Document of
The World Bank

FOR OFFICIAL USE ONLY

Report No: PAD1704

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED GRANT
IN THE AMOUNT OF US$ 22.5 MILLION

TO THE

REPUBLIC OF HAITI

FOR A

RENEWABLE ENERGY FOR ALL PROJECT

APRIL 28, 2017

{Energy & Extractives}
{LATIN AMERICA AND CARIBBEAN}

CURRENCY EQUIVALENTS

(Exchange Rate Effective April, 26th 2017)

Currency Unit = USD

0.730764 SDR = US$1

US$ 1.368430 = SDR 1

FISCAL YEAR

January 1 – December 31

ABBREVIATIONS AND ACRONYMS

BRH	Banque de la République d'Haïti
Capex	Capital Expenditure
CFL	Compact Fluorescent Lamp
CPF	Country Partnership Framework
CTF	Clean Technology Fund
DA	Designated Account
DESCO	Distributed Energy Service Company
ECVMAS	Enquête sur les Conditions de Vie des Ménages après le Séisme
EDH	Electricité d'Haïti
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
EPC	Engineering, Procurement and Construction
ESMAP	Energy Sector Management Assistance Program
ESMF	Environmental and Social Management Framework
FDI	Fonds de Developpement Industriel
FIRR	Financial Internal Rate of Return
FM	Financial Management
FY	Fiscal Year
KGGTF	Korean Green Growth Trust Fund
kWh	kilo-Watt hour
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GOH	Government of Haiti
GOGLA	Global Off-Grid Lighting Association
GRS	Grievance Redress Service
GTF	Global Tracking Framework
GWh	Giga-Watt per hour
GP	Global Practice
HTG	Haitian Gourdes
IDA	International Development Association
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IFM	International Fund Manager

IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IP	Investment Plan
IPF	Investment Project Financing
IPP	Independent Power Producer
IS	Implementation Support
LAC	Latin American and the Caribbean
LED	Light-Emitting Diode
M&E	Monitoring and evaluation
MEF	Ministere de l'Economie et des Finances
MTF	Multi-Tier Framework
MTPTC	Ministry of Public Works, Transportation and Communication
MW	Mega-Watt
NGO	Non-Profit Organization
NPV	Net Present Value
O&M	Operation and Maintenance
OEF	Off-Grid Energy Fund
OM	Operations Manual
Opex	Operating Expenditure
PAYG	pay-as-you-go
PCU	Project Coordination Unit
PDO	Project Development Objective
PIU	Project Implementation Unit
PPA	Power Purchase Agreement
PPP	Public-Private Partnerships
PP	Procurement Plan
PPSD	Project Procurement Strategy for Development
PRELEN	Projet de reconstruction de l'infrastructure électrique et d'expansion de l'accès à l'énergie
PSIA	Poverty Social Impact Assessment
PV	Photovoltaic
QA	Quality Assurance
RE	Renewable Energy
RAP	Resettlement Action Plans
RPF	Resettlement Policy Framework
RISE	Regulatory Indicators for Sustainable Energy
SCD	Systematic Country Diagnostic
SEforALL	Sustainable Energy for All
SME	Small and Medium Enterprises
SHS	Standalone Home Systems
SPDH	Strategic Plan for the Development of Haiti
SREP	Scaling up Renewable Energy Program
TA	Technical Assistance
US$	United States Dollar
UAE	United Arab Emirates
UNFCCC	United Nations Framework Convention on Climate Change

USTDA	U.S. Trade and Development Agency
VAT	Value Added Tac
vRE	Variable renewable energy
WACC	Weighted Average Cost Of Capital
WBG	World Bank Group
Wp	Watt Peak Capacity
WTP	Willingness to Pay

Regional Vice President:	Jorge Familiar Calderon
Country Director:	Mary A. Barton-Dock
Senior Global Practice Director:	Riccardo Puliti
Practice Manager:	Antonio Barbalho
Task Team Leader:	Dana Rysankova / Frederick Verdol

HAITI: Renewable Energy for All

TABLE OF CONTENTS

PAD DATA SHEET

Haiti

HAITI: Renewable Energy for All (P156719)

PROJECT APPRAISAL DOCUMENT

.

LATIN AMERICA AND CARIBBEAN

0000009262

Report No.: PAD1704

.

