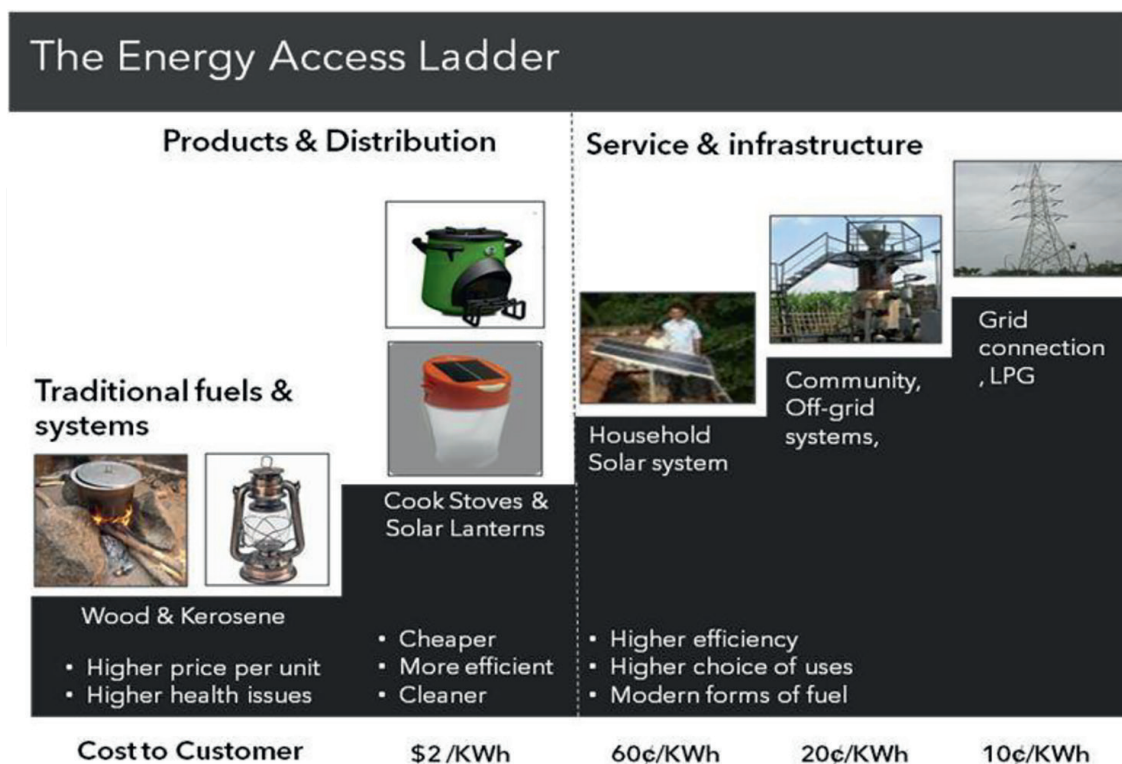
provide increased revenue to communities. Again, this approach not only addresses the UN SDG 7 goal of Clean and Affordable Energy but also addresses the UN SDG 8 goal of Decent Work and Economic Growth.

The concept of an energy ladder is an important concept for rural electrification projects (see **Figure 4**) [13]. On the lowest rung of the ladder is very basic access to electricity. This can simply comprise electric lights. Two major companies that have been using an entrepreneurial model to manufacture and distribute solar lights in LMIC's are d.light [14] and Green Light Planet (recently rebranded as Sun King) [15]. d.light has partnered with many large companies, including Unilever, Total, Orange as well as international non-governmental organizations (NGO's) to distribute their solar lighting products. Partnering with established large companies and using those companies' existing, extensive supply chains has allowed d.light to distribute over 100 million products in 70 countries [14]. The company has been able to raise over \$100 million of investment financing to support their growth.

Sun King offers a range of products starting with the entry level Sun King Pico Plus solar LED light (see **Figure 5**) [16]. This solar light provides five times the brightness of a kerosene lamp and sells for 1169 Kenyan Shillings (<\$10) in Kenya [17]. In comparison to the price of kerosene and the fire hazards and toxic fumes coming from being breathed in by children using kerosene lamps, solar LED lights offer a much cleaner, affordable, and healthier lighting option.

