



# Best Practices for Electrifying Rural Health Care Facilities with Decentralised Renewables



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Rural  
Electrification  
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## **Electricity is a prerequisite to enable quality health services for every health care facility around the globe.**

Decentralised renewable energy is not just an essential pillar to empower health care facilities and vulnerable citizens in their fight against COVID-19, but also a promising catalyst to power tomorrow's clean infrastructure and speed up post-disease socio-economic recovery in the most affected regions across the world.

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## ABOUT THE ALLIANCE FOR RURAL ELECTRIFICATION (ARE)

ARE is an international business association with over 150 Members that promotes a sustainable decentralised renewable energy industry for the 21<sup>st</sup> century, activating markets for affordable energy

services, and creating local jobs and inclusive economies in emerging countries in Sub-Saharan Africa, Asia-Pacific and Latin America & the Caribbean.

With a vision of achieving affordable energy for all, since its inception in 2006, ARE has taken leadership and has established itself for its efforts on mobilisation, linking and coordination of private sector activities with international cooperation and development support programmes. To find out more about how ARE supports sector and industry development please visit: <http://www.ruralelec.org/are-service-lines>

## ABOUT GET.INVEST

GET.invest is a European programme which supports investments in decentralised renewable energy. The programme works with private sector business and project developers, financiers and regulators to build sustainable energy markets.

Services include project and business development support, market information as well as matchmaking. They are delivered across different market segments.

GET.invest is supported by the European Union, Germany, Sweden, the Netherlands, and Austria, and works closely with other initiatives and industry associations. Learn more on the GET.invest website: <https://www.get-invest.eu/>

## ARE-GET.INVEST COOPERATION

ARE and GET.invest work towards the common goal of advancing the development and bankability of decentralised renewable energy projects in developing markets. Based on this shared objective, ARE and GET.invest cooperate on several activities, including information and matchmaking events with developers, financiers and government officials, capacity building activities for the public and private sector, as well as outreach and mobilisation activities, such as publications, workshops, webinars and business delegations.

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## LIST OF ABBREVIATIONS

<b>AE Solar</b> Alternative Energy Solar	<b>EUR</b> Euro	<b>NEP</b> Nigeria Rural Electrification Programme	<b>SHS</b> Solar Home System
<b>AC</b> Alternating Current	<b>GHG</b> Greenhouse Gas	<b>NGO</b> Non-governmental Organisation	<b>TTA</b> Trama TecnoAmbiental
<b>AGM</b> Absorbent Glass Mat	<b>H<sub>2</sub></b> Hydrogen (molecular formula)	<b>Nm<sup>3</sup></b> Normal Cubic Metre	<b>UN</b> United Nations
<b>Ah</b> Ampere hour	<b>HH</b> Household	<b>NTUA (ICCS)</b> National Technical University of Athens (Institute of Communication and Computer Systems)	<b>UN DESA</b> United Nations Department of Economic & Social Affairs
<b>ARE</b> Alliance for Rural Electrification	<b>HTES</b> HT ENERGY (S) Sdn Bhd	<b>OPEX</b> Operational Expenditure	<b>UNOPS</b> United Nations Office for Project Services
<b>ATM</b> Automatic Teller Machine	<b>IDCOL</b> Infrastructure Development Company Limited	<b>OPzV</b> Ortsfest Panzerplatte Verschlussen	<b>URC</b> University Research Co. LLC
<b>BOO</b> Build Own Operate	<b>KAPEG</b> Kathmandu Alternative Power and Energy Group	<b>O&amp;M</b> Operations & Maintenance	<b>USAID</b> U.S. Agency for International Development
<b>BTU</b> British Thermal Unit	<b>km</b> Kilometres	<b>PAYGO</b> Pay-as-you-go	<b>USB</b> Universal Serial Bus
<b>CAPEX</b> Capital Expenditure	<b>KPI</b> Key Performance Indicator	<b>PEEDA</b> People, Energy & Environment Development Association	<b>USD</b> United States Dollar
<b>CHAZ</b> Churches Association of Zambia	<b>kVa</b> Kilovolt-ampere	<b>PHC</b> Primary Health Centre	<b>V</b> Volt
<b>CHC</b> Community Health Centres	<b>kWa</b> Kilowatt-ampere	<b>PPA</b> Power Purchase Agreement	<b>VA</b> Volt-ampere
<b>CHPS</b> Community-based Health Planning & Services	<b>kWh</b> Kilowatt-hour	<b>PV</b> Photovoltaic	<b>VDC</b> Volts Direct Current
<b>CHPS</b> Community-based Health Planning & Services	<b>kWp</b> Kilowatt-peak	<b>PWM</b> Pulse-width Modulation	<b>W</b> Watt
<b>CMCTH</b> Chitwan Medical College Teaching Hospital	<b>LED</b> Light Emitting Diode	<b>RBF</b> Results-based Finance	<b>WCS</b> We Care Solar
<b>CO<sub>2</sub></b> Carbon Dioxide	<b>MC4</b> Multi-contact 4 mm	<b>RE</b> Renewable Energy	<b>Wh</b> Watt-hour
<b>COVID-19</b> Coronavirus Disease 2019	<b>MCB</b> Miniature Circuit Breaker	<b>RREP</b> Rural Renewable Energy Project	<b>WHO</b> World Health Organization
<b>CSR</b> Corporate Social Responsibility	<b>MENA</b> Middle East & North Africa	<b>RurERG</b> Rural Electrification Research Group	<b>VISIONS</b> Wuppertal Institute for Climate, Environment & Energy
<b>DC</b> Direct Current	<b>MoE</b> Ministry of Energy		
<b>DFID</b> UK's Department for International Development	<b>MoF</b> Ministry of Finance		
<b>DISCOM</b> Electricity Distribution Company	<b>MoH</b> Ministry of Health		
<b>DRE</b> Decentralised Renewable Energy	<b>MPPT</b> Maximum Power Point Tracking		
<b>ECG</b> Electrocardiogram	<b>MW</b> Megawatt	<b>SEforALL</b> Sustainable Energy for All	

# 1. Introduction





## 1. INTRODUCTION

In 1946, the World Health Organisation (WHO) recognised access to quality health services as a fundamental human right “without distinction of race, religion, political belief, economic or social condition”.<sup>1</sup> Yet health care remains a privilege for only half of the world’s population today.<sup>2</sup> One of the main barriers to achieve SDG-3 is the lack of sufficient and reliable electricity, which is an enabler for health care facilities to provide essential services. The WHO notes that 70% of medical devices cannot be used in developing countries due to unreliable power supply,<sup>3</sup> while the United Nations (UN) Foundation and Sustainable Energy for ALL (SEforALL) estimate that only 41% of health care facilities have access to electricity across the world.<sup>4</sup> This figure is significantly lower in rural areas of Sub-Saharan Africa, with a rate of only 28%,<sup>5</sup> and India, where 46% of health care facilities serving an estimated 580 million people lack reliable electricity access. The absence of quality health services is attributed to the death of more than 289,000 women and 1.7 million children annually worldwide.<sup>6</sup>

**Electricity is a prerequisite to enable quality health services for every health care facility around the globe. Today, many modern medical appliances used to provide basic services such as medical refrigerators, sterilisers, incubators, microscopes and electrocardiogram (ECG) machines need a source of reliable electricity to function.**<sup>7</sup> In practice, the lack of reliable electricity often means that doctors need to deliver emergency services such as childbirths and surgeries in near darkness, without the necessary equipment or elemental sterilisation standards.

Additionally, a stable supply of quality electricity can significantly improve work-

ing conditions for health workers, thus increasing the ability of isolated health care facilities to retain and attract highly skilled medical labour to rural areas and thereby improving their health services to the surrounding local communities.<sup>8</sup>

**AGAINST THIS EMERGENCY BACKGROUND, DECENTRALISED RENEWABLE ENERGY OFFERS THE CLEANEST, CHEAPEST AND SMARTEST SOLUTION TO ELECTRIFY RURAL HEALTH CARE FACILITIES IN MOST CASES**

**While the struggle of rural communities to access quality health services has always been a critical issue, the COVID-19 pandemic in 2020 has highlighted the essential role that electricity plays in rural health care facilities.** More than ever, health care workers are required to conduct screenings and tests on the local population,<sup>9</sup> treat infected people using safe,

1 WHO, *Human Rights and Health*, 2017 (online)

2 WEF, *Half of the world’s population lack access to essential health services – are we doing enough?*, 2019 (online)

3 WHO, *Medical Devices: Managing the Mismatch*, 2010: page 56

4 UN Foundation & SEforALL, *Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education*, 2019: page 10

5 WHO & WB, *Access to modern energy services for health facilities in resource-constrained settings: a review of status, significance, challenges and measurement*, Reprinted in 2015 with changes, 2014: page 2

6 SEforALL, *Powering Health Care*, 2019 (online)

7 WHO & WB, *Access to modern energy services for health facilities in resource-constrained settings: a review of status, significance, challenges and measurement*, Reprinted in 2015 with changes, 2014: page 22-30

8 DFID & Mini-Grids Partnership, *Update on UK DFID support to the Green Mini-Grids sector in Africa*, 2019 (online)

9 Solarkiosk & UNITAR, *Solarkiosk & UNITAR launch a “Solar Power Initiative against COVID-19”: Increasing Response Capacities of African Healthcare Systems*, 2020 (online)

sterilised medical equipment, store blood and vaccinations and perform emergency operations at night.<sup>10</sup> Furthermore, electricity is also needed for ventilators, which are vitally important when treating respiratory diseases like COVID-19.

**Against this emergency background, decentralised renewable energy (DRE) offers the cleanest, cheapest and smartest solution to electrify rural health care facilities in most cases.<sup>11</sup>**

Based on recent data from ARE Members, DRE projects for health care facilities can take less than five months from inception to commissioning, with procurement processes taking three months while shipping, customers and installation on site takes two months (the actual installation only taking a few days). **In times of need, this time frame can be shortened further.**

Moreover, **DRE is not just an essential pillar to empower health care facilities and vulnerable citizens in their fight against COVID-19, but also a promising catalyst to power tomorrow's clean infrastructure and speed up post-disease socio-economic recovery in the most affected regions across the world.**

As demonstrated by the case studies in this publication, DRE lays the foundation for the post-COVID-19 recovery by creating a suitable environment for local enterprises to grow, innovate and increase job opportunities while ensuring food and water supply, safety and other essential needs that enable communities to flourish.<sup>12</sup>

With this in mind, the Alliance for Rural Electrification (ARE) stands by the DRE sector to fast-track<sup>13</sup> the electrification of health care facilities across the world with clean, cost-effective and reliable energy. By showcasing 16 relevant case studies from ARE Members, this publication aims to demonstrate the ability of DRE solutions to quickly deliver sustainable, quality power for rural health care facilities and in turn serve as inspiration for new projects.

**With additional support from governments, international funding partners and philanthropies, ARE believes it is possible to scale up and electrify thousands of health care facilities in a matter of a few months.**



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CEO *ad interim*  
Alliance for Rural Electrification

<sup>10</sup> UN Foundation & SEforALL, *Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education*, 2019: page 22

<sup>11</sup> ARE & GIZ, *Position Paper - Off-Grid Renewable Energies to achieve SDG-7 and SDG-13: Cheaper, Cleaner and Smarter*, 2020: page 1-3

<sup>12</sup> AEEP & ARE, *The Productive Use of Renewable Energy in Africa*, 2015: page 5-6

<sup>13</sup> ARE, *Call to Action: Roadmap for the DRE sector to survive and flourish in the wake of the COVID-19 crisis*, 2020: page 6



# 2.

## Executive Summary



## 2. EXECUTIVE SUMMARY

The objective of this publication is to demonstrate best practices for electrifying rural health care facilities with decentralised renewables. The case studies featured in this publication exhibit diversity both in the challenges faced to electrify rural health care facilities, as well as in the delivery models that DRE companies have used to overcome these challenges.

In view of best practices from this publication, it appears that **projects to electrify rural health care facilities must combine speed and scale of delivery in the short term, with project sustainability and longevity in the long term**. The sense of urgency caused by health crisis like pandemics underlines the need for an immediate response.

Evidence from this publication also shows that a number of delivery models and technologies can help address these challenges, most notably through crowding in of private investments, deployment of high quality and modular DRE technologies, as well as by developing strong partnerships between DRE companies, governments and communities.

Overall, ARE finds that the short- and long-term goals are best met through a **public-private partnership delivery model that combines smart grants with a market-based compensation mechanism** (see figure 1).

The **smart grant ensures speed and scale of delivery in the short term**, notably through grants to (co-) finance upfront capital expenditures of projects (CAPEX), results-based financing (RBF) schemes, or a combination of both, which can effectively crowd-in private investment in the projects themselves or the actors implementing them. To further de-risk private sector investment, additional measures, such as a concessional debt finance facility in local currency, could also be considered.