Basic Information

Project ID P156719	EA Category B - Partial Assessment	Team Leader(s) Frederic Verdol,Dana Rysankova
Lending Instrument Investment Project Financing	Fragile and/or Capacity Constraints [ ] - Fragile States	
	Financial Intermediaries [ ]	
	Series of Projects [ ]	
Project Implementation Start Date August 1, 2017	Project Implementation End Date March 31, 2023	
Expected Effectiveness Date October 1, 2017	Expected Closing Date September 30, 2023	
Joint IFC No		

Practice Manager/Manager	Senior Global Practice Director	Country Director	Regional Vice President
Antonio Alexandre Rodrigues Barbalho	Riccardo Puliti	Mary A. Barton-Dock	Jorge Familiar Calderon

Approval Authority
Approval Authority

Safeguards Deferral (from Decision Review Decision Note)
Will the review of Safeguards be deferred? [ ] Yes [X] No

Project Financing Data (in USD Million)					
[ ]	Loan	[ ]	IDA Grant	[ ]	Guarantee
[ ]	Credit	[X]	Grant	[ ]	Other

Total Project Cost:	62.5	Total Bank Financing:	.00
Financing Gap:	0.00		

Financing Source	**Amount**
Borrower	0.00
Strategic Climate Fund Grant	22.50
Clean Technology Fund	16.00
IDA	24.00
Total	**62.5**

Expected Disbursements (in USD Million)

Fiscal Year	2018	2019	2020	2021	2022	2023	0000	0000	0000	0000
Annual	1.00	2.00	7.00	6.00	4.00	2.50	0.00	0.00	0.00	0.00
Cumulative	1.00	3.00	10.00	16.00	20.00	22.50	0.00	0.00	0.00	0.00

Institutional Data

Practice Area (Lead)

Energy & Extractives

Contributing Practice Areas

Proposed Development Objective(s)

The Project Development Objective is to scale-up renewable energy investments in Haiti in order to expand and improve access to electricity for Haitian households, businesses and community services.

Components

Component Name	**Cost (USD Millions)**
Grid-connected distributed RE	12.00

Off-grid distributed RE	10.50

Systematic Operations Risk- Rating Tool (SORT)	
Risk Category	**Rating**
1. Political and Governance	High
2. Macroeconomic	Substantial
3. Sector Strategies and Policies	High
4. Technical Design of Project or Program	Substantial
5. Institutional Capacity for Implementation and Sustainability	High
6. Fiduciary	Substantial
7. Environment and Social	Moderate
8. Stakeholders	Substantial
OVERALL	HIGH

Compliance		
Policy		
Does the project depart from the CAS in content or in other significant respects?	Yes [ ]	No [X]
Does the project require any waivers of Bank policies?	Yes [ ]	No [X]
Have these been approved by Bank management?	Yes [X]	No [ ]
Is approval for any policy waiver sought from the Board?	Yes [ ]	No [X]
Does the project meet the Regional criteria for readiness for implementation?	Yes [X]	No [ ]

Safeguard Policies Triggered by the Project	Yes	No
Environmental Assessment OP/BP 4.01	X	
Natural Habitats OP/BP 4.04	X	
Forests OP/BP 4.36		X
Pest Management OP 4.09		X
Physical Cultural Resources OP/BP 4.11	X	
Indigenous Peoples OP/BP 4.10		X
Involuntary Resettlement OP/BP 4.12	X	
Safety of Dams OP/BP 4.37	X	
Projects on International Waterways OP/BP 7.50		X
Projects in Disputed Areas OP/BP 7.60		X

Legal Covenants (TBD)

Name	Recurrent	Due Date	Frequency

Description of Covenant

Conditions

Source Of Fund	Name	Type

Description of Condition

Team Composition

Bank Staff

Name	Role	Title	Specialization	Unit
Frederic Verdol	Team Leader (ADM Responsible)	Sr Power Engineer	Energy	GEE04
Dana Rysankova	Team Leader	Senior Energy Specialist	Energy	GEEES
Rose Caline Desruisseaux-Cadet	Procurement Specialist	Procurement Specialist		GGO04
Fabienne Mroczka	Financial Management Specialist	Sr Financial Management Specialist	Financial management	GGO22
Asli Gurkan	Safeguards Specialist	Senior Social Development Specialist	Social specialist	GSU04
Lucine Flor Lominy	Team Member	Energy Specialist	Energy	GEE04
Nicolas Kotschoubey	Safeguards Specialist	Consultant	Environmental specialist	GEN04
Monyl Toga	Team Member	Energy Specialist	Energy	GEESO
Vincent Launay	Team Member	Infrastructure Finance Specialist	Financial Solutions/Energy	GEEFS
Juliette Besnard	Team Member	Consultant	Energy	GEESO
Stephanie Nsom	Team Member	Consultant	Energy	GEE04