Sun King also offers upgraded products including a solar home system that includes a larger solar panel, several lights, and the capability for recharging cell phones [15]. Sun King recently expanded its Series D investment to \$330 million with additional funding of \$70 million from Leap Frog Investments [18].

A product developed through the IEEE Smart Village program is called the Sunblazer unit [19]. This is a modular system where solar panels are mounted to a



**Figure 4.**  
 Concept of an energy ladder [13].



**Figure 5.**  
*Sun King Pico Solar LED light [16].*

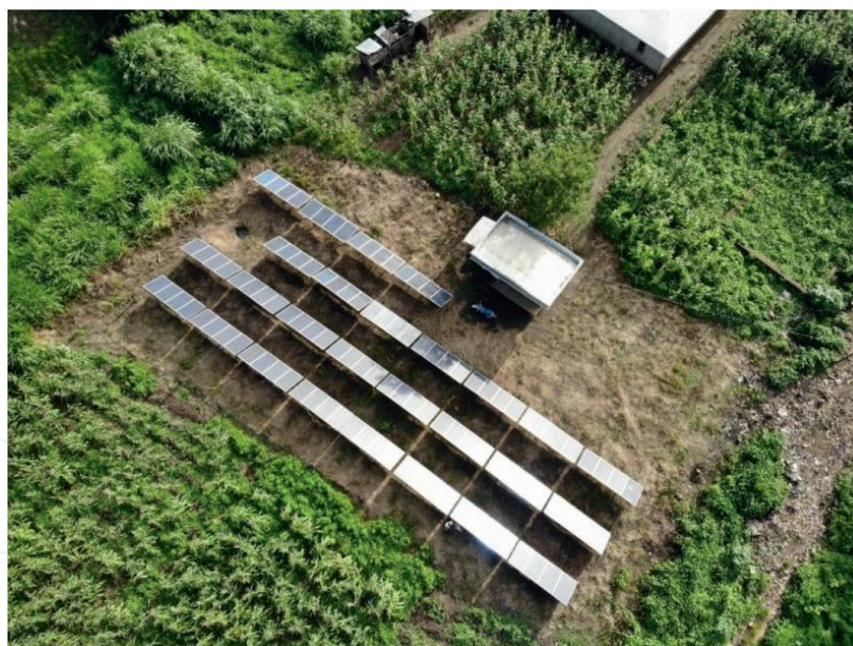
towable trailer frame with batteries located in the base of the frame. This system can be towed to remote communities and set up into a scalable system to power a village (typically starting at 1 kW). **Figure 5** shows the second-generation unit. The most recent version, generation IV, ranges in power from 1800 to 3600 W [19]. The first such system was deployed in Haiti in 2013 (**Figure 6**). More recently Renewable Energy Innovators Cameroon (REIc) has deployed larger scale systems in villages to provide electricity for running enterprises (see **Figure 7**) [20]. REIc is also a qualified manufacturer of the Sunblazer units, the first in the African continent. These multikilowatt systems are being used to support small businesses such as barber shops, small workshops, refrigerators to provide cold drinks, etc. Again, this opens up new revenue streams for the small businesses in developing communities.

An important paradigm shift in recent years for providing access to electricity in LMICs is the pay-as-you-go (PAYG) financing approach. Similar to how cell phone credits are bought by families of low means in small chunks to provide access to mobile phone service, electricity access can be provided in chunks to families who cannot afford the upfront investment in a solar electric system. Several companies including M-Kopa in Kenya [21], d.light [14], and Sun King [15] offer such schemes. The client pays a down payment for a small solar electric system (typically ~100-200 W) that the company installs in the client's home. The company then finances the balance of the system. A box that can connect and disconnect the electricity supply to the home is located between the home and the solar electric system (see **Figure 8**). The client can pay for an increment of electricity, e.g. 5 kWh through mobile payments. The company can then unlock the box to allow access to this chunk of electricity and once it is consumed, the client can again send a mobile payment to the company for purchasing another chunk of electrical energy.