The **market-based compensation mechanism secures sustainability and longevity in the long term as operators will be incentivised to maintain and operate the DRE systems over the project lifecycle**. The mechanism could be structured as a long-term power purchase agreement

(PPA) between the DRE operator and a relevant government entity, for example the Ministry of Health (MoH) or Ministry of Finance (MoF), which oversees the health care facilities, backed by a guarantee from a development finance institution (DFI).

As a result, ARE recommends that support from international funding partners, governments and philanthropies focuses on the following areas: providing smart grants, guaranteeing off-taker payments, supporting the development of standard PPA clauses and contracts, supporting inventory financing, optimising the processes of existing programmes, facilitating deployment of high quality and robust technologies, supporting data gathering and assisting governments and private sector with technical assistance.

**GOALS ARE BEST MET THROUGH A PUBLIC-PRIVATE PARTNERSHIP DELIVERY MODEL THAT COMBINES SMART GRANTS WITH A MARKET-BASED COMPENSATION MECHANISM**

In recognition of the pivotal role of national and regional governments in electrification schemes for rural health care facilities, ARE proposes that governments enable public-private partnerships as described above, such as through engaging in PPAs with private sector for multiple health care facilities to aggregate demand, identifying and assessing priority health care facilities to be electrified, setting key performance indicators (KPIs) for private operators including adherence to technical standards and supporting data gathering.

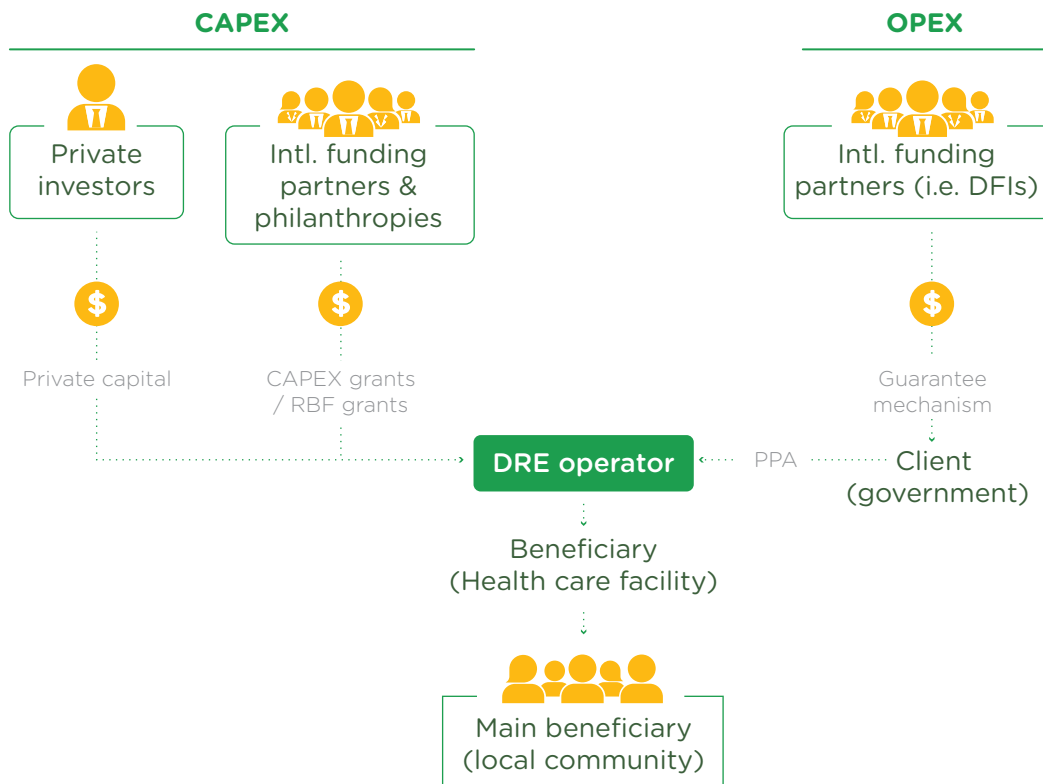


Figure 1: Proposed PPA model



# 3.

## Recommendations







### 3. KEY RECOMMENDATIONS FOR INTERNATIONAL FUNDING PARTNERS, PHILANTHROPIES AND GOVERNMENTS

Based on best practices from the 16 case studies in this publication and general observations, ARE has the following recommendations for governments, international funding partners and philanthropies that wish to support electrification of rural health care facilities fast and at scale, but also sustainably and with a long-term perspective (see summary of recommendations in figure 2).

#### RECOMMENDATIONS TO SUPPORT LONG-TERM FINANCIAL, TECHNICAL AND SOCIAL SUSTAINABILITY OF PROJECTS

**Financial sustainability of the operator of the DRE system over the lifecycle of the project is a central challenge across health care electrification projects.** The end-user, the health care facility, may experience difficulties in paying for electricity, as public budgets allocated to the facility might not fully consider or prioritise spending money on electricity payments on a regular basis.<sup>14</sup> The high off-taker risk makes the business case difficult for the

operator and limits the appetite for large-scale private investments in such projects.

Similarly, the **technical sustainability of projects, related to the operations and maintenance (O&M) of systems is also challenging.** Challenges are especially rooted in lack of budget allocations for

**FINANCIAL AND TECHNICAL SUSTAINABILITY CHALLENGES CAN BEST BE ADDRESSED THROUGH A MARKET-BASED COMPENSATION MECHANISM**

<sup>14</sup> World Bank, *Increasing Human Capital by Electrifying Health Centers, and Schools through Off-Grid Solar Solutions*, 2020: page 2

operational expenditures (OPEX) during the project lifecycle and in defining sustainable O&M plans that secure longevity of systems.<sup>15</sup> Failure to do so increases operational risks, as the absence of allocated budgets complicates and delays the replacement of, for instance, broken equipment.

**Best practices from ARE members demonstrate a variety of innovative ways to address these challenges.** For example, DRE companies are using innovative technologies such as cloud-based monitoring platforms, modular clinics, smart meters, new storage methods, high quality inverters and other digital tools to increase technical sustainability.

**Concerning the delivery and business model, ARE believes that financial and technical sustainability challenges can best be addressed through a market-based compensation mechanism,** such as a long-term PPA over 10-15 years, between the MoH, or another relevant Ministry, and the DRE operator. The Ministry pays for electricity consumption of one or several health care facilities in this model. Quality O&M will be delivered, as in addition to good business practices, the DRE operator has a financial incentive to operate and keep the system running throughout the lifecycle of the project.

To improve the risk profile of such projects further and the ability of DRE companies to access cheaper finance, **ARE advises that DFIs implement guarantee schemes to mitigate risks for all stakeholders.** To make the guarantee scheme more nuanced, different risk matrices can be developed according to government capacities and different electricity requirements of health institutions.

The guarantee not only reduces the financial risk of projects, but also the risk of project failure. It therefore benefits all stakeholders, notably the DRE company, Ministry, funding partners, doctors at the rural health facilities and patients of the clinic in rural communities.

To facilitate PPAs between governments and private sector, **ARE further recommends that standard contractual clauses for PPA agreements between DRE companies and public off-takers are developed** (as has been done for humanitarian settings).<sup>16</sup>

Another related **challenge emerging from the case studies is the social sustainability**

## HEALTH CARE ELECTRIFICATION PROJECTS COULD ALSO BE STREAMLINED WITH INTEGRATED ELECTRIFICATION APPROACHES THAT TARGET NOT ONLY THE HEALTH CARE FACILITIES AS END-USERS, BUT ALSO AIM TO CREATE LONG-LASTING SOCIO-ECONOMIC IMPACT

**of the projects.** Best practices show that to ensure social sustainability, projects need to have a strong governance structure that includes many diverse actors, including the local and national public sector (energy, health and finance ministries), local communities, as well as the private sector. The governance structure should clearly define responsibilities, secure accountability, limit bureaucracy and define ownership, while empowering local communities via knowledge transfer and capacity building.<sup>17</sup>

<sup>15</sup> IRENA, *Off-Grid Renewables Supply: Life-Saving Power to Rural Health Centres*, 2018: page 2

<sup>16</sup> GIZ, GPA & BBH, *Identification and analysis of standard clauses of PPA and leasing agreements for energy provision in the humanitarian sector*, 2020

<sup>17</sup> UNF & SEforALL, *Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education*, 2019: page 36

ARE thus believes that a public-private partnership, where the private sector operator co-invests, builds, operates and maintains systems and where the government is the customer and sets clear and measurable KPIs and quality standards for the operator, addresses this challenge.

## ROBUST, HIGH QUALITY AND INNOVATIVE TECHNOLOGIES PLAY A CENTRAL ROLE IN ENABLING LONG-TERM SUSTAINABILITY OF ELECTRIFICATION PROJECTS FOR RURAL HEALTH CARE FACILITIES

Moreover, the case studies show that **local communities play a central role in the success of DRE projects for health care facilities**. Communities should be involved throughout the project in the decision-making process, as well as in the design, installation and post-commissioning phases, for example as local technical and sales experts. Furthermore, communities play a key role in averting vandalism and theft of assets thus lowering the risk profile of such projects further. The case studies in this publication indicate that **training local technical staff to help operate DRE solutions systems is central to project success**. Such training can be conducted through capacity building programmes, which can be developed by private sector in partnership with governments, international funding partners and philanthropies.

Health care electrification projects could also be streamlined with integrated electrification approaches that target not only the health care facilities as end-users, but also aim to create long-lasting socio-economic impact by supporting local entrepreneurs and other productive uses of energy,<sup>18</sup> such as agriculture. In particular, best practices in various Sub-Saharan and Asian countries, illustrate that the power infrastructure of the health facility could serve as the central node from which the surrounding area can be electrified.<sup>19</sup> In this case, the business model can be rooted in providing electricity services to more customers and in more broad socio-economic development and income generation via productive uses of energy. This, in turn, also means that CAPEX investments will be higher than in electrification projects that uniquely address rural health facilities.

More holistic projects will enable broader sustainable development, rather than 'working in silos'. Best practices indicate that there can be strong linkages between the energy and health sectors, for example in offering of energy efficient electrical equipment and appliances such as vaccine refrigerators or X-ray equipment. On this note, it is important to **understand and have adequate data in order to accurately understand the load of each clinic and therefore the size of the DRE configurations**.

As shown in the case studies, special attention should also be paid to **ensure an equal and gender-balanced selection of the local stakeholders to be involved in such cross-cutting and productive use programmes**.

Lastly, it is clear from the publication that **robust, high quality and innovative technologies play a central role in enabling long-term sustainability of electrification projects for rural health care facilities**. The case studies in this publication demonstrate a wide variety of such technological solutions ranging from modular DRE solutions and clinics to cloud-based control platforms, inverters and other software. For example, remote monitoring software,

<sup>18</sup> AEEP & ARE, *The Productive Use of Renewable Energy in Africa*, 2015: page 5

<sup>19</sup> DFID & Mini-Grids Partnership, *Update on UK DFID support to the Green Mini-Grids sector in Africa*, 2019 (online)



installed within or in combination with the DRE system, can help tremendously with O&M by making maintenance efforts mostly proactive, rather than reactive. A major factor is the ability to carry out remote assessments, and hence for the DRE company to delegate preventive maintenance to on-site local technical staff.

**Governments, international funding partners and philanthropies can support the proliferation of high-quality technologies by prioritising high-quality equipment in tenders, by prioritising delivery models as described above, by including quality innovation as a scoring criteria or by supporting innovation competitions.**

### RECOMMENDATIONS TO INCREASE THE SPEED AND SCALE OF DELIVERY OF HEALTH CARE ELECTRIFICATION PROJECTS

In the face of health crisis and pandemics such as COVID-19, the need to rapidly electrify rural health care facilities at scale is apparent. **Projects to electrify rural health care facilities must combine speed and scale of delivery in the short term, with project sustainability and longevity in the long term.**

Best practices from ARE members show that international funding partners and philanthropies can **increase the speed and the scale of deployment by de-risking private sector investments in these projects via a smart grant mechanism.** The mechanism could either direct CAPEX grants to (co-) finance projects or an RBF mechanism, where payments are made to the DRE operator based on pre-defined and verified KPIs, or a combination of both.

As an additional support to mitigate currency exchange risks for DRE companies and hence de-risk and crowd-in more private capital, international funding partners and philanthropies could consider **supporting a concessionary debt facility, which can offer long-term and low interest loans in local currency.**

More efforts are also needed to **gather accurate data on the exact amount of health care facilities that are unelectrified or underserved and their location.** New technologies such as GIS mapping pioneered

by ARE members can play a critical role in addressing this need. Additionally, **more nuanced data collection is necessary to measure reliability and quality of electricity services in already electrified health facilities,** as power supply might be unreliable and thus result in lower quality of services for patients of these clinics. A more nuanced picture is also needed to identify energy needs of health facilities of various sizes. A mapping exercise of existing and past projects related to electrification of rural health care facilities, could also be conducted to avoid duplication of efforts and better inform future programmes.