Extended Team

Name	Title	Office Phone	Location

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
Haiti					Nation-wide program

Consultants (Will be disclosed in the Monthly Operational Summary)

Consultants Required ? Yes

I. STRATEGIC CONTEXT

1. The Republic of Haiti has been selected as one of the recipients of the Scaling up Renewable Energy Program (SREP) in Low Income Countries. In May 2015, the SREP Sub-Committee endorsed a US$30 million SREP Investment Plan for Haiti, to be implemented by the World Bank (US$21-23 million) and IFC (US$7-9 million). The proposed Project covers the World Bank-led SREP components, amounting to US$22.5 million.

A. COUNTRY CONTEXT

2. **Haiti's geography, people, and history provide it with many opportunities.** The Republic of Haiti shares the island of Hispaniola with the Dominican Republic, and it is the third largest Caribbean nation by area (27,750 km2) and population (10.4 million). In addition to an illustrious early history, as the first nation in the world to be led to independence by former slaves, Haiti benefits from proximity and access to major markets, a young labor force, a dynamic diaspora, and substantial geographic, historical, and cultural assets, as well as diverse and abundant renewable energy (RE) resources.

3. **However, Haiti has considerable development challenges**. Haiti ranks 163rd out of 188 countries on the 2015 Human Development Index, and according to the most recent national household survey (ECVMAS),[1] nearly 60 percent of the Haitian population is classified as poor (living under the national poverty line of US$2 a day) and almost a quarter of the population is very poor (<US$1 a day). Haiti is one of the most unequal countries in the region with a 2012 Gini co-efficient of 0.61, where the richest quintile holds over 64 percent of the total country income, while the poorest quintile holds less than 1 percent.

4. **There are also strong disparities between urban and rural areas.** Over the last decade, there have been some improvements in terms of reducing extreme poverty, but the progress has been uneven. In rural areas, where half of the Haitian population lives, there has practically been no progress in reducing poverty in the last 10 years. 70 percent of rural households are considered chronically poor.

5. **Gender inequality is also persistent**. Despite sizable progress in school enrollment, adult women are still less well educated and are more likely to be illiterate. Women are significantly disadvantaged in monetizing their economic assets and obtaining relevant returns, particularly in the labor market. Gender-based violence and low participation in the public sphere remain widespread in Haiti.[2]

6. **Haiti's economic performance has been repeatedly compromised by political shocks and natural disasters.** The magnitude 7 earthquake in 2010 killed around 230,000 people (including scores of professionals and public servants) and displaced 1.5 million, making it one of the world's deadliest natural disasters on record. It resulted in damages and losses of around US$8 billion (120 percent of GDP). Then again, on October 4, 2016 the country was smashed by

---

[1] ECVMAS, Enquête sur les Conditions de Vie des Ménages après le Séisme (2012)
[2] World Bank, Creating Opportunities for Poverty Reduction in Haiti (2015)

Hurricane Matthew, striking southwestern Haiti near Les Anglais - recorded as the strongest storm to hit the nation since 1964, and the third strongest Haitian landfall on record. Nationwide, the hurricane nearly or completely destroyed around 200,000 homes, leaving 1.4 million people in need of humanitarian aid and a death toll of over 1,000. Monetary damage was estimated at US$1.89 billion.

7. Lacking sufficiently long periods of stability, Haiti has struggled to develop the institutional mechanisms, capacity, and policy fundamentals essential for long-term economic development. Most recently, on February 7, 2017, Jovenel Moise was inaugurated as Haiti's President, ending a two year-long electoral process and paving the way towards much needed stability to attract investment and boost growth. President Moise is coming after two years of the interim government, which was put in place when former President Martelly completed his term in February 2015 without a successor, while the first round of the Presidential elections had to be repeated due to the fraud allegations.

8. Gross domestic product (GDP) per capita was US$818.3 in 2015—less than 10 percent of the Latin America and the Caribbean regional average. In addition, while the post-earthquake period was generally characterized by a positive economic growth, which allowed a moderate increase in GDP per capita, the last two years were marked by the political uncertainties resulting from contested elections and the impact of natural hazards, which have slowed down the economic growth and accelerated inflation and gourde depreciation.

9. **World Bank's 2015 Systematic Country Diagnostic[3]** illustrates that significant acceleration of growth rates is needed to reduce poverty, but also that growth has to become more inclusive. This calls for more attention to the development of economic opportunities in secondary cities and rural areas, including better access to basic infrastructure services, such as electricity.