M-Kopa established the PAYG model for solar financing about 10 years ago. Since then, they have provided “over \$600 million of credit that has enabled over 1 million customers to access solar lighting, energy efficient televisions and fridges, smart phones, cash loans and more” [21]. They have received several awards for their enterprise development including the Financial Times' Africa's Fastest Growing Companies in 2022 award.



**Figure 6.**  
*Sunblazer unit for powering remote communities [19].*

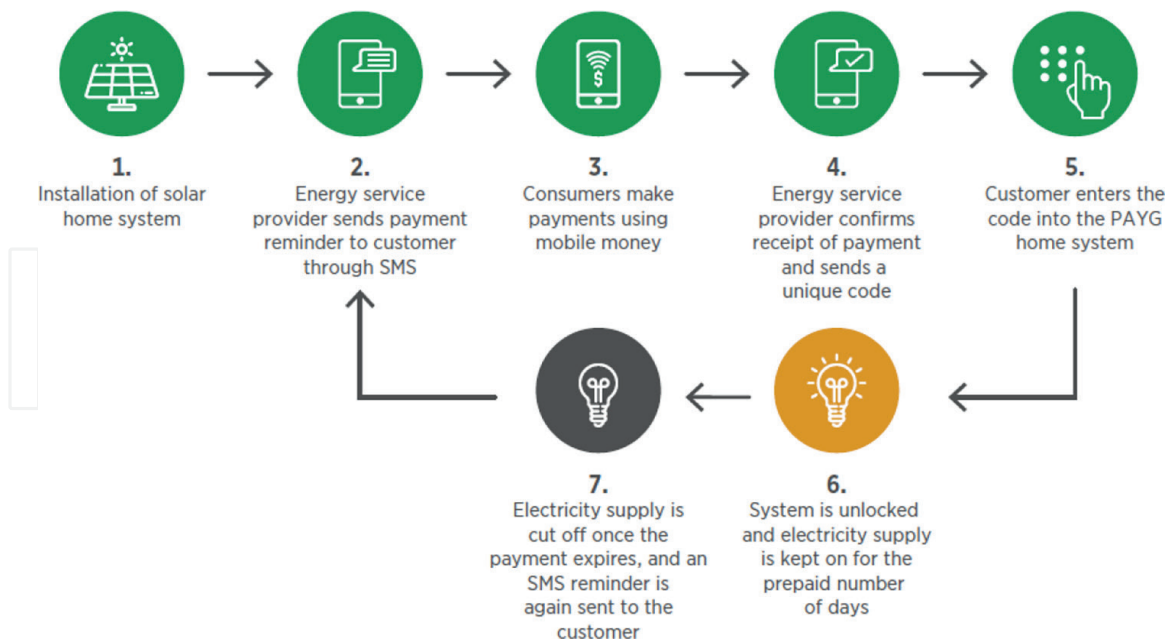


**Figure 7.**  
*Village solar minigrig deployed by REIc in Northwest Cameroon [20].*

### **3. Good health and well being**

UN SDG 3 focuses on Good Health and Well Being and includes several subgoals/targets. Among these are reducing maternal mortality rates, infant and child mortality rates, and reducing the incidence of preventable, non-communicable diseases. In most LMIC's the health care system is a public system which is typically under-resourced both in terms of facilities and qualified medical staff. Patients in these countries are





**Figure 8.** Pay-as-you-go electricity access system concept [22].

often willing to pay for private health services that offer higher quality service than the public health system without the long wait times associated with the public systems.

One approach to offering higher quality of service is through telemedicine programs. These systems may be developed using low-cost communications technology and open-source software. We have implemented such a system in Nicaragua using basic feature phones using 2G connectivity and the open-source software, Rapid SMS, available through UNICEF [23]. An important element of this program was to adequately train the front-line health care workers who generally have limited education and health care training in rural communities in LMICs. In the program we developed, we trained the community health workers (CHWs) both in basic nursing skills as well as in technology. They learned not only to measure basic vital signs, such as temperature, pulse rate, respiration rate, blood pressure, etc. but also to text this information in a coded format using their cell phones to a server. The data was entered into a database on the server as a patient health record. A volunteer doctor reviewed data that was flagged to be out of a normal range and, if necessary, the patient was referred for further clinical investigation. This process could catch manageable diseases, such as diabetes and hypertension, that may be asymptomatic. This could reduce the incidence of premature deaths related to non-communicable diseases.