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Furthermore, ARE recommends that international funding partners and philanthropies could **help support inventory financing for DRE products, equipment and components.** Various types of DRE products, equipment and components could be stored in hubs around Sub-Saharan Africa, South and South-East Asia, as well as Latin-America and the Caribbean, much closer to project locations. **This would reduce project delivery times, as procurement of equipment and shipping would be facilitated.** The biggest advantage is to separate a fully transparent and competitive procurement process from the actual deployment of the DRE assets, which may be required on very short notice when the need is most critical as in the case of a pandemic or a climate disaster. A satisfactory procurement process that meets both the Government's and the funding partners' requirements, may take many months. Deployment on the other hand may be required in a matter of days. Inventory fi-



nancing presents a workable solution to this conundrum.

Inventory financing is prominent in other industrial sectors, such as the car manufacturing industry and typically involves a line of credit or concessional loans made by financiers to private sector companies, allowing the companies to produce and stock goods before these are purchased by end-users.<sup>20</sup> With this type of loan, the business' inventory can then also be used as collateral against the loan and can be surrendered to the lender in case the business is unable to repay.

In line with this argument, ARE believes that **procurement and import procedures could be optimised and bureaucracy reduced in existing programmes funded by international funding partners**. For example, additional flexibility could be given to DRE operators in choosing their suppliers for projects under programmes that are currently being rolled-out.

The cases presented in this publication show that **government agencies are instrumental in building up the framework for an integrated electrification approach to electrifying health care facilities at scale**. For example, governments play a key role in identification and assessment of the energy needs of rural health care facilities. They can thus support demand aggregation of sites, which are often

remote and have relatively low energy demand by bundling such projects to make a more attractive an aggregated project portfolio for private investors.

Moreover, as demonstrated in many ARE case studies, **governments can also work in tandem with the private sector to develop standardised capacity building programmes for local operators and sales agents, which helps create jobs in rural communities**. Without such programmes, human resources in local communities to operate systems might be limited.

Lastly, **governments play an instrumental role in setting and enforcing standards for quality electricity provision, consumer protection and project evaluation**. For instance, government-led tendering and quality assurance processes can be streamlined by leveraging digital technologies and platforms, including pre-qualification of private operators, could for example be done via online platforms, as done in the Nigeria Rural Electrification Programme (NEP).<sup>21</sup> To implement all these activities, governments might in some instances require additional support and technical assistance, for example in the form of project preparation support.

This includes support for the design of technical and financial solutions unique to each geography, support for the tender process and capacity building and more.



20 Cox Automotive, [2017 Used Car Market Report](#), 2017, page: 19

21 Odyssey Energy Solutions, [Case Study | Nigeria Electrification Project](#), 2019 (online)

Challenge	Recommendation	Stakeholder
<b>Financial sustainability</b>	 Power-purchase agreement (PPA) between a public authority and the DRE operator	DRE operators; governments
	 Guarantee schemes to support PPA	International funding partners (i.e. DFIs)
<b>Technical sustainability</b>	 Support high quality and innovative technology	International funding partners; governments; philanthropies
	 Capacity building programmes to train local technical staff to help sustain the O&M of DRE solutions	DRE operators; governments
<b>Social sustainability</b>	 Inclusive project governance structure in partnership with local communities defining responsibilities, accountability and ownership	Governments; private sector
	 Streamline health care electrification projects with integrated electrification approaches	International funding partners; governments; philanthropies
<b>Speed &amp; scale of delivery</b>	 Smart grant mechanisms to de-risk private sector investment	International funding partners; philanthropies
	 Concessionary debt facility to offer long-term and low interest loans in local currency.	International funding partners; philanthropies
	 Inventory financing for DRE products, equipment and components	International funding partners; philanthropies
	 Optimise procurement and import procedures and reduce bureaucracy existing programmes funded by international funding partners	International funding partners; governments
	 Improve the availability of data through data gathering and mapping exercises	International funding partners; governments; philanthropies
	 Set and enforce standards for quality electricity provision, consumer protection and project evaluation	Governments

Figure 2: Summary of recommendations

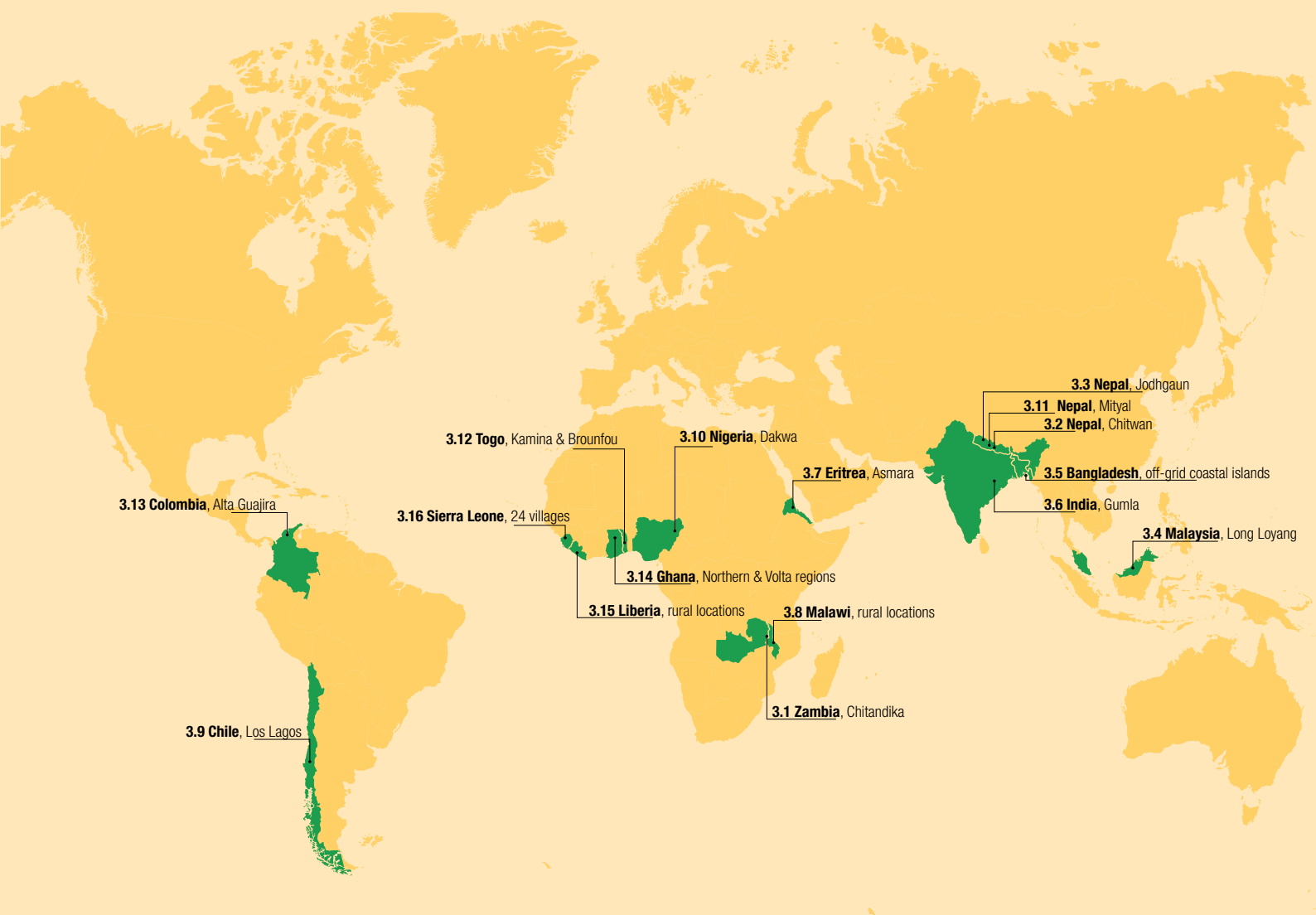


# 4.

## Case Studies



# ARE MEMBERS IMPACT IN ELECTRIFYING RURAL HEALTH FACILITIES: 16 CASE STUDIES AT A GLANCE





### 3.1 ENGIE POWERCORNER ZAMBIA 28.35 KWP SOLAR PV MINI-GRID (ZAMBIA, CHITANDIKA)

March 2018 - April 2019

#### Stakeholders

- » **DRE project developer:** ENGIE PowerCorner Zambia
- » **Customers:** Chinunda Rural Health Centre and Chitandika community
- » **Beneficiaries:** Chitandika community and surrounding villages

## CONTEXT

Chinunda Rural Health Centre is the main health care facility in Chitandika, Eastern Province, Zambia, servicing at least 20 villages in a radius of 20 km. The average demand of the Chitandika village is 22.5 kW and around 2 kW for the health care facility. Chinunda Rural Health Centre had initially received support from USAID and Churches Association of Zambia (CHAZ) in the construction of a maternity & mothers shelter, and some solar panels to power up the administration block. When ENGIE PowerCorner installed the mini-grid in Chitandika, the Chinunda Rural Health Centre, through the District Health Office, formally made a request to be connected to the mini-grid to supply power to the maternity ward, general wards, administration block and staff houses. The health care facility claimed that the solar panels previously placed at the administration block were not sufficient for the provision of health services, especially at night (i.e. in the maternity ward, where nurses would use phone lights for deliveries and manual suction pumps for complicated births). Similarly, the panels did not provide enough electricity to maintain and operate Smart Care, an online programme used by the Ministry of Health (MoH) for health record filing.

## DRE SOLUTION

ENGIE PowerCorner Zambia escalated its engagement to the highest offices in the district and province to obtain the necessary buy-in and commitments to ensure timely payments for the connections. Community consultations were carried out to gather information of the power ratings for all connection bundles as well as of the tariff prior to installation works, to enable

customers make informed decisions. ENGIE has a strict adherence to health and safety for all its employees and customers. As such, monthly trainings are held for these and other customer queries. A local operator is also trained to provide reliable customer services and basic maintenance.

The solution was a 28.35 kWp smart solar photovoltaic (PV) mini-grid, with 96 kWh of battery storage and a three phase distribution grid of 9 km. The solution also includes smart metering and cloud-based supply, as well as demand side management and a payment platform.



©Engie PowerCorner

## BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 250,000, comprising mainly equity (70%) and a small grant (30%). The business model has a focus on the productive use of electricity, enabling the unlocking of the economic potential of rural communities. Smart metering and the cloud-based payment platform greatly limits operation

and management costs, such as logistics and fault resolution. All customers have access to electricity by topping up their pay-as-you-go (PAYGO) meter. The system is owned by ENGIE PowerCorner Zambia.

## PROJECT OUTCOMES

Since the installation of the mini-grid, the quality of the health services for the region has significantly increased, with better maternity care for pregnant women. Through the power generated from the mini-grid, several fridges have also been able to be electrified, allowing for the storage of vaccines and medicine, and saving lives thanks to the timely administration of medicine in case of illness or accident. Finally, the Chitandika Health Centre has been able to retain and attract health workers due to its improved access to electricity, providing a promising future and higher quality of life and work.

There are currently 127 customers (including households) connected to the grid, benefitting 635 people and improving health care for at least 1,200 people every month. Overall, 40 jobs were created, including two employees that have stayed in the village and the remaining 38 had access to part-time jobs related to construction, carrying poles, batteries, etc. Furthermore, an estimated 100 tonnes of CO<sub>2</sub> per year have been saved.

## LESSONS LEARNT AND NEXT STEPS

One of the main barriers for the project developer arose from administrative delays, which slowed down the flow of public money to pay for the connection fees of the public institutions. An alternative solution for public institutions could be to engage in income-generating activities able to cover part of the connection fees, such as selling vegetables and crafts.

ENGIE PowerCorner has a pipeline with a target of 60 sites in five provinces, which have been endorsed for development of mini-grid activity.

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## 3.2 GHAM POWER PRIVATE LIMITED: 200 KWP SOLAR PV ROOF-TOP SOLUTION (NEPAL, CHITWAN)

November 2019 - March 2020

### Stakeholders

- » **DRE project developer:** Gham Power Private Limited
- » **Customer:** Chitwan Medical College Teaching Hospital (CMCTH)
- » **Beneficiaries:** Chitwan community

### CONTEXT

CMCTH is one of the biggest hospitals in Nepal. It consumes 1.6 million kWh energy per year and spends EUR 250,000 annually to cover utility energy costs. Nepal's utility grid is unreliable and the diesel generator backups previously used by CMCTH increased energy costs and carbon emissions. At the beginning, it was difficult for the hospital to afford the upfront system cost. Local banks do not have an appetite for long-term financing of such projects, so an innovative financing model was developed, allowing CMCTH to not make an initial outlay to fund the project but pay for energy usage under a PPA contract instead.