B. SECTORAL AND INSTITUTIONAL CONTEXT

10. The energy sector in Haiti is overseen by the Ministry of Public Works, Transportation and Communication (MTPTC) through its Energy Cell. There is no regulatory agency currently in place. MTPTC oversees Haiti's national electricity utility EDH (Electricité d'Haïti), which is the main distributor of power in Haiti, which until recently[4] had a monopoly over transmission and distribution of electricity.

11. **Haiti's energy sector is characterized by low access to electricity, intensive biomass use** and increasing reliance on imported fossil fuels. Total primary energy consumption is 0.4 tons of oil equivalent per capita, one of the lowest in the world; of which biomass (wood and charcoal primarily) represent around 74 percent, petroleum products 23 percent, and hydropower 3 percent.

12. **Haiti electricity sector's reliance on petroleum products is increasing**. The generation capacity on Haiti's electricity grids – managed by EDH – is about 320 MW; however, only about 176MW are available for dispatch, inadequate to meet peak demand estimated well above 400MW. Most of this on-grid power generation (81 percent) is supplied through oil-based thermal

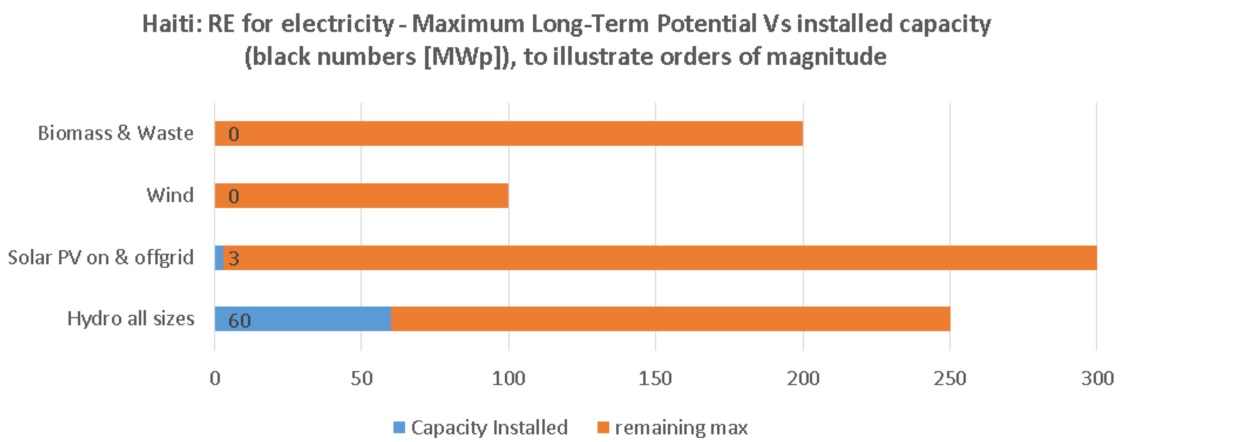
[3] Haiti: Towards a New Narrative; Systematic Country Diagnostic, 2015.
[4] Presidential decrees dated February 03, 2016 ended EDH monopoly on electricity transmission and distribution, and provided framework for the creation of an Energy regulatory body (ANARSE)

generation (diesel and fuel oil, mostly provided through independent power producers). EDH-owned hydropower contributes 19 percent. While on-grid capacity has not increased significantly, the total aggregated capacity of diesel engines, used for self-generation and back-up power has been growing steadily since the 1990s. It is now estimated at striking 500MW -- three times the available generation capacity of EDH.

13. **Haiti's reliance on imported petroleum products is costly.** EDH's average costs of thermal generation (from IPPs and own generation) is around $0.30/ kWh, and generally it is higher on its smaller isolated grids, running on diesel. The average costs of generation from individual diesel gensets varies depending on their size and efficiency, but typically ranges from US$0.40 to almost US$2 per kWh. While renewable energy generation costs are site-, context- and transaction- specific, renewable energy, such as solar PV, is highly competitive in such price conditions, even without considering positive environmental externalities.

14. **Haiti has excellent renewable energy resources.** The available studies of renewable energy potential in Haiti confirm that economic potential exists for hydropower, solar PV, wind and biomass generation.[5] As of now, however, only hydropower potential has been at least partially exploited (see Figure 1).