Also, in the training program, the CHWs were trained in how to deal with issues arising from pregnancy such as eclampsia and pre-eclampsia. We found that the CHWs were better able to handle emergency situations with pregnant women following our training programs and having access to cell phones. They were more informed of the signs of these distresses in pregnant mothers and could use the cell phones to seek professional guidance when dealing with the situation. As a result of our program, several mothers' and infants' health outcomes have been drastically improved.

Of course, during the period of severe Covid restrictions, where people were not allowed to leave their homes, telemedicine consultations grew rapidly in developed countries also. Telemedicine between consultant doctors in cities in developed countries and clinics in developing countries has also been growing as an emerging paradigm to provide a higher quality of health care in LMIC's.

Another entrepreneurial model that the author has witnessed in Managua, Nicaragua, are health kiosks located in shopping centers in the city. Representatives of a for-profit company collect patients' vital signs for free. This information is then shared with pharmaceutical companies that can then suggest appropriate medication that can address health problems uncovered by these health screenings. The pharmaceutical companies therefore provide the support to allow these screenings to be offered for free to the general public while also increasing the market for their products.

A sustainable business model was developed by Prof. Khanjan Mehta for providing medical information in rural communities in Kenya [24]. He discovered that people in the rural communities were interested enough in finding out their medical information (e.g. blood pressure) that they were willing to pay for it. By arranging for one or two nurses to serve a particular catchment area, these vital sign measurement services could be run in a sustainable way [24].

The Aravind Eye clinic in India was established to provide cataract surgeries in remote communities in South India. Using innovations in low-cost replacement lens technology and large volumes of procedures through mobile clinics going out to the field, the Aravind Eye clinic has been able to provide cataract surgeries at low cost and high quality. The surgeons conducting the operations typically perform hundreds of surgeries per day. They have optimized their operations so that patients are rotated through various stages of the operation, including pre-op preparation, surgery, and post-op recovery in a very efficient and streamlined way. This allows the operations to be performed at low cost, high volume leading to low charges for patients. In the case of very poor people who cannot pay even the low fees, their operations are offered at subsidized prices (even free) depending on the patients' financial means [25]. A picture of a nurse examining the eyes of a patient in the Aravind Eye Care system is shown in **Figure 9**.

Business models for primary health care delivery in LMIC's was presented in a paper by Lokman and Chahine [27]. In this paper, the authors studied nine social enterprises delivering primary health care in LMICs in a sustainable, profitable way. They found some common patterns in the business models of these social enterprises as follows. They were all able to purchase medicines in bulk at low cost; they offered flat rate



**Figure 9.**  
*Doctor examining a patient in the Aravind Eye Care System [26].*

pricing for patients but cross-subsidizing for services; they offered high quality health care; and they generated revenue from alternative streams such as selling their in-house IT systems, subscription packages, telemedicine services, franchising, and mobile units.

#### 4. Clean water and sanitation

UN SDG 6 is focused on ensuring availability and sustainable management of water and sanitation for all [23]. Between 2015 and 2020, the percentage of the world's population having access to safely managed drinking water increased from 70–74%. Similarly, the percentage of the world's population having access to safely managed sanitation rose from 47–54% [28]. To obtain universal coverage of these two types of services by the year 2030, the rate of expansion to these services would need to increase four-fold.

Water and sanitation utilities have been improving services to their customers over the last two decades. Such utilities have the expertise and capabilities to effectively manage the development of these systems and to attract commercial financing [29]. There are several examples of water and sanitation successes as presented in [29]. In Brazil, for example, the establishment of world class utilities has resulted in an increase in sanitation services from 73–87% in the last 20 years.

The World Bank has developed an initiative titled “Water Global Practice’s Utilities of the Future” that “supports the establishment of efficient, reliable, transparent, responsive and inclusive utilities.” By putting in place stronger incentives for improved policies and governance of utilities, the goal of this initiative is to “help utilities transition towards a sustainable business model that enables them to build resilient water supply and sanitation services for all” [29].