### DRE SOLUTION

The system installed at CMCTH is grid-tied and consists of 200 kWp solar panels with a 175 kW inverter. The system is owned by Gham Power, which also provides reliable after-sales service for the entire project period through local operator partners. CMCTH provides people with many health services such as X-rays, surgeries, ECGs and 24/7 emergency services. The additional solar energy provided by the solar PV system works as a backup to help the hospital provide its services more effectively, even when power cuts occur, while reducing CO<sub>2</sub> emissions.

### BUSINESS MODEL AND PROJECT FINANCING

The total budget of the project was EUR 125,000, funded entirely by Gham Power and leased to CMCTH under a PPA contract at EUR 0.09/kWh. The installed system at CMCTH applies the OPEX model,

allowing customers to install solar without any initial investment. The rate of the PPA is lower than Nepal Electricity Authority's (the national utility) rate. Gham Power owns the system for 15 years, during which CMCTH will pay back Gham Power. After those 15 years, the hospital will legally own the system and get access to solar electricity for 10 additional years. The system has helped reduce the daily load by 800 kWh throughout the year.



©Gham Power

To ensure the long-term sustainability of the project, the Gham Power organised training programmes for local operators, and it currently provides its customers with a reliable after-sales service for the entire project period of 15 years. The trainings were provided to teach the staff of the hospital to handle general issues in the system, such as restarting the system in case of malfunction. The ultimate goal of the trainings was to ensure the provision of quick-response services combined with remote support. These services are managed locally by Gham Power, which supports its local staff on the ground and they include: cleaning of solar modules, checking the voltage on the PV combiner and all me-



tre readings, as well as technical support in case of system failure.

## OUTCOMES

CMCTH employs more than 1,400 people and provides services to approximately a quarter of a million people annually, with more than 1,500 patients. The installed system can power critical medical equipment like ECG, anesthesia and radiography machines, etc. After its installation, the PV system has been estimated to save 196 tonnes of CO<sub>2</sub> emissions per year. Gham Power also estimates that the system will help save EUR 175,000 over the project lifetime, thanks to a reduction in the overall cost of electricity, as the solar PPA price is more competitive than that offered by the national utility, as well as a decrease in diesel consumption.



©Gham Power

## LESSONS LEARNT AND NEXT STEPS

While energy supply is critical for health institutions, the cost incurred is relatively high in order to maintain a consistent supply. Solar is a good solution, but the financing model needs to be worked out. If the financing term is sufficiently long (more than 10 years), solar power can be used to provide electricity to health institutions at a cost that is cheaper than the national grid's tariff. Furthermore, digital tools can be vital in measuring system performance, predicting failures and responding to any technical faults quickly when delivering solar solutions to institutions in remote locations.

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### 3.3 GRID ALTERNATIVES: 3.19 KWP SOLAR PV SYSTEM WITH BATTERIES (NEPAL, JODHGAUN)

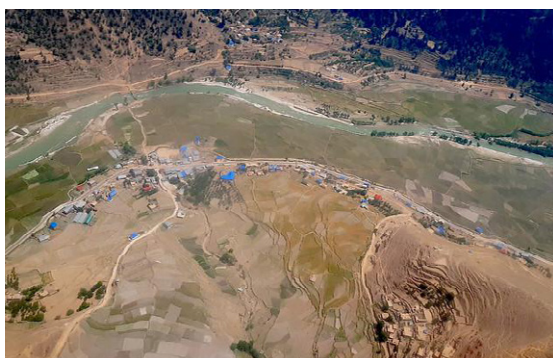
June 2018 - June 2019

#### Stakeholders

- » **DRE project developer:** GRID Alternatives
- » **Customer:** Action Works Nepal and Municipality of Jodhgaun
- » **Beneficiaries:** Users of the Miteri Birthing Centre

#### CONTEXT

The national grid had not yet arrived to the Sinja Rural Municipality of Jumla, where the Miteri Birthing Centre is located. Action Works Nepal constructed the centre, which was finished in spring 2019. Despite having staff available to work at the facility and medical equipment ready to use, the lack of electricity access meant that the equipment could not be used. Action Works Nepal approached GRID Alternatives to develop a solar project to cover the centre's 8.02 kWh daily load needs.



©GRID Alternatives

#### DRE SOLUTION

The 3.19 kWp battery-based solar PV system now provides the facility with adequate electricity to cover the electric load necessary for operations. The system has powered lighting and a heater for the facility, a refrigerator for vaccines, medical testing equipment and a warming bed for newborn babies. During the installation, the ward chairperson and his son were trained in the general operations and maintenance (O&M) of the system, so that they were able to conduct basic maintenance tasks. The solar PV system is made up of the following components:



©GRID Alternatives

Items	Description	Quantity
<b>Solar panel</b>	AE solar 320 Wp	15
<b>Solar tubular battery</b>	200 Ah UNI solar battery	12
<b>Inverter</b>	Easy Solar 5000 VA/48 MPPT 150/100	1
<b>Victron Energy accessories</b>	Battery fuse and all required accessories	1
<b>Installation materials</b>	Cables, MC4 connectors, MCBs, conduit, wiring materials, etc.	1
<b>Mounting structure</b>	Aluminium structure	1

## BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 22,300, provided by individual donors to buy the equipment and pay for installation, through a crowdfunding campaign managed by GRID Alternatives. The centre, as well as the solar PV system on its roof, is owned by Action Works Nepal for the first two years of operation. After that point, ownership and fiscal responsibility will be passed on to the municipality. The solar PV system produces enough electricity to power the equipment in the centre free of charge.

In case of an issue, GRID Alternative's partner Gham Power provides free maintenance for the first two years after installation. Then, the Municipality has committed to provide the financial resources necessary for the centre's O&M, while GRID Alternatives will provide technical assistance throughout the whole lifetime of the project. Additionally, GRID Alternatives has a long-term commitment to all of its projects and conducts biannual site visits to ensure the proper operation of the systems.

## OUTCOMES

The electrified centre provides improved maternal and postnatal care for about 250 households. The centre also provides general health care to approximately 1,250 residents of the village and surrounding areas. Furthermore, the installation served as a hands-on training opportunity in solar installation for nine women who participated in the installation. These women gained practical skills which they can now use to find a job in the solar energy industry or a related field. The centre employs a midwife who provides maternal and postnatal care for the women and children. These clinics are the closest source of health care services for the villagers of Jumla, as hospitals and larger clinics are far away. The remote

health clinics provide important maternal and postnatal care that village women would otherwise not be able to access at all. Furthermore, it is estimated that the solar PV system offsets 1.46 tonnes of CO<sub>2</sub> per year, compared to an scenario where the centre would be hooked up to the national grid or a diesel generator.

## LESSONS LEARNT AND NEXT STEPS

The project was an overall success, as it accomplished its main goal of improving the health services provided by the health centre. A key success factor has been that the centre is being fully funded and staffed for the first two years by Action Works Nepal and will subsequently be so by the municipality. If the centre had not been funded nor staffed, the ability to plug in medical equipment would have been in vain without staff to provide health services. A core challenge of working with a new centre meant that some of the medical equipment that the centre should have had from the beginning was delayed. Therefore, the system was not taken full advantage of until a few months later.

The project can be replicated and GRID Alternatives has a goal of electrifying all the Jumla health clinics that currently lack access to energy.

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### 3.4 HT ENERGY (S) SDN BHD: 2.88 KWP SOLAR POWERED HYDROGEN GENERATION SYSTEM (MALAYSIA, LONG LOYANG)

April 2018 - July 2020

#### Stakeholders

- » **DRE project developer:** HT Energy (S) Sdn Bhd (HTES)
- » **Customers:** State Health Department of Sarawak, MoH Malaysia
- » **Beneficiaries:** Long Loyang Clinic, Sarawak local community

#### CONTEXT

Long Loyang Clinic is located approximately 183 km south of Miri town, serving Long Loyang village as well as 15 remote settlements along the Tinjar river and it is accessible by metalled and logged roads or via the Tinjar river. The clinic relies on diesel for its electricity, the supply of which is extremely irregular and costly, and even less accessible when logged roads become inaccessible during rainy seasons. Furthermore, diesel generators only run during certain hours of the day and require periodic maintenance. At times, there is no electricity supply when diesel runs out or when the generator breaks down. The average energy demand totals 25-30 kW a day. Electricity is used for essential lighting and refrigeration (vaccines, medicines, etc.), defibrillators and other basic medical equipment.

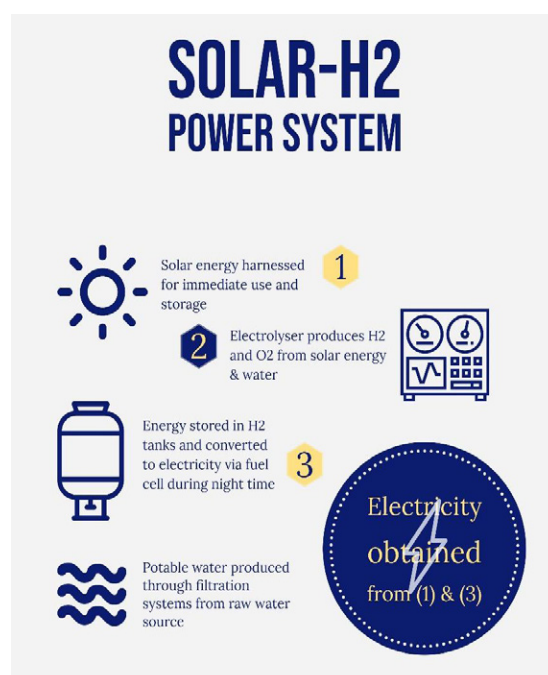


©HT Energy

#### DRE SOLUTION

A sustainable and circular power generation system, with minimal manual intervention/supervision, is being installed to serve the electricity needs of the Long Loyang Clinic on a 24/7 basis by providing the required power during operating

hours, a minimal base load for refrigeration and other essential electrical/medical appliances during non-operating hours at competitive costs. HTES has designed modular, compact and highly mobile systems that are easily transportable and highly scalable/customisable to accommodate different load profiles. HTES's "H2 system" supplies 25-30 kW per day (daytime usage of 15 kW and night-time usage of 10 kW), with a peak load of 2.88 kWp. The system consists of solar PV panels to generate electricity, an electrolyser to produce hydrogen cells, captured and stored in hydrogen storage tanks and depleted during times of solar inactivity. The energy storage in the form of hydrogen gas has a designed capacity of 30 Nm<sup>3</sup>. When converted back to electricity, it yields 38 kWh (energy storage medium).



## BUSINESS MODEL AND PROJECT FINANCING

The project is a pilot currently owned and financed entirely by HTES, and it is pending the transfer of ownership to the MoH of Malaysia upon its successful completion. There will be periodic routine maintenance by the technical team to ensure that the project is running and fully functional. Operative trainings shall be conducted with the designated staff on site as well as representatives from the State Health Department of Sarawak. Other future projects shall be commissioned on either sale or lease type arrangements.

## OUTCOMES

2,172 people in the community will benefit indirectly from the project. The total direct jobs created is estimated to be 10, but the number of indirect jobs is unclear. It is estimated that the clinic will avoid 13 to 33 tonnes of CO<sub>2</sub> annually, as opposed to a scenario where the clinic would be fully powered by diesel.



©HT Energy

## LESSONS LEARNT AND NEXT STEPS

The major challenge experienced by HTES is related to the weather conditions and remoteness of the site, which has resulted in logistical difficulties to transport equipment and personnel, as well as the bureaucratic approvals. Wet weather conditions and the imposition of movement restrictions by the Malaysian government in re-

sponse to the COVID-19 pandemic have delayed the planned commissioning. The project has undergone several rounds of technical design and tests to ensure that the module will be able to work well under the site conditions, as well as to make sure that the module is designed to enable transport into hard to reach remote areas. HTES has also encountered some administrative barriers which delayed immediate clearance by the local customs authority. The company has since resolved those issues and, going forward, the design and testing process is expected to be routine as major issues have since been rectified, and the experience with customs has been logged and instituted in their administrative process.

HTES' scalable and customisable technology has widespread applications across other types of rural settings such as settlements and schools, which the company is actively exploring with relevant government agencies. Other future projects shall be commissioned on either sale or lease type arrangements. There are 57 other rural clinics in Sarawak which are the subject of future projects. HTES envisages that it will take no more than five months to commission a similar project from inception. As HTES moves up the learning curve, the company expects to shorten the rollout lag time even more.