Figure 1. Haiti renewable energy potential



15. **Haiti is falling behind other countries, including its Caribbean neighbors**, which are all investing in the diversification of their energy supply. Utility-scale solar PV prices have become highly competitive in recent years, driven both by falling PV technology costs and competitive pressures through solar auctions. Latest statistics produced by the SE4ALL Knowledge Hub demonstrate that Haiti is an outlier both in terms of the failure to enact a supportive policy and regulatory framework for clean energy and access (Haiti ranked second from bottom in RISE[6] 2017 out of 111 countries), and in terms of actual achievements on the ground in these areas (GTF, 2017).

---

[5] See Haiti SREP Investment Plan for summary of the available studies and resulting estimates of economic potential

[6] Regulatory Indicators for Sustainable Energy

16. **About a third of the Haitian population has “some", mostly sporadic and unreliable access to electricity,** a rate that has remained practically unchanged for the past 40 years. Electricity access is sparse and sporadic throughout the country and absent in much of rural Haiti – less than 15 percent of rural Haitians have access to electricity. Furthermore, access is highly skewed towards higher income quintiles and increasingly provided through informal connections, which are ironically seen as more reliable than the legal EDH connections (see Box 1). Off-grid electrification is beginning to fill in the access gap in rural areas, but the sector is still in its infancy, constrained by barriers typical to the early stage of off-grid energy markets – limited access to finance, regulatory constraints and lack of knowledge and trust in off-grid technologies.

Box 1. Electricity Tariff in Haiti - Who gets it and how

A 2016 World Bank report highlights four key challenges facing Haiti with respect to access to electricity by the poor, as highlighted in the Poverty Social Impact Assessment (PSIA) on improving billing and recovery rates in Haiti. In effect:

(1) **It is estimated that more than 66 percent of the population with electricity have access informally**. Expenditures on electricity represents 2.7 percent of households’ consumption budget.

(2) **Households favor informal connections** because amounts to be paid are more predictable and more transparent than EDH bills. With an informal access, households know upfront how they have to pay for electricity. The connection process for informal connections seems simpler, more straightforward, and much less complicated than installing a working EDH connection. Informal connections are installed by a person from the neighborhood typically from a direct request by the client.

(3) **Transferring payments from “informal providers” to EDH would significantly increase its revenues**. Assuming that EDH collects what informal consumers pay to their informal ‘providers’ and that consumers do not modify their consumption, EDH revenues could increase by 50 percent.

(4) **Regularization may decrease poor households’ welfare**. Formal electricity being likely more expensive than informal electricity, when becoming formal—everything else being equal—households who were previously connected informally may need to pay more for electricity.

(5) Most of the poor remain excluded from the grid. Therefore, the **subsidies to electricity sector are very regressive**

EDH-owned grids

17. EDH operates one main “interconnected” grid serving the capital Port au Prince and surrounded areas and nine smaller isolated grids[7]. EDH has a total of about 270,000 “active” (*id est*, legally connected, metered and billed) customers, and many more illegal/informal connections.[8]

18. About 90,000 active customers are spread out through nine isolated grids across the country, serving secondary cities and larger rural towns. Typical grids would serve between 500-20,000 customers[9] with peak demand of 0.5 and 10 MW, generally supplied intermittently by

[7] Sometimes referred to as 11 isolated grids. Some isolated grids are administratively grouped together, so they appear as 9 isolated grids.
[8] A recent study estimates that the share of illegal connections may be as high as 66 percent (see Box 1 above).
[9] A few reach 100,000 customers.

diesel units and in some cases, small hydropower, in all cases with peak demand outstripping the available supply.

19. **EDH faces considerable technical, managerial, and financial challenges.** Technical and nontechnical losses are 62 percent, in large part due to electricity fraud and theft (i.e. illegal/informal connections). Further, the collection rate is only two–thirds, hence EDH ultimately recovers only 22 percent of the value of the electricity it purchases and generates. In addition, purchases (fuel, power) are made in US$ and all revenues are collected in Haitian Gourdes, which has depreciated significantly in recent years, exacerbating the already precarious EDH situation. Consequently, EDH faces difficulties in paying for fuels, basic maintenance, and other operating costs, and depends on government subsidies to bridge the gap, contributing to an annual financial deficit of US$200 million (2015), equivalent to 4 percent of the national budget. These subsidies have been identified by the IMF as the major threat to Haiti's fiscal stability and the Government of Haiti (GOH) is considering measures to reduce EDH losses[10], including outsourcing EDH commercialization functions (metering, billing and collection) to independent entities. Improving EDH commercial performance is GOH's greatest challenge, an unanimously acknowledged imperious step for a viable sector and economic development.