Gravity-fed water distribution systems are becoming popular in village communities in developing countries. These systems take clean water from above the animal grazing line and pipes it down to communities. These systems provide water to villagers free of contamination from animals grazing at lower levels. These systems are typically built by community members under the guidance of a water committee. This committee also needs to be organized to collect funds to be used for making repairs to the systems in the event of damage to the systems. This type of program may be considered as a social enterprise.

#### 5. Zero Hunger

UN SDG 2 is to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. Large agricultural corporations are turning to more automated systems for farming particularly incorporating sensors and software systems into the agricultural enterprise. This so-called *precision agriculture* is a “farming management strategy based on observing, measuring, and responding to temporal and spatial variability to improve agricultural production sustainability” [30]. The use of this technology can improve land productivity while using fewer resources. Higher productivity can lead to improved crop yield and livestock yield from a particular parcel of land. However, while this technology can benefit large farming corporations, bringing down the cost of the technology for use on small holder farms is still being researched.

Most of the world's poor rely on agriculture for their livelihoods. A significant issue that small holder farmers face is lack of water for irrigating their farms.



**Figure 10.**  
*Deployed drip irrigation system on a farm in India [34].*

Depending on rainfall to water their farms can lead to food insecurity, particularly with climate change adjusting regional rainfall patterns. Being able to irrigate small holder farms can offer farmers increased crop yield, with potentially increasing the number of crop cycles from only one per year to several crop cycles per year and therefore higher income to the families. A technology that offers such an opportunity is treadle pumps. Several versions of this technology have been commercialized but one of the most popular is the Super Money Maker pump [31]. This pump comprises two pedals that a farmer can stand on and alternately move up and down. The up and down motion results in water being pumped in each cycle of the motion. Such systems have been deployed in many different African countries. Over 350,000 of these pumps have been sold and have resulted in 13 million people being fed and \$230 million in new farm profits and wages being produced [32].

Another technology to irrigate and fertilize farms at low cost are drip irrigation systems. In this approach, water and nutrients can be delivered precisely to crops through a series of pipelines. The pumping system may be solar powered so that these systems may be used in remote, small farms which do not have access to grid electricity. This type of system again allows for crop irrigation without reliance on rainfall and can result in multiple crop cycles in a year from a piece of land. An example of a company manufacturing and selling such drip irrigation systems is Netafim, a company headquartered in Israel but with subsidiaries all over the world. The company is operating in 110 countries with 17 manufacturing plants worldwide. They have sold systems to over 2 million farmers [33]. A picture of a deployed Netafim drip irrigation system in India is shown in **Figure 10**.

## **6. Quality education**

UN SDG 4 is focused on providing quality education to all. In low resource settings, providing access to quality educational materials can be a challenge. Several companies have developed entrepreneurial solutions to this challenge.

World Possible is a non-profit corporation based in the US that has developed an open-source hardware-based system with educational content that can be used in locations where the internet is not accessible. Based on the open-source Raspberry Pi micro-computer, the remote area community hotspot for education and learning (RACHEL) device stores educational content on the Raspberry Pi server and distributes it by Wi-Fi to a classroom of students in a school setting [35]. The RACHEL-Plus 4.0 sells for \$500 and includes 500GB of data storage as standard. The educational materials are available in several languages including English, Spanish and French. The standard educational content includes Wikipedia, Kolibri, several mathematics packages, Great Books of the World, Moodle class management software, TED talks, KA Lite, and many more [36]. The Rachel system has been distributed throughout the world. We have also developed our own Rachel-type system by configuring and setting up a Raspberry Pi microcomputer for use in a school computer laboratory in Guatemala [37].

A communications company, Brck, based in Nairobi, Kenya is bringing free connectivity to communities without access to the Internet. They have developed a rugged WiFi router with 8 hours of battery life and an embedded SIM card for 3G Internet access [38]. Interfacing this unit to a Raspberry Pi microcomputer along with the development of ruggedized and customized tablet PCs led to the formation of



**Figure 11.** Tablet PCs plus server laptop computer and router donated by the Telefonica Foundation to the Colegio Liceo in San Cristobal Island in the Galapagos Islands.

the Kio Educational kit [39]. Many of these kits have been distributed to schools in rural communities in Kenya and Uganda, improving the quality of education in these schools.