## CONTACT

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### 3.5 IDCOL: 100 TO 280 KWP SOLAR MINI-GRID PROJECTS (BANGLADESH, OFF-GRID COASTAL ISLANDS)

April 2010 - December 2019

#### Stakeholders

- » **Project financier:** Infrastructure Development Company Limited (IDCOL)
- » **DRE implementation partners:** Local project sponsors (NGOs and private entities availing concessionary financial facility, technical assistance and capacity building support from IDCOL)
- » **Beneficiaries:** Rural off-grid island communities

## CONTEXT

Bangladesh has more than 20,000 health care facilities in the rural regions of the country. Although almost 80% of these facilities are connected to the national grid, only 9% of them avail continuous electricity connection. Many of these health care facilities require continuous electricity access for service delivery, refrigeration of medicines and other services. The rural health care facilities where IDCOL installed the renewable energy systems are mostly from the remaining 20% that are not connected to the national grid. IDCOL had to overcome business viability barriers as well as technological hurdles to install renewable energy systems in remote locations where people were neither familiar with nor trained to use those.

## DRE SOLUTION

The IDCOL programme ensures the supply of clean electricity to households as well as commercial, educational, prayer and rural health care facilities and irrigation pumps. The 26 solar mini-grid projects that IDCOL has implemented range from 100 to 280 kWp. The health care facilities in the project areas usually have higher load requirements, which cannot be fulfilled by stand-alone solar systems. IDCOL's mini-grids fulfill the basic electricity requirements in those health care facilities, as well as the utilisation of computers, scanners, refrigerators, etc. IDCOL also provides promotional support to the project sponsors to raise awareness about the systems and trains the health centre operators on proper usage and maintenance of the systems.

The technical features include:

- **Solar PV module:** PV modules with capacity of 100 to 280 kWp are installed to supply electricity to the grid, while grid-connected inverters are installed to convert DC output from solar panels to grid quality AC electricity.
- **Battery bank and bi-directional inverters:** Excess power from solar PV modules is stored in the battery bank using bi-directional inverters.
- **Multi-cluster box:** A multi-cluster box is equipped with a connection facility for the external generator, load distribution and PV system.
- **Diesel generator:** A backup diesel generator is connected to the mini-grid to supply electricity in case of electricity shortage from solar PV modules and the batteries.

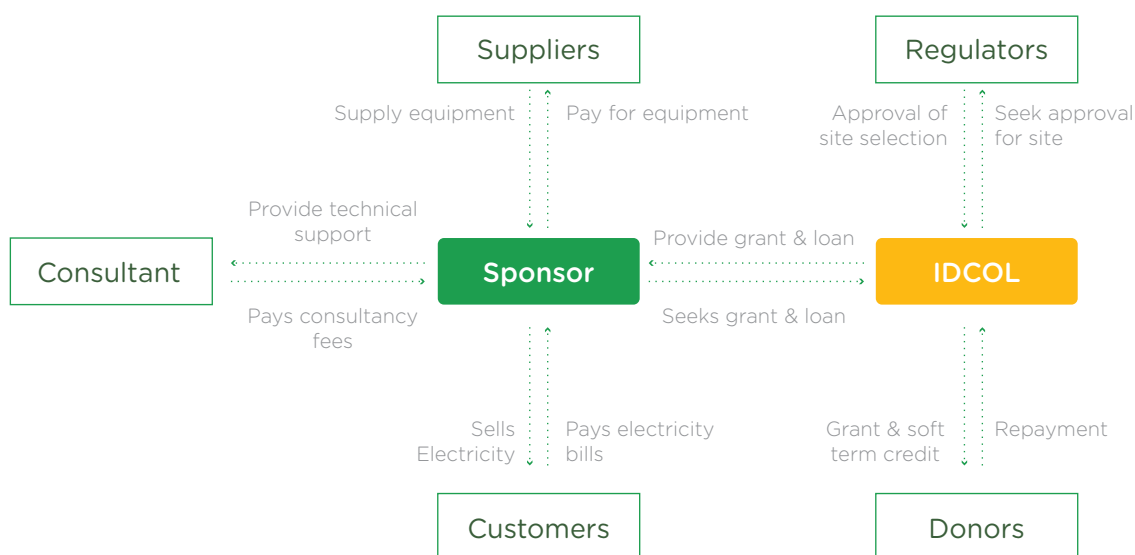
## BUSINESS MODEL AND PROJECT FINANCING

The total project budget is EUR 20.3 million, while the project cost of a mini-grid with a capacity of 250 kWp is approximately EUR 1.07 million. IDCOL provides 50% of the project cost as grant, which is sourced from various multilateral and bilateral development partners to reduce the CAPEX, make the projects financially viable for the project sponsor and offer an affordable tariff to the rural customers. 30% of the project cost is extended as a concessionary loan with a tenor of 10 years, and the remaining 20% is invested by the sponsor as equity. IDCOL also provides technical assistance support to the proj-



ect sponsors for improving their capacity, which includes staff training, promotional assistance for customer acquisition and retention, supply chain development etc. The projects are owned and operated by the project sponsors. The operating lifespan of a mini-grid is approximately 20 years. Project sponsors are mostly selected private sector project developers and, in some

cases, NGOs. They are responsible for the operational sustainability and maintenance of the projects, as well as the after sales services to customers. During the loan repayment period and beyond that, IDCOL closely monitors the operational performance of the mini-grid systems and provides technical assistance.



## OUTCOMES

IDCOL has so far financed the installation of 26 solar mini-grids that benefit more than 22,000 off-grid customers by generating 5 MW of clean electricity. Amongst these 26 mini-grids, four of them provide electricity to the rural health centres in isolated off-grid islands, serving around 6,000 people. In addition, the projects also electrify local pharmacies that in many cases serve as local health centres. Due to the remoteness and poor economic conditions of these locations, standard health services were out of reach for the people living in these communities. The installation of solar mini-grids has changed this scenario and the local health care facilities can now operate at full capacity, even at night for emergencies. The greatest beneficiaries are pregnant women and children, who previously had little to no access to health services. Furthermore, direct job creation from the solar mini-grids stands at around 150 positions and it is estimated that IDCOL solar mini-grids have led to a CO<sub>2</sub> reduction of 1,523 tonnes per year and an overall figure of 30,472 tonnes CO<sub>2</sub> over 20 years.

## LESSONS LEARNT AND NEXT STEPS

IDCOL's business model ensures affordable electricity tariff for customers as well as a reasonable return for the sponsors, with a minimum return on equity of 13-15% and a payback period of six to eight years. The use of a prepaid metering system ensures a 100% collection efficiency and the technical design guarantees that the project capacity is not under nor oversized.

Three major challenges are:

- **Possibility of grid expansion:** Grid expansion in the project area might make the electricity tariff uncompetitive. IDCOL coordinates with governmental entities before project site selection.
- **Lack of adequate technical support:** IDCOL provides incentives through grant for which the project developers can hire required technical personnel/consultants.
- **Availability of quality equipment:** IDCOL provides guarantees and soft loans to the local suppliers for value chain development.

The business model and the implementation framework of IDCOL is designed to improve energy access in underserved rural and/or peri-urban areas and enhance productive uses of energy. It has the potential for replication in Sub-Saharan Africa and MENA countries, where a similar context exists. IDCOL is working with government bodies and research centres in these regions to structure investment proposals for mini-/off-grid power generation.

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### 3.6 MLINDA: 25 KWP DRE-BASED MINI-GRIDS (INDIA, GUMLA)

May 2016 - June 2020

#### Stakeholders

- » **DRE project developer:** Mlinda
- » **Funding partners:** Institutional lenders for debt, government, foundations, own equity, international developmental institutions
- » **Customer:** Hospital in Phori village, health centre at Patia village, private clinics and pharmacies at Kashira and Murkunda villages and local communities and businesses
- » **Beneficiaries:** Rural communities including farmers, entrepreneurs, women, children, self-help groups, schools, health centres, banks, etc.

#### CONTEXT

In rural India, the government-run health centres are the primary health care delivery mechanism for immunisation, postnatal care and prevention and control of infectious diseases. In the State of Jharkhand, there are over 550 health care facilities, of which 92% are in villages. A health centre normally has a load ranging from 1 to 5 kW, depending on size and appliances. Daily energy consumption ranges from 2 to 12 kWh.

The health centres require reliable and good quality electricity to power baby warmers, refrigeration for vaccines and drugs, as well as the equipment needed during child births and minor surgeries. These villages are connected to the Electricity Distribution Company (DISCOM) grid but the supply is not reliable and the voltage tends to fluctuate. This can easily hamper the operations of the health centres, preventing them from functioning efficiently and to its maximum capacity, thereby obstructing poor people's access to basic health care facilities.

#### DRE SOLUTION

Mlinda works in the rural district of Gumla in 40 villages, providing 24/7 three-phase electricity for domestic, productive and commercial loads through DRE-based mini-grids. Energy storage was enhanced through lead acid gel batteries with a battery bank capacity of 48 V, 2,000 Ah and the grids were also set up with a 15 kVA diesel generator for peak load manage-

ment. The average solar PV plant size was 25 kWp, with an inverter capacity of 30 kW. The connected customers were provided with smart prepaid meters with different tariffs for day and night usage. The grids primarily power productive loads for livelihoods. They also power domestic appliances and institutional loads such as banks, ATMs, post offices, schools, hospitals and health centres.



©Mlinda

Mlinda mini-grids power health infrastructure in four villages: a 10-bed hospital at Phori village, a health centre at Patia village, private clinics and pharmacies at Kashira and Murkunda villages. The Phori Health Centre/Hospital caters to 13 villages of the Phori panchayat, reaching 1,950 families and 10,000 people in total.

It takes two to three months to develop a whole project for one village. One organisation can implement a project involving 20-40 villages in one year by simultaneously working on a large number of villages. Inception to commissioning is normally



four months to one year, depending on the size of the project.

## BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 5 million, with a proportion of equity (45%), debt (10%) and grant (45%). The DRE system is owned and operated by Mlinda. Mlinda follows a Build Own Operate (BOO) project model. Mlinda operates and maintains the grids for a minimum of 20 years. The consumers pay upfront connection fees and then pay for energy usage through pre-paid metres. Local operators are also trained in maintenance and repair of the mini grids.

For long-term sustainability, the project needs to both be commercially viable and bring about positive socio-economic outcomes for the communities. To achieve this, Mlinda invests in productive demand growth that spurs economic development and provides reliable and good quality power 24/7 along with repair and maintenance support. To do this, Mlinda organises peer interactions with satisfied entrepreneurs and provides business advisory, product finance and linkage to external markets.

## OUTCOMES

Mlinda's DRE-based mini-grids have already electrified 5,883 households and a total number of 32,400 users. Furthermore, 115 local jobs have been created in 40 villages (66 direct jobs and 49 indirect jobs). The direct jobs include technicians, community workers, agri-processing devices operators, warehouse assistants and storekeepers. Indirect jobs include grain/seeds sorters, graders, electricians, packagers, electric vehicle operators, huller/miller operators, etc. The project has also led to a reduction in greenhouse gas (GHG) emissions of 47%, from 720 to 411 tonnes of CO<sub>2</sub>.



©Mlinda

## LESSONS LEARNT AND NEXT STEPS

Mlinda is in the process of introducing a large number of small loads ("swarm" loads) that are productive and will result in a more even distribution of livelihoods and a greater gender diversity amongst entrepreneurs. In order to scale up Mlinda's complex model, the organisation needs to create tools and knowledge products to support its internal staff as well other companies/organisations replicate the system.

Mlinda is currently preparing to scale up and replicate its model in 100 villages in India by 2023, as well as assist with their replication to other organisations by training core teams and management and sharing technical, microbusiness models and community engagement techniques in other geographies such as Nepal, Myanmar and Ethiopia.

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**M L I N D A**

### 3.7 PHAESUN GMBH: 14.4 KWP SOLAR PV OFF-GRID CONNECT SYSTEM (ERITREA, ASMARA)

November 2013 - November 2014

#### Stakeholders

- » **DRE project developer:** Phaesun GmbH
- » **Funding partner:** Archemed (NGO)
- » **Customer:** Orotta Hospital
- » **Beneficiaries:** Orotta Hospital and surrounding communities.

## CONTEXT

The electricity grid in Eritrea is poorly developed. Even the electricity users in the capital Asmara suffer from power cuts that can last from some seconds up to several hours or even days. In the past, the Orotta Hospital often struggled with power blackouts. The part of the hospital that deals with children's pediatric cardiac surgery and neonatology is specifically sensitive to power failure and therefore a sustainable solution was needed to keep all activities of the hospital running day and night. The existing diesel backup generator was unreliable due to fuel shortage and the need for frequent maintenance. Project implementation went smoothly as Archemed, the funding partner for the project, is well established in Eritrea.