20. **The average residential tariff (US$0.21/kWh) is below the LAC region average**, but the average tariff for the industrial and commercial customers (US$0.30/kWh) is at the higher end of the regional range. The average daily electricity service– in the metropolitan area - of only 13 hours[11] and the relatively high tariff for commercial and industrial users compels most industries to self-generate.

21. **The overall distribution infrastructure is outdated and poorly maintained**, suffering from damages from frequent natural disasters and illegal connections and expansions. The latest – hurricane Matthew – in October 2016 hit the South of the country and left a path of destruction, including the EDH grids in South and South-West. Cities of Les Cayes, Jérémie and Aquin/Petit Goâve all sustained severe damages to lines and generation units, leaving over 10,000 households without power.

Municipal diesel grids

22. **Apart from EDH-owned grids, there are over 30 diesel-powered municipal grids,** operated under the Decentralization Law of 2006 (or informally).[12] These are generally much smaller than EDH grids – mostly 100-500kW, serving mostly smaller rural towns. Their diesel units are typically oversized and expensive to run. The service is at best sporadic. A recent study[13] of 36 municipal diesel mini-grids found that all 36 diesel grids have been operating for far fewer hours than their nominal operating schedules (which are typically anyway only three to four hours a night for four to five nights per week). Customers are typically not metered but rather charged a flat tariff based on lights used and appliances. The tariff, however, tended to be set below operating

[10] See MTPTC's 2017-2022 roadmap for the Electricity sector, dated April 04, 2017.
[11] Typical even lower in the isolated grids
[12] The 2006 Decentralization Law gives rights to municipalities to provide energy services on their territories, which have resulted in municipalities investing in their own diesel mini-grids, and more recently signing concessions with the private sector to build and operate mini/micro-grids.
[13] Schnitzer D., Microgrids and High-Quality Central Grid Alternatives: Challenges and Imperatives: Elucidated by Case Studies and Simulation

costs, preventing them from operating at their scheduled output. In addition, the study found that the municipal grid operators lacked working capital to make up for gaps in untimely customer tariff payments. Many of them, therefore, have already ceased to operate.

23. **Most of these grids have relatively complete and recently built distribution networks** and could therefore become operational if efficient and sustainable generation supply was available and power was adequately commercialized. The municipal grids are not required to apply the EDH tariffs, and tariffs therefore could be set at cost-recovery levels. In addition, costs of operation could be significantly reduced by solar PV hybridization and introduction of energy efficiency measures, such as replacement of incandescent light bulbs with CFLs or LEDs.[14]

Renewable energy village grids

24. **Most of the Haitian rural towns and villages are not connected to any grid**. Recently, renewable energy village grids started to emerge as a viable solution for such sites. Currently, there are two village grid operators in Haiti with a nation-wide scale-up ambition (EarthSpark and Sigora), charging cost-reflected tariffs and using smart meters and energy efficiency measures to minimize the costs of operations, while maximizing service levels to their customers.

25. **A recent study reconfirms high potential for renewable energy village grid development in Haiti.** A recent USTDA-financed study[15] has identified 41 micro-grid-able towns, with suitable characteristics, such as total population and its density, productive loads potential and other economic potential, political will, state of infrastructure, accessibility etc. The results are included in Annex 2.

Self-generation – from diesel fuel to solar PV power

26. With the vast majority of households and businesses unelectrified or under-electrified, self-generation is currently the most widespread method how individual users acquire electricity access in both urban and rural areas in Haiti. This includes primarily individual diesel generators.

27. **The combined capacity of individual diesel generator sets is estimated to be 500MW** (far more than all EDH grids, municipal and private mini-grids combined). Most of those are run by industries and businesses that require reliable power supply that EDH is unable to provide, or wealthier households in urban areas. Diesel gensets, however, are also quite common in rural areas, supplying a range of enterprises, such as hotels and other tourism establishments, branches of financial institutions, agribusinesses, as well as small rural workshops and retail businesses.

28. Most households and micro-enterprises in rural areas, however, have no electricity access, and pay large amounts for inferior and harmful lighting alternatives. Household surveys[16] show that Haiti's rural poor spend a very large share of their total household budget on basic lighting and energy services (such as cell phone charging) for very poor service quality and quantity at high unit costs, and negative health and environmental impacts. The departmental averages for

---

[14]The same study demonstrated that tariff increases may even not be necessary if efficiency measures were executed.

[15]Implemented by EarthSpark and Energy and Security Group

[16] Both a large household survey - ECVMAS (2012) - and a more recent (2014) telephone survey carried out by Digicel/iiDevelopment for the preparation of the Haiti Investment Plan have confirmed very high spending of unelectrified households on fuel-based lighting, dry cell batteries and cell phone charging.

rural households spending on electricity-substitutable items is between US$10 and US$20 a month – which is high in international comparison. Significant opportunities exist for converting these expenditures to installments to purchase quality solar lighting/solar home systems.