Other companies have also developed low-cost tablet PCs that are aimed at the educational market. One such company, Datawind, developed one of the first such tablet PCs initially for the Indian market. The company chose to develop a tablet PC with lower features than tablet PCs developed for the developed countries markets. The screens had to be custom made since there were none on the market that met the company's low-cost requirements. The Datawind tablet PC sells for about Rs. 3000 (about \$36) in India and is widely available in schools [40]. In 2015, Datawind accounted for 24% of the 4.4 million Tablet PC sales in India, most of them sold to the Indian government for use in schools [41].

Similar tablet PCs have been deployed in schools globally. For example, in Nicaragua, the Zamora Thurán Foundation supplied the Datawind tablet PCs under the name Mochila Digital to schools. Similarly, the Telefonica Foundation has provided similar tablet PCs to schools in the Galapagos Islands. A picture of the tablet PCs, server computer and the wireless router in their carrying case donated to the Colegio Liceo school in San Cristobal Island in the Galapagos archipelago is shown in **Figure 11**.

The Telefonica foundation has also developed a complete educational program together with educational resources called ProFuturo [42]. This program has been delivered to several schools in the Galapagos Islands. This project again represents a hybrid business model where a large telecommunications company, Telefonica, is using the revenues from its primary business to fund interventions in LMIC schools to improve the quality of education offered in these schools.

## **7. Discussion**

In this chapter, various technology and business innovation models have been considered to address UN SDGs 2, 4, 6, 7 and 8. Some common approaches emerge in the innovations developed to date. The first is hybrid business models where services to wealthier customers are used to subsidize services for poorer clients. The Aravind Eye Care example and the GVE-group solar electric systems are examples of this type of hybrid business approach. A second common theme is that quality of service and attention to customer satisfaction are very important considerations to ensure that the customer is willing to outlay money for the private services rather than relying on public services. Again, the Aravind Eye Care center offers a good example in the health care sector while the sustainable tourism work by Global Himalayan Expeditions offers another excellent example. Third, innovations to improve efficiencies in the delivery of services is common to many of the enterprise approaches described in this book chapter. Fourth, the volume and scale of the enterprise can be used to reduce costs and thereby make the business competitive against other development approaches. The examples of the solar lanterns from d.light and Sun King as well as the tablet PCs from Data Wind are good examples of these business models. Finally, the use of technology to improve services and to support additional means of revenue generation is a common theme seen in the successful enterprises addressing the UN SDGs. In this case, pay-as-you-go models for electricity provision, the low-cost water pumping systems, and the use of open-source hardware and software tools to improve the quality of education are examples of technological innovations.

Areas for further work in this field are to apply these common innovations in technology and business models to other UN SDGs and to deploy these innovations more broadly to scale enterprises to advance progress in meeting the UN SDGs.

## **8. Conclusions**

The UN Sustainable Development Goals outline goals in various development sectors to be achieved by the year 2030. Different mechanisms may be used to address these challenges including public services provided through governments, programs supported through donor aid funded and charitable organizations, or through private enterprise solutions.

In this book chapter we have illustrated various business models that have been used to address several of the UN SDGs. The advantages of entrepreneurial solutions are that they are not reliant on donations or public funds. They are often built out more efficiently than public services and require consideration of financial sustainability in planning the business model right from the outset. Entrepreneurs also must consider growth and scaling of their enterprises to achieve their overall company objectives.

The UN SDGs are scheduled to be met by the year 2030. While significant progress has been made in addressing some of the goals to date, there is still a lot of work to be done to achieve the goals. Entrepreneurial approaches if adequately financed and scaled have the potential to achieve these goals. It is important that the entrepreneurs working to meet these goals are provided the support needed to succeed in their important enterprises.