## DRE SOLUTION

Solar resources and therefore PV systems in Eritrea are extremely favourable. An off-grid connected system, comprising of a PV solution backed up by the grid and an extra diesel generator, was selected as an ideal solution to ensure the reliable power supply of the most important electrical loads in the hospital. The total daily energy demand and peak power of the department was identified (42 kW peak load and 20 kW continuous critical loads for three hours, which is 60 kWh of critical demand for three hours). The system was then designed to provide 60 kWh daily production from solar PV and a battery storage of four hours for the critical 20 kW loads at 80% maximum depth of discharge. The inverter charger was designed to provide the 42 kW peak load. That way, the system can provide around seven hours of power during the day, without grid or diesel

generator and four hours without sun, thus providing a reliable power supply during critical hours.



©Phaesun

The off-grid connected system bridges power blackouts with a battery bank (124 kWh storage capacity, OPzV), which is additionally fed with a 14.4 kWp PV generator (72 x 200 W/24 V monocrystalline solar modules), supplying the most important consumers without interruption.

For the power management, high quality electronics from the Swiss manufacturer Studer were used. Three Studer VarioTrack 80 MPPT charge controllers, six inverter/chargers Studer XTH 8000 and a remote control ensure a reliable energy management. The installation and commissioning was done by a local company in collaboration with the MoH's technical staff members, who oversaw all solar installations in the country. Therefore, regular maintenance was arranged by the MoH Technical Department — since there are many rural health centres and hospitals that run by solar energy, the Ministry has a dedicated Technical Department who installs and maintains these solar systems.

## BUSINESS MODEL AND PROJECT FINANCING

The total project budget including material, installation and transport was EUR 75,000, which was financed with donations from Archemed. The MoH owns the system and has the responsibility to operate and maintain it. As an NGO, Archemed supports the hospital in different ways (i.e. sending doctors for short-time emergency periods and medical materials). Archemed was involved in the installation of the system with a technician, as they were doing other technical stuff at the hospital as well. After the installation, Archemed handed over the system to the MoH, who is the official owner and who is also in charge of maintenance with its technical team. The technicians employed by MoH are experienced in operating and managing rural health care facilities powered by solar systems.

## OUTCOMES

The Orotta Hospital is the largest one in the country and acts as the central referral hospital. The result was a secure and uninterrupted power supply for the two wards. The system has now been running since December 2014. After the installation of the DRE system, the hospital can operate round the clock and doctors can provide essential health services without having to worry about a possible interruption in the middle of an operation.



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## LESSONS LEARNT AND NEXT STEPS

Integrating the solar power system with the existing electrical installation of the hospital was a technical challenge at the beginning. Nevertheless, local Phaesun technicians managed to separate the critical loads and make them independent when powered by solar, while still being part of the system during the 'normal' operation of the grid.

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### 3.8 RESOLVE SOLUTION PARTNERS: 5 TO 10 KWP SOLAR POWERED MODULAR HEALTH CARE DISPENSARIES AND MEDICINE STORAGE FACILITIES (MALAWI, RURAL LOCATIONS)

September 2018 - March 2019

#### Stakeholders

- » **DRE project developer:** Resolve Solution Partners
- » **International funding partners:** USAID and UKAID
- » **Customer:** Malawi MoH
- » **Beneficiaries:** Rural communities within Malawi's countryside

## CONTEXT

Rural communities in Malawi's countryside often suffer from electricity black-outs, sometimes for up to 12 hours at a time, which makes the storage of vital medicines very difficult in those areas. In practice, people had to travel to regional hospitals because local clinics were unable to store vaccines, insulin, and other basic medicines. To solve this problem, Resolve designed, built and installed 239 pharmaceutical dispensaries across Malawi's rural countryside for the compliant storage of medicines, 117 of which were deployed in underdeveloped areas with no access to the central power grid. A DRE solution to provide these critical pharmaceutical storage units with electricity and cooling systems, independently of any centralised power system, was key to the success of the overall project. Now, after the installation of the DRE solutions, local health care facilities can store medicines closer to where they are needed and the inhabitants of rural communities do not need to travel long distances to access vital medicines anymore. The average energy demand of the health care facilities varies between 5 and 10 kWp.

### DRE SOLUTION

A typical system for the larger of the two types of buildings (a 75 m<sup>2</sup> unit) consisted of:

- (30) 265 W Solar modules
- (2) 5 kVa Inverter, 80 Amps
- (12) 200 Ah Deep cycle gel battery 12 VDC



©Resolve

This was to drive two 12,000 BTU air conditioners on permanent 12-hour rotation cycles, as well as internal and external lighting. The solar panels were deployed as a roof-top system fixed to an aluminum sub-frame. The units have a dedicated 'power room' which contains all cables, inverters and batteries. The power room also has its own ventilation to remove excess heat. The entire unit, including solar system, is connected via various IoT sensors to the internet, monitored centrally by the customer's control room.

Following the completion of an installation at each site, training and orientation is provided to the end-users at the health care facility. The end-users for this orientation are the pharmacy staff, the head of the health care facility and the maintenance staff of the health care facility. The staff are oriented, at the time of handover, on the correct use of the following items: air conditioner units, PV system, electrical components (i.e. distribution board switches, change-over switch, automatic voltage regulators, surge protection, lights, etc.).

In addition to the orientation on the correct usage of the equipment to health care staff, the maintenance staff received further training on procedures for routine maintenance of the prefabricated storage units and associated equipment. A manual on all aspects of the O&M of the site was finally handed over to all facility managers.

## BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 14.7 million, of which 100% were donor grants by USAID and UKAID. The system is owned by the MoH. The long-term sustainability of the project is ensured through a two-year post-implementation maintenance service level agreement (managed by Resolve) training and orientation for end-users.

## OUTCOMES

The project improved access to health care in rural communities through the provision of a DRE system to increase the ability of local health care facilities, serving 17.6 million people, to also store temperature sensitive medicines such as vaccines, insulin, chemotherapy drugs, topical preparations and some types of eye drops. Additionally, the project allowed for some unintended extra benefits by providing a place for the medical staff and the communities to recharge their cell phones and maintain communication.



©Resolve

## LESSONS LEARNT AND NEXT STEPS

The largest obstacles Resolve had to overcome were a combination of tight timelines (six months to deploy all infrastructure), rainy season, treacherous rural road infrastructure and last-minute synchronisation of 20 construction teams with on-site arrival of construction material. Each 'construction round' timed the deployment of 20 units within eight days.

The solution can be replicated across Africa, where Resolve estimates that there is a 70% shortage of compliant medicine storage facilities in the continent, based on discussions with the MoH in Uganda, Tanzania, Ethiopia, Mali, Zambia, Angola, Democratic Republic of the Congo, Nigeria, etc.

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**resolve**

### 3.9 RYSE ENERGY: 8 KWP WIND AND SOLAR PV MINI-GRID SYSTEM (CHILE, LOS LAGOS)

May - October 2014

#### Stakeholders

- » **DRE project developer:** Ryse Energy
- » **Funding authority:** Government of Chile
- » **Beneficiaries:** Los Lagos health care facilities, schools and other critical infrastructure (i.e. telecoms)

#### CONTEXT

Los Lagos region in southern Chile is located between Argentina to the east and the Pacific Ocean to the west. It is also a remote and rural location known for its forests, Andean mountains and lakes. Within this region, there are remote island clusters with an estimated population of 2,000 people living without energy and using expensive diesel generators for few hours a day to meet their basic electricity needs. Health care infrastructure across each island was minimal, basic and also disparate, and the communities had little access to mainland facilities. Therefore, DRE was vital in providing decentralised energy across multiple locations. By combining small-wind, solar and energy storage, Ryse Energy designed a small, decentralised solution for 16 islands across the region in order to provide electricity to school and health care facilities across the isolated communities.



©Ryse Energy

#### DRE SOLUTION

In order to enable reliable electricity access for the school and health care facilities within these communities, Ryse Energy had to build and install the mini-grid system from the ground up. It required a completely new electrical installation across multiple buildings and schools on each of the 16 islands.

Each system incorporated:

- 5 kWp Ryse Energy E-5 wind turbine
- Tilt tower
- 3 kWp Solar array
- 1,000 Ah 48 V Battery Storage
- 5 kW Inverter
- Emergency diesel generator backup

#### BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 400,000, which was fully funded by the Government of Chile. The system is owned by the Government of Chile. Despite the high efficiency of the system and its low maintenance requirements, a specific challenge that Ryse Energy faced across the multiple islands was the ongoing maintenance of the system due to its remote locations.

In order to ensure long-term sustainability, an O&M training was conducted by the Ryse Energy team to the local communities to ensure the resilience and reliability of



the system. Community members conducted an intensive one-week training course at Ryse Energy's manufacturing facility and have ongoing support via phone and online communication channels.

## OUTCOMES

A region of 2,000 people has gained access to electricity through a number of support centres, such as schools and health care facilities. Furthermore, 35 jobs have been created across the 16 islands and it is estimated that the system has helped reduce around 18 tonnes of CO<sub>2</sub> per year.

The replication potential of the solution is extremely high. The combination of wind, solar and energy storage creates a resilient and reliable system which is able to generate consistent renewable energy to power essential services.



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## LESSONS LEARNT AND NEXT STEPS

Key success factors were the planning, engineering and results achieved themselves. On the other hand, local logistics to access and install the system correctly were a challenge - yet expected. Because of the remoteness of the islands, they had no machinery available, so all the mechanical installation had to be done by hand.

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### 3.10 SCHNEIDER ELECTRIC & VAYA ENERGY: 12 KWP SOLAR POWERED SYSTEM FOR A COMMUNITY HEALTH CENTRE (NIGERIA, DAKWA)

September 2015 - May 2016

#### Stakeholders

- » **DRE project developer & funding partner:** Vaya Energy
- » **Technology provider & technical partner:** Schneider Electric
- » **Beneficiaries:** Dakwa Primary Health Centre (PHC) and local communities

## CONTEXT

Dakwa is situated in the outskirts of Nigeria's federal capital territory. The community suffered from one of the highest maternal mortality rates in the country, due to recent polio cases and the fact that many women still gave birth in their homes. The PHC was established by the government with the goal of boosting the community's compliance to the national immunisation programme (especially after the outbreak of polio in 2013), and to increase maternal health. However, the health care facility had never truly functioned to its full capacity. Since it was set up in 2014, the centre had never had access to grid power. The centre provides first aid and primary health care to the Dakwa community, serving 600 people. Without electricity, PHC workers depended on kerosene lamps for lighting at night and could not store their medicines and vaccines in a cool place, like a refrigerator, as recommended by the health authorities.

To solve this, Vaya Energy and Schneider Electric powered a community's health care centre in Dakwa, Abuja. Providing electricity to the PHC has helped go a long way in improving the socio-economic standards of the community. The aims of the project were to provide 24/7 power to the Dakwa PHC and to educate the Dakwa community and health workers on solar technology. To ensure the sustainability of the project, a few staff of the PHC were taught on simple maintenance of the system, which includes operating the system and cleaning off the solar panels of dirt. It is a small system and little maintenance is required.

## DRE SOLUTION



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The DRE solution is a 3 kWp, DC-Coupled system with a 2.5 kW load size. It comprises the following components:

- **Inverter:** Schneider Electric Conext SW 2524 2.5 kW 24 VDC battery-based inverter/charger
- **Charge Controller:** Schneider Electric Conext MPPT 60 150 solar charge controller
- **Solar Modules:** (12) 4 kWp Solar Modules
- **Monitoring Solution:** Conext ComBox and communication devices
- **Batteries:** (4) Deep-Cycle VRLA, Gel Batteries
- **Accessories:** Conext System Control Panel and Conext Battery

Vaya Energy, as part of its corporate social responsibility, provided the PHC with a refrigerator and a fan, and replaced the night lamps with energy saving compact fluorescent lamps.

## BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 10,000, which was fully funded by Vaya Energy as part of its corporate social responsibility (CSR) budget allocation. Dakwa PHC is the first microgrid system designed and deployed by Vaya Energy. Schneider Electric was contacted to provide the products and technology for the system as well as training of Vaya Energy engineers and on-site commissioning support. The project was a pilot to showcase the benefits of off-grid solar PV systems on rural health clinics. After commissioning, the ownership and operation of the microgrid system was handed over to the Dakwa community, so the PHC does not pay for the electricity generated and consumed.

## OUTCOMES

Since powering the PHC, there has been a 50 to 60 % reduction in maternal and child mortality, as well as an 80% increase in night-time deliveries and procurement of more medical ice packs for vaccine cooling. Prior to the installation of the DRE solution, at least 35 homes rejected the polio vaccination for their kids. Today, the health care centre has its own dedicated vaccine refrigerator and the community is much more receptive to vaccinations. The health workers go on daily vaccination drives and no new cases of polio have been reported. Also, more women are ready to go to the health care centre to give birth.