29. **This market potential is increasingly realized by a number of solar PV companies** offering both pico-PV and larger solar home systems (SHS) to unelectrified households. The recent global trends in off-grid electrification indicate that private sector-driven, off-grid electrification solutions could accelerate electrification efforts on an unprecedented scale[17]. Innovative business models are emerging now, such as the so called "pay-as-you-go" (PAYG) model, which offers households a possibility to pay electricity in installments, typically over a period of 12 to 36 months. This model enables customers to receive a greater amount of energy services (lights, mobile phone charging, TVs, fans, radios) than they could afford on a cash retail purchase basis and supports customer confidence-building that the products really work. This incremental mode of consumer payments has been shown to increase sales of offgrid solution by three times.[18]

30. **Haiti is beginning to catch up with these global trends**. The relatively high penetration of solar lanterns in Haiti (at least 15 percent) shows that Haitians are appreciating modern lighting products. Most of the lanterns on the market, however, are not quality-certified and do not provide sustainable access. More recently, three companies have started to experiment with PAYG solutions (DigitalKap, Re-Volt and EKOTEK). These three Haitian companies are currently in the process of launching, piloting or scaling up PAYG business models. However, Haiti's relative isolation from the main markets in Africa and South Asia, as well as a number of domestic barriers (high import duties and VAT, high level of spoilage by low quality products, difficulty to access financing etc.) constrain the market growth. The Renewable Energy for All Project aims at unlocking the enormous market potential for diverse distributed renewable energy solutions to help Haiti achieve its goal of universal electricity access.

31. **The government's vision for the energy sector is based on the Strategic Plan for the Development of Haiti (SPDH),** which sets a path for Haiti to become an emerging economy by 2030. The SPDH envisages strengthening the private sector and providing basic services (including electricity) to the population, reaching universal access by the target year 2030.

32. **The new Government's National Roadmap[19], announcing its development priorities, was released in April 2017.** The Roadmap sets an ambitious plan for the energy sector, calling for improving EDH performance and for dual efforts to build the national grid while supporting mini-grid and off-grid solutions for electrification. The Roadmap also calls for a diversification of Haiti's generation mix with indigenous renewable energy sources. The Roadmap specifically calls on MTPTC to implement the present SREP-funded project, as well as the related CTF-funded Modern Energy Services for All Project.

33. **The World Bank has been a key strategic partner in Haiti's electricity sector,** actively engaging with key stakeholders pertaining to the energy policy, the planning capacity and the financing sustainability of the sector; and supporting the development of innovative solutions to

[17] The Global Off-Grid Lighting Association (GOGLA) estimates that globally over 93 million people today live in households served by at least one quality (branded) off-grid lighting product.
[18] Lighting Africa: State of the pico market. Lighting Africa Team meeting. March 2016.
[19] http://www.sgcm.gouv.ht/feuilles-de-route/

restore and expand electricity access to urban, peri-urban and rural areas of Haiti. The IDA-financed Rebuilding Energy Infrastructure and Access Project – PRELEN (IDA Grant H-8060-HT, P127203) has facilitated the rehabilitation of critical power infrastructure and the strengthening of the capacity to Energy Cell, within the MTPTC. The PRELEN project is currently being restructured to focus more resources on energy access and renewable energy, including co-financing for the proposed Renewable Energy for All Project. See Box 2.

Box 2. Rebuilding Energy Infrastructure and Access Project (PRELEN)
Effective since February 2013, PRELEN project is a US$90 million IDA grant whose objective is to rebuild and expand the electricity grids affected by the 2010 earthquake, expand energy access and strengthen the energy institutions. On the power distribution grid sub-sector, the project rehabilitated 180km of grids in Port-au-Prince, improving the electricity service for 30,000 customers. PRELEN has also provided critical technical assistance to the utility EDH, in financing the 2015-2030 Electricity Masterplan and the electricity sector financial model, and supported supervision of EDH commercial improvement plan. Under the ongoing project restructuring, It will rehabilitate the Drouet mini-hydropower plant, adding 3MW of baseload power in the Saint-Marc power system (equivalent to US$5.1 million worth yearly of thermal energy). Off-grid activities were also implemented under the PRELEN: supply and installation of the first public solar PV and battery plant (100kWp PV + 500kWh Lithium-Ion battery), installation of more than 800 solar street lights in poor urban and peri-urban areas, support to the Government's Numerical Education program (500 rural schools electrified with solar PV and lithium-ion batteries). Ongoing project rehabilitation (including a 1 year project extension until end 2018, restructuring process to be completed in May 2017) will reallocate funding available to implement more off grid activities, in coordination with SREP and CTF funded operations, and in synergy with productive and social sectors. PRELEN is an essential component of the Haiti Energy sector institutional strengthening, by financing the MTPTC Energy Cell staff and logistical costs, and the activities implemented under this entity on regulatory reform and capacity building (electricity reform framework, PhD student on Renewable Energy).