## **Acknowledgements**

The author gratefully acknowledges the contributions of his students to the educational outreach programs in the various countries (primarily in Nicaragua, Ecuador and Guatemala) in which he has worked. In particular, he would like to thank Javier Urquizo, Viviana Villavicencio, Nathaly Sanchez, Diego Villacreses, John Beyer, Scarleth Vasconcelos, and Melvin Mendoza. He is also grateful to Mr. Edward Tohom of Catholic Relief Services. Finally, he would like to thank professors at various universities with whom he has partnered including Professors Ruth McDermott-Levy, Dr. Betty Keech and Dr. Betty Mariani of Villanova University's, M. Louise Fitzpatrick College of Nursing, Prof. Jim Klingler of the Villanova School of Business and Prof. Maria Virginia Moncada, retired from Universidad Nacional de Ingenieria (UNI), Drs. Cecilia Paredes, Cesar Martin, and Angel Ramirez as well as Prof. Jimmy Cordova of ESPOL and Prof. Elfego Ovalle of Landivar University in Quetzaltenango, Guatemala.

He is also grateful for financial support to Villanova University, Venture Well and Halloran Philanthropies for supporting his work.

This work received funding from Villanova University's Falvey Memorial Library Scholarship Open Access Reserve (SOAR) fund.

## **Conflict of interest**

The author declares no conflict of interest.

## **Notes/thanks/other declarations**

To be added.

IntechOpen

IntechOpen

## **Author details**


Pritpal Singh

Department of Electrical and Computer Engineering, Villanova University, Villanova, USA

\*Address all correspondence to: [pritpal.singh@villanova.edu](mailto:pritpal.singh@villanova.edu)

## **IntechOpen**

---

© 2023 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 



## References

- [1] Available from: <https://sdgs.un.org/goals> [Accessed January 11, 2023]
- [2] Moyo D. *Dead Aid*. London, England: Penguin Books; 2009
- [3] Polack P, Warwick M. *The Business Solution to Poverty*. San Francisco, California, USA: Berrett-Koehler Publishers, Inc.; 2013
- [4] Prahalad CK. *The Fortune at the Bottom of the Pyramid*. Upper Saddle River, New Jersey, USA: Pearson Education, Inc.; 2010
- [5] Karamchandini A, Kubzansky M, Frandano P. *Emerging Markets, Emerging Models*. Rockville, Maryland, USA: The Monitor Group; March 2009
- [6] Apostolopoulos N, Al-Dajani H, Holt D, Jones P, editors. *Entrepreneurship and the UN Sustainable Development Goals*. R. Newbery Emerald Publishing; 2018
- [7] Available from: <https://www.ghe.co.in/Impact/Solar-Energy/> [Accessed January 3, 2023]
- [8] Available from: <https://gve-group.com/services/> [Accessed January 3, 2023]
- [9] Available from: <https://gve-group.com/portfolio/bisanti-village-mini-grid-project/> <https://www.seforall.org/> [Accessed January 3, 2023]
- [10] Available from: <https://gve-group.com/> [Accessed January 3, 2023]
- [11] Available from: <https://www.seforall.org/> [Accessed January 3, 2023]
- [12] Energy Sector Management Assistance Program. *Mini grids for half a billion people: Market outlook and handbook for decision makers*. In: License: Creative Commons Attribution CC BY 3.0 IGO. The full ESMAP report is available for download at the following website. Washington, DC: World Bank; 2022 [Accessed January 3, 2023] Available from: [https://esmap.org/Mini\\_Grids\\_for\\_Half\\_a\\_Billion\\_People\\_The\\_Report](https://esmap.org/Mini_Grids_for_Half_a_Billion_People_The_Report)
- [13] Schnitzer D, Lounsbury DS, Carvallo JP, Deshmukh R, Apt J, Kammen D. *Microgrids for rural electrification: A critical review of best practices based on seven case studies*. Technical Report published by UN Foundation. February 2014. DOI: 10.13140/RG.2.1.1399.9600
- [14] Available from: <https://www.dlight.com/> [Accessed January 3, 2023]
- [15] Available from: <https://sunking.com/> [Accessed January 3, 2023]
- [16] Available from: <https://sunking.com/solar-lanterns/sun-king-pico-plus/> [Accessed January 3, 2023]
- [17] Available from: <https://www.jumia.co.ke/pico-plus-portable-solar-emergency-light-sun-king-mpg327221.html> [Accessed January 3, 2023]
- [18] Available from: <https://sunking.com/solar-news/sun-king-expands-its-series-d-to-330m-with-additional-investment-of-70m-led-by-leapfrog-investments/> [Accessed January 3, 2023]
- [19] Available from: <https://smartvillage.ieee.org/tech/sunblazer-iv/> [Accessed January 3, 2023]
- [20] Available from: <https://rei-cameroon.com/projects-completed> [Accessed January 3, 2023]