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## LESSONS LEARNT AND NEXT STEPS

The PHC is planning to install new equipment that will need to be powered, thus there will be a need to scale up the system. Aside from some regulatory approval delays to build the microgrid system, there were no other challenges in this project. However, it is important to note that the PHCs serving marginalised communities through non-profit business model cannot afford the upfront cost of installing a solar PV system. While renewable energy companies like Vaya Energy can afford to power one or two PHCs under their CSR budget, a coordinated effort from private companies, governments and development organisations can help more rural PHCs like Dakwa's overcome these challenges and tap into the benefits of solar technology.

Future plans with the local government, directly responsible for the development of the community, involve supporting the project by expanding the microgrid to a 12 kWp system to electrify more homes and businesses in the community.

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### 3.11 SMARTRUE (NTUA): 0.6 KWP HYBRID WIND SYSTEM (NEPAL, MITYAL)

April - November 2017

#### Stakeholders

- » **DRE project developer:** The Rural Electrification Research Group (RurERG) (part of the SmartRUE research group) of the National Technical University of Athens, Kathmandu Alternative Power & Energy Group (KAPEG) and People, Energy & Environment Development Association (PEEDA)
- » **Funder:** Wuppertal Institute for Climate, Environment & Energy (WISIONS)
- » **Customer:** Village ward in Mityal
- » **Beneficiaries:** Rural population in Mityal area

#### CONTEXT

The overall energy demand of the health clinic is approximately 1.5 kWh per day. Previously, the health clinic used a small freezing box with icepacks to store vaccines, with a periodic supply of ice packs that arrived from the closest city. The vaccines could only be used for a short period of time in the absence of a freezing system, so a basic vaccine freezing apparatus was an immediate requirement for the clinic. The clinic also had insufficient LED lighting from a very small SHS, therefore complete illumination of the clinic's four rooms was necessary. The successful development of the project was achieved through the communication of all partners in order to increase its long-term sustainability. A major challenge was communication barriers due to the remoteness of the village community and the need to coordinate between several international partners.

The project started with a two-day course on hybrid system design in Kathmandu, where a small wind turbine was designed using locally available materials, which then led to a five-day construction course in cooperation with the Kathmandu University, during which the small wind turbine was built. The following week, the wind turbine was installed in Mityal on a 12-metre tower as part of a hybrid off-grid system, along with 600 Wp of solar panels, a 700 W inverter, a 24 V 200 Ah battery bank and a diversion load charge controller. The hybrid system provided electricity for mobile phone charging, lighting and a laptop computer in the ward offices, as well as refrigeration of vaccines and lighting in the local health post. A maintenance workshop was carried out on site with the participation of local community members, where all aspects of preemptive maintenance were explained, such as painting of the blades of the wind turbine and greasing the yaw hub, tail hinge and bearing hub.

#### DRE SOLUTION



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#### BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 9,000 and was funded through a grant from WISIONS. The system was handed over to the village ward, who owns the system and supplies the clinic with electricity free of charge. The ward is also responsible for the system's maintenance requirements, along with the project partners' support (i.e. assuring its technical and financial sustainability). The village ward makes monthly cost savings which are destined for future maintenance requirements and replacement of the system components.

Furthermore, its staff is in close communication with the local technical partners of the project, who provide maintenance services when required.

## OUTCOMES

After the installation of the DRE system, the occasional use of diesel generators was reduced. The rural health clinic managed to sustain its operation and jobs (which include a doctor and a nurse), while also creating the job opportunities for two local electricians, trained by the project partners on the details of the DRE system to provide occasional O&M paid services. Additionally, the rural population of the area has benefited from improved access to health services, mostly due to the longer operating hours of the clinic thanks to of the newly introduced evening lighting, as well as the larger on-site capacity to store and distribute vaccines.



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## LESSONS LEARNT AND NEXT STEPS

DRE hybrid systems using solar panels and locally manufactured small wind turbines have the potential to supply remote areas with a sustainable energy source, while strengthening local economies by providing energy for productive uses such as mobile phone charging and refrigeration. Such hybrid systems have also been successful in other projects conducted by RurERG, for example in rural areas of Ethiopia. Several hundreds of those systems have been installed on all continents by members of the Wind Empowerment Network, a global association active in more than 50 countries with the mission to deliver sustainable rural electrification through the local manufacturing of small wind turbines.

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### 3.12 SOLERGIE: 0.3 KWP SOLAR PV SYSTEMS (TOGO, KAMINA & BROUNFOU)

July - September 2019

#### Stakeholders

- » **DRE project developer:** Solergie
- » **Funding:** Own equity
- » **Beneficiary:** Two health centres and surrounding communities in Kamina & Brounfou

#### CONTEXT

The two health centres, located in Kamina and Brounfou villages, were previously running without electricity. Before the installation of the DRE solution, health care workers needed to use flashlights for child deliveries at night. This posed a serious problem for nurses to conduct their work properly and deterred women from staying in the centre after they gave birth, therefore leaving them unattended and increasing the health risks for them and their babies.



©Solergie

To solve this, Solergie installed lights in every room with 220 V outlets. The major obstacle was the price of the system, as the health care facilities could not pay for a solar system at once. That is why Solergie offered a monthly payment over a limited period that is affordable for the local health care facilities. The energy consumption of the health care centres is around 600 Wh per day.

#### DRE SOLUTION

Solergie trained more than 300 independent technicians to operate and maintain

all the solar systems in the country. Thanks to the after sales service of Solergie, the long-term sustainability of the project is guaranteed. The project started with a request from the local health care centre. One week later, Solergie installed the system and started the follow-up. The systems consist of two solar panels of 155 Wp, one battery of 145 Ah and an inverter of 800 W.

#### BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project to electrify the two health centres was EUR 2,440, covered by equity investors to pre-finance the equipment. Solergie is the owner of the system until the total amount is paid off by the health care facility. The local health care facilities paid a one-time small fee (EUR 15) for the installation. Afterwards, the health care facilities have been paying a fixed amount of EUR 30 per month. 40 months (3.4 years) later, the system will become their property. Once the health care facilities have paid off the systems and they become the owners, they will only need to pay a maintenance fee of EUR 10 per month so Solergie can continue to follow up on the system maintenance. The cost is equivalent to only one third of their initial monthly fee.

#### OUTCOMES

7,000 people now benefit from the electricity improvement of the local health care facilities. Before, the facilities used flashlights, whose batteries needed to be replaced every two weeks and were afterwards disposed of by littering. This resulted in pollution to the drinking water and made it unhealthy for local children who played with the broken batteries. Now, the



health care facilities have reliable and sustainable 24/7 light. The quality of work of the nurses has been improved and health problems reduced. In addition, with a light installed outside the health centres, people can easily find their way to the facility at night. Mr. Tissou from the health centre in Brounfou, said: *“Before, women didn’t want to stay after they gave birth, because they didn’t want to stay in a dark room. Now, thanks to the light provided by Solergie-Box, women stay a few days so mother and baby can be followed up and be taken care of. This has helped reduce the mortality of mothers and babies.”*

This project is only one of the installations that Solergie has implemented in Togo. In total, Solergie has now 35 full-time employees and has trained more than 300 independent sales and technical experts.



©Solergie

## LESSONS LEARNT AND NEXT STEPS

The main challenge was the amount of money that the health care facility needed to cover its monthly electricity fees. Their budget was very limited, which is why they could not afford a larger system, which would be needed to run a fridge for vaccines or medicines. In the next project, Solergie wants to solve this problem by assigning a local entrepreneur in the village and neighbouring households to the system.

This way, the entrepreneur can start an economic activity thanks to the electricity and he or she will help pay off the system. The SolergieBox has eight different energy metres that can be controlled and monitored remotely. Solergie is able to guarantee the necessary energy for the health care facility even if other users are connected to the system by giving priority to the health care.

To deploy this project, Solergie relied on a competitive cost advantage that is possible thanks to the scale Solergie has already achieved in Togo, with more than 500 nano-grids installed, serving almost 2,400 customers (families, health centres and businesses). The Solergie system can be replicated in other countries. Preparations are being made to develop projects in Mali, Benin, Burkina Faso, Ivory Coast and Nigeria.

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### 3.13 STUDER INNOTECH SA: 960 KWP SOLAR PV SYSTEM (COLOMBIA, ALTA GUAJIRA)

October 2015 - January 2018

#### Stakeholders

- » **Technology provider:** Studer Innotech SA
- » **DRE & installer project developer:** COANTEC
- » **Designer & provider partner:** HEMEVA S.A.S
- » **Funding authority:** Colombian Ministry of Foreign Affairs
- » **Customer:** Plan Fronteras
- » **Project beneficiary:** The Paraíso Medical Centre and the Wayúu community

## CONTEXT

Plan Fronteras is a programme developed by the Colombian Government to carry out socio-economic development projects in the areas along the borders of the country. The main activities of the programme evolve around the provision of electricity supply projects with renewable energy for schools and medical centres in difficult contexts due to both their remoteness and poor access to electricity.

The Paraíso Medical Centre, located in Alta Guajira and bordering Venezuela, provides medical care to the Wayúu community, comprising about 200 families. In this region, medical centres are very distant, the closest one being a four hours drive away. The Paraíso Medical Centre provides general consultations, postnatal care and first aid services to the members of the community. The health centre was stocked with medical equipment that could only be used for a limited period of time throughout the day, as the facility only had power for three hours at night, provided by a diesel generator.

One of the key challenges for Studer Innotech to guarantee the long-term sustainability of the project was engaging with the local community, whose members were sceptical of aid projects as previous projects were not all finished. A second barrier was the remoteness of the site, which is very difficult to reach, especially during the rainy season.

## DRE SOLUTION

With a 960 Wp solar generator and a 750 Ah/24 Vdc battery bank, sufficient power is supplied to connect the main medical equipment such as vital signs monitors, a vacuum, an ECG machine and consultation equipment such as a laptop and a printer as well as lighting, ventilation and a small refrigerator.



©Studer Innotech

The components that make up the system are:

- (1) AJ-1300-24-01 STUDER inverter/charger.
- (3) 320 Wp ET Solar panels
- (12) 750 Ah/2 V AGM battery
- (1) PWM Morningstar 45 A solar controller
- (1) cabinet to house the controller and inverter (1) covered battery rack

## BUSINESS MODEL AND PROJECT FINANCING

The project was designed and installed by COANTEC. The users are the Paraiso Medical Centre and the Wayuú community. During the warranty period, COANTEC is responsible to solve any system malfunctioning and replace its technical components. Additionally, two people from the community were trained on basic maintenance tasks and reporting in case of system failure. Once the warranty ends, the Border Plan (Plan Fronteras) will have the responsibility of replacing, repowering and adding equipment for the future needs of the medical centre and general consultations throughout the day.

## OUTCOMES

Previously, the facilities had power for only three hours at night; now they no longer use the diesel generator and the community is in charge of maintaining the system. It is estimated that more than 200 families benefit from this project, with special regard to first aid services and pediatric consultations. Since the project is part of the Colombian Government's Plan Fronteras to build essential public infrastructure in remote areas, there was no external financing needed.



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## LESSONS LEARNT AND NEXT STEPS

Firstly, it is important to use high quality technology to avoid system failures as much as possible and reduce maintenance costs in the medium and long term, including transportation. Additionally, several people from the medical centre must be trained on O&M tasks (at least for preventive purposes) and ensure a constant flow of direct communication with the technology installer.

Due to the long distances in Alta Guajira between different sites, further plans are being developed to scale up this solution across the region as a means to provide medical assistance to remote local communities.

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### 3.14 TRAMA TECNOAMBIENTAL: 3.5 KWP STAND-ALONE SOLAR PV SOLUTIONS FOR HEALTH CARE FACILITIES (GHANA, NORTHERN & VOLTA REGIONS)

November 2017 - October 2018

#### Stakeholders

- » **DRE project developer:** Trama TecnoAmbiental (TTA)
- » **Funding partner:** USAID
- » **Beneficiaries:** Eight remote communities in the Northern Region (Districts: Mion (2), Mamprusi West, Sawla Tuna Kalba, Bole, Gonja North (2), Central Gonja) and seven remote communities in Volta Region (Districts: Krachi East (2), Krachi West (2), Nkwanta South (2), Biakoye)

## CONTEXT

As part of a broad programme funded by USAID, Community-based Health Planning and Services (CHPS), compounds were newly constructed in the Northern and Volta Regions of Ghana to provide essential health care to the local communities, which otherwise had to travel to the main cities to get treatment. A CHPS compound is a standard designed set of buildings where health care officers live and provide relevant primary health services to the community. This project supplied the CHPS compounds with electricity through stand-alone solar PV solutions (solar kits).