- [21] Available from: <https://m-kopa.com/> [Accessed January 3, 2023]
- [22] IRENA. Innovation Landscape brief: Pay-as-you-go models. Abu Dhabi: International Renewable Energy Agency; 2020
- [23] Singh P, McDermott-Levy R, Keech E, Mariani B, Klingler J, Moncada MV. Challenges and successes in making health care more accessible to rural communities in Waslala, Nicaragua using low-cost telecommunications. In: Procs. 2013 IEEE Global Humanitarian Technology Conf. San Jose, CA. Piscataway, New Jersey, USA: IEEE; Oct. 20-22, 2013
- [24] Suffian S, Lackey J, Dzombak R, Mehta K. Demonstrating demand for preventive health services in rural Kenya. *Journal of Humanitarian Engineering*. 2015;3(1):24-35
- [25] Available from: <https://d3.harvard.edu/platform-rctom/submission/aravind-eye-care-system-mcdonaldization-of-eye-care/> [Accessed January 4, 2023]
- [26] Available from: <https://ravoof.com/aravind-eye-care-system-eye-care-for-the-poor/> [Accessed January 4, 2023]
- [27] Lokman L, Chahine T. Business models for primary health care delivery in low- and middle-income countries: A scoping study of nine social entrepreneurs. *BMC Health Services Research*. 2021;21:211
- [28] Available from: <https://sdgs.un.org/goals/goal6> [Accessed January 4, 2023]
- [29] Available from: <https://blogs.worldbank.org/water/utilities-future-how-build-universal-and-resilient-water-supply-and-sanitation-systems> [Accessed January 4, 2023]
- [30] Available from: [https://en.wikipedia.org/wiki/Precision\\_agriculture](https://en.wikipedia.org/wiki/Precision_agriculture) [Accessed January 4, 2023]
- [31] Available from: <http://moneymakerpumps.org/> [Accessed January 4, 2023]
- [32] Available from: <https://kickstart.org/impact/> [Accessed January 4, 2023]
- [33] Available from: <https://www.netafim.com/en/Netafim-irrigation-company-about-us/> [Accessed January 4, 2023]
- [34] Available from: <https://www.netafim.com/en/news-and-events/news/Netafim-Chosen-to-Deploy-Four-Large-Community-Irrigation-Projects-Across-India/> [Accessed January 4, 2023]
- [35] Available from: <https://store.worldpossible.org/pages/about-us> [Accessed January 4, 2023]
- [36] Available from: <https://store.worldpossible.org/products/rachel-plus> [Accessed January 4, 2023]
- [37] Singh P. Collaboration between Landivar University in Guatemala and Villanova University in the US on Humanitarian Projects for Computer Scientists and Engineers. In: Procs. 2022 American Society of Engineering Education Conference. Minnesota USA: Minneapolis; June 2022
- [38] Available from: <https://unreasonablegroup.com/ventures/brck> [Accessed January 4, 2023]
- [39] Available from: <https://brck.com/brck-education-kio-and-kio-kit-launch/> [Accessed January 4, 2023]
- [40] Available from: <https://www.indiamart.com/proddetail/datawind-7sc-tablet-18522341797.html> [Accessed January 4, 2023]

[41] Available from: <https://indianexpress.com/article/technology/mobile-tabs/tablet-sales-grow-to-4-4-million-in-india-datawind-on-top-cmr-study/> [Accessed January 4, 2023]

[42] Available from: <https://fundaciontelefonica.com.ec/educacion/profuturo/>