©Trama TecnoAmbiental

## DRE SOLUTION

One stand-alone solar PV solution was installed at each CHPS. Each kit consisted of 3.5 kWp PV with storage, providing a minimum of two days of autonomy. All CHPS compounds were electrified with the same solar kit in order to minimise the diversity of components and facilitate the operations. The strategy was to supply clean energy to priority loads (clinics) and non-priority loads (houses) using demand-side management techniques. This was done by installing energy dispensers in the clinics and houses. The dispensers, developed by TTA, control both the energy and power consumption, but also give incentives for the efficient use of energy through real time pricing. As a result, the electricity is now consumed efficiently and the lifetime of batteries has been increased. Social innovation includes local capacity building and user empowerment.

## BUSINESS MODEL AND PROJECT FINANCING

The cost of the turnkey project was around EUR 330,000, including activities such as capacity building. All funding consisted of a grant fully provided by USAID and managed by the University Research Co. LLC (URC). The system is owned by the Ghana Health Service. The proposed technical solution enhances the long-term durability of the project with an adequate management of the demand and energy made available to users, thus ensuring a long lifetime of the equipment. Ghana Health Service covers the energy expenses of both the clinics and the residential compounds. Training of the local workforce was a key aspect to the sustainability of the service over the long term: besides an initial training course, a refresher training cycle was performed months after the commissioning. Additionally, a WhatsApp platform was created to report faults and share user experiences.

## OUTCOMES

In total, the 15 clinics serve more than 200 communities and 85,000 people. A typical day in the dry season allows for the operation of laptops, internet modems, fans and refrigerators. The equipment can run for up to 10 hours during the day. The refrigerators run uninterruptedly, since they store essential vaccines and medicines. Infrequently used equipment include laser multifunction printers, a 2 kW autoclave, water pumps, a nebuliser machine and a washing machine. The horizontal installation and stacking of batteries allowed for a minimum footprint and compact installation - together, the 15 solar stand-alone solutions were estimated to avoid up to 52.5 tonnes of CO<sub>2</sub> per year.

## LESSONS LEARNT AND NEXT STEPS

Training the staff was key, not only during installation, but also the refresher cycle of trainings, to solve doubts that arose after commissioning. Furthermore, excellent collaboration with the local partner was key to carry out the works successfully. Due to previous experiences with other similar solar projects in Ghana, such as rural mini-grids, there were no delays nor issues related to customs clearance, logistics and the timely delivery of works, where all operations were carried on smoothly and without obstacles. If the rest of the CHPS were to get electricity, the same solar kit shall be used in order to avoid engineering and minimise delivery times. Sourcing components locally would help deliver the kits even sooner. On average, it is estimated that the full commissioning timeframe for a single solution since its inception would

be around four to five months. If the components can be procured locally, then the estimated time could be reduced to one month, also depending on local logistics and capacities.



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The 15 solar kits were a pilot project with the aim to replicate a total of 55 clinics in the Northern and Volta Region, once additional funding is provided. Moreover, the Ministry of Energy and UN Foundation are also working towards the electrification of rural communities and health centres and are identifying more compounds to be electrified with this modular kit.

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### 3.15 WE CARE SOLAR: “LIGHT EVERY BIRTH” - 0.13 TO 0.25 KWP SOLAR SUITCASES FOR RURAL HEALTH CARE FACILITIES (LIBERIA, RURAL LOCATIONS)

March 2017 - December 2022

#### Stakeholders

- » **DRE project developer:** We Care Solar (WCS)
- » **Government partner:** Liberian MoH
- » **Funding partners:** UBS Optimus Foundation, UN Women, UNICEF, Gilead Foundation, Meadow Fund, Starr International Foundation, UN DESA, Music for Relief, Wells Fargo Foundation
- » **Beneficiaries:** Local health care facilities and communities

## CONTEXT

A majority of health care facilities in Liberia lack any reliable source of electricity, forcing health workers to work in near-darkness. A DRE solution was needed to ensure that essential maternal-newborn health services could be provided by frontline health care facilities at all times. The Light Every Birth programme focuses on medical-surgical lighting and essential energy needs for childbirth. Challenges included: (1) conducting more than 500 facility assessments to verify the electricity status, (2) long distances between health care facilities with poor infrastructure (lack of intact roads, bridges, etc.), (3) shortage of trained personnel to conduct installations and (4) lack of existing solar electric service network. To overcome these, WCS leveraged health and government partners to assist with health care facility assessments, trained WCS technical partners to conduct installations and adjusted its timeline. WCS is currently developing a comprehensive sustainability plan to ensure the Solar Suitcases can be serviced when needed, which includes development of a supply chain and a public-private partnership to respond to maintenance needs.

## DRE SOLUTION

The Light Every Birth Initiative offers every woman in a country the opportunity to give birth in a public health care facility with reliable power and light. The We Care Solar Suitcase®, is a self-contained, easy to install solar electric system with an advanced solar controller, ports and plugs,

in a watertight, dust-proof suitcase, made to hold up in harsh environments. The system contains a 12 V, 12.8 Ah lithium battery that is charged by a 100 W solar panel. The Solar Suitcase is a complete system that pairs energy generation and energy consumption. It comes with four rugged, high-efficiency LED medical lights, a phone charger, two LED headlamps with a micro-USB charging cable, a fetal Doppler with rechargeable batteries, and an AA/AAA battery charger.



© We Care Solar

445 of 540 health care facilities qualified based on electricity assessment, and 45 local technicians were trained to conduct installations. In addition, over 2,300 health workers were trained to operate and maintain the Solar Suitcases and appliances. Once inventory was in place, the Solar Suitcases were installed throughout each district. Each installation and health worker training was conducted in a few hours. As a result, every public maternal health



care facility in Liberia has power for safe deliveries.

## BUSINESS MODEL AND PROJECT FINANCING

The total cost of the project was EUR 1,370,000, for which grant financing was provided by UBS Optimus Foundation, Wells Fargo Foundation, Starr International Foundation, UNDESA, Gilead Foundation, Music for Relief and Meadow Fund. The 445 DRE systems are now owned by the MoH.

A co-created sustainability plan will empower the MoH and County Health Teams to assume full responsibility for maintenance at the end of a 2-year handover period. During the two-year period, WCS will provide financial and programmatic support to: engage stakeholders including MoH, local government, and NGO partners, train over 30 government technicians, build a local supply chain of spare parts, develop a system for incident reporting, and oversee a public-private partnership with a local maintenance contractor to strengthen and support government maintenance activities.

## OUTCOMES

As a result of the project, 445 health centres were equipped with reliable lighting and electricity and health workers are empowered and able to provide emergency obstetric care throughout the night. Annually, each health centre conducts an average of 192 deliveries (85,440 total deliveries per year), meaning that 85,440 mothers and 85,440 newborns each year have safer care.



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Though the course of the project, jobs were provided for 48 local Liberians, including installers and WCS programme managers.

By replacing fossil fuel sources of light (candles, kerosene lanterns, and generators), the project has saved approximately 1,380 tonnes of CO<sub>2</sub> emissions per year.

## LESSONS LEARNT AND NEXT STEPS

Liberia is now a “Model of Excellence” for national electrification of maternity care; this initiative is being replicated in three additional countries (Uganda, Zimbabwe, Sierra Leone). The Light Every Birth programme illustrated the importance of defining clear goals for government and stakeholder engagement, identifying local champions and verifying health care facility electrification status.

In light of COVID-19, the Solar Suitcase inventory is being increased in Africa for rapid deployment. Infrared thermometers with rechargeable batteries are being included in COVID-19 deployments. Further information on health centre energy needs can be found in the Powering Health tool<sup>1</sup> that was developed with assistance from WCS.

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<sup>1</sup> Powering Health, HOMER Powering Health Tool, 2020 (online)

### 3.16 WINCH ENERGY: ELECTRIFICATION OF COMMUNITY HEALTH CENTRES THROUGH 16 TO 110 KWP SOLAR POWER PLANTS (SIERRA LEONE, 24 VILLAGES)

September 2017 - March 2020

#### Stakeholders

- » **Project developer:** Winch's subsidiary "Winch Energy (SL) Limited"
- » **Funding partners:** UK's Department for International Development (DFID)
- » **Tender implementor:** United Nations Office for Project Services (UNOPS)
- » **Customer:** The Ministry of Energy
- » **Beneficiaries:** Local Community Health Centres (CHC) and the communities themselves.

#### CONTEXT

Sierra Leone was one of the countries worst affected by the Ebola virus, which was declared an international health emergency by the WHO in August 2014, resulting in an estimated 3,955 deaths. Before the Ebola outbreak, Sierra Leone was already facing stress on rural health infrastructure due to a long period of conflict. Winch's Rural Renewable Energy Project (RREP) was established to strengthen rural health infrastructure in the event of future epidemics or pandemics such as the COVID-19 crisis. DRE was the most feasible solution to the problem due to its ability for rapid and cheap deployment in a country where on-grid electricity infrastructure is limited and constrained to large towns only. In Sierra Leone, only Freetown and some of the large district towns have access to electricity through a formal main grid. The health care facilities electrified by Winch can use the power for critical appliances and communications, which are essential components of the rural response to virus outbreaks. All the CHCs have a deep freezer where they keep vaccines. In addition, each room in the CHC has a bulb and one socket. The average number of bulbs in a CHC is 8. The average demand per facility is 4.06 kWh. They have access to up to 6.6 kWh each day for free as part of the project, with the option to pay for more electricity beyond this at the same rate as the rest of the community.

#### DRE SOLUTION

RREP puts CHCs at the centre of each mini-grid. The project started in 2017 through a

public mini-grid tender. The first 12 health centres were electrified in 2018 and were later expanded into village mini-grids, commissioned by Winch in March 2020. The whole process, from contract signing to having all 12 mini-grids fully operational and serving customers, took one year. The second set of 12 villages and health centres is planned to be commissioned by Winch in Q2 2021, with the aim to have them operational by July 2021.



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The solution was to install solar power plants in pre-identified rural villages, which serve the local CHC with reliable, clean and affordable electricity. The excess electricity generation is distributed to the surrounding households and businesses through a low voltage network. The CHC has access to a limited amount of free daily electricity to ensure cost is not a barrier to the service they can provide to the communities. The projects are 100% renewable, avoiding the need for expensive diesel supply chains and storage costs. The total capacity of the project is 1,107 kWp, generated by 24 mini-grids. Each mini-grid consists of:

- 400 Wp modules (the mini-grid size ranges from 16 to 110 kWp).

- Narada 2 V lead acid cells with capacity of 2,400 Ah (@C10 storage capacity, ranging from 80 to 445 kWh).
- SMA inverters, ranging from 12 to 100 kW.

## BUSINESS MODEL AND PROJECT FINANCING

The total estimated project cost was EUR 6.5 million, financed through a combination of private (Winch) and public sector (DFID) funding, which was injected into the project through in-kind subsidies with the aim of reducing the tariff to the end customer and encourage a return for investors to ensure the long-term sustainability and efficiency of the project. The private sector financing is a combination of debt and equity raised through Winch's mini-grid portfolio financing platform. The proportion of the financing sources will be approximately: 31% grant, 35% equity and 35% debt. The ownership of the first 12 mini-grids remains public, while the second set of 12 mini-grids will be private. All 24 mini-grids are privately operated and an agent in the village is trained to conduct basic system operations as well as reloading credit for customers. The maintenance is done by Winch staff.

## OUTCOMES

The settlements have a combined population of approximately 50,000 people across the 24 villages. Winch has connected over 1,200 business and household customers so far and will aim to connect over 4,000 customers once the final phase of the project is complete. The projects will connect 25 CHCs, as well as approximately 20 rural pharmacies. So far, the project has created 30 local jobs, including community support staff, technicians, project and technical managers, office staff and drivers, which are expected to rise as more villages come online. The mini-grids also connect larger industrial users such as milling and welding businesses, which have additional benefits for the local communities. Since the projects are 100% renewable, they will also continue to displace GHG emissions in Sierra Leone, helping the country to meet its climate change targets.



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## LESSONS LEARNT AND NEXT STEPS

One of the many barriers to overcome in this project was affordability. The project required a subsidy to bring the tariff down to the affordable levels expected by regulators. The balance between donor subsidy, regulator tariff expectation and private sector internal rate of return expectation implied a lot of careful thinking for this project. Having tender implementors such as UNOPS involved in the project helped considerably to tackle some of the usual problems with regulations and project development that can sometimes be overwhelming for the private sector alone to tackle. Furthermore, access to some of the Winch sites in Sierra Leone has been a problem. The sites are remote and some of them have river crossings, without bridges, which the company can only navigate with raft crossings.

Due to the early success of the project, there are already plans to expand the project to other villages in Sierra Leone that currently do not have access to a reliable electricity source. Other mini-grid developers are also operating in Sierra Leone, partially due to the new clear mini-grid regulation developed in the country as part of this project. To allow further replication in other countries, it is recommended that future projects follow this public-private partnership approach, whilst adopting high enough subsidies to ensure the tariff for customers is low as possible.

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