C. Higher Level Objectives to which the Project Contributes

34. **The proposed Project is fully aligned with the World Bank Group's Country Partnership Framework (CPF)** for FY16-18 (Report No. 98132-HT) that was approved by the World Bank Executive Directors on September 29, 2015. The proposed Project will contribute to CPF focus area of Inclusive Growth by supporting the development of greater economic opportunities beyond Port-au-Prince, increasing energy access, and supporting the development of renewable energy. It will support Haiti's competitiveness and productivity by promoting private-sector growth through energy investments.

35. **The project supports the World Bank Group (WBG) objectives of ending extreme poverty and promoting shared prosperity** by providing sustainable energy to fuel economic growth in Haiti's secondary cities and rural areas, supporting SCD's call for making Haiti's growth more equitable.

36. **The project supports the government's newly released development priorities, summarized in the National Roadmap,** which calls for diversifying generation mix, increasing renewable energy potential and supporting access through both smart mini-grids and solar PV off-

grid solutions. The Project also supports Haiti's commitment in INDC to expand renewable energy generation to 47 percent of the generation mix by 2030. These goals are in line with the new Sustainable Development Goal 7—which calls for ensuring universal access to reliable, affordable, sustainable, and modern energy.

37. The path towards scaling up renewable energy and access in Haiti is embodied in the US$30 million SREP[20] Investment Plan (IP) for Haiti, endorsed by the SREP sub-committee in May 2015.[21] Separately, in October 2015, the Clean Technology Fund (CTF)[22] approved US$16 million funding for Modern Energy Services for All Project, which establishes the Off-Grid Energy Fund (OGEF) to finance commercially viable off-grid energy enterprises in Haiti, which has been included as co-financing for the SREP IP. The priorities identified in the IP are the result of extensive consultations with government agencies, NGOs, the private sector, academic institutions, and civil society, under the leadership of MTPTC and support from Multilateral development banks (the World Bank, IFC and IDB).

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

38. The Project Development Objective is to scale-up renewable energy investments in Haiti in order to expand and improve access to electricity for Haitian households, businesses and community services.

B. PROJECT BENEFICIARIES

39. The proposed SREP project initiates a transformation from Haiti's presently underdeveloped, unreliable, and expensive fossil fuel-based power generation mix to a modern and sustainable energy system relying on diverse sources of power. Harnessing the country's RE potential will enhance energy security (by reducing Haiti's dependency on imported oil), alleviate poverty (by providing households cheaper sources of power), create jobs and generate new economic opportunities (by providing a more reliable electricity and by creating a new clean energy industry).

40. The project, including its CTF and SREP co-financing, will provide new or improved electricity services to at least 900,000 people and 11,000 enterprises/community services. Women, in particular, will benefit as energy users, as entrepreneurs and as employees of the newly created off-grid energy businesses. The project includes specific actions to ensure that the gender-differentiated benefits materialize and are properly tracked (see Annex 1 for gender-related indicators and Annex 5 for gender assessment and actions).

[20] SREP is a multi-donor trust fund under the framework of the Climate Investment Funds (CIFs) established in 2010 to pilot and demonstrate the economic, social and environmental viability of low carbon development pathways in the energy sector by creating new economic opportunities and increasing energy access using renewable energy.
[21] Of US$30 million approved, US$21-23 million was approved for a World Bank project, and US$7-9 million for IFC.
[22] CTF is one the funds established under the umbrella of the Climate Investment Funds to empower transformation in developing and emerging economies by providing resources to scale up low carbon technologies with significant potential for long term greenhouse gas emission savings.

C. PDO LEVEL RESULTS INDICATORS

41. The PDO will be measured against the following indicators:

- Capacity of energy capacity constructed or rehabilitated (MW) (Bank core);
- People provided with new or improved electricity service (Bank core), of which female;
- Enterprises provided with new or improved electricity service;
- Enabling policy and regulatory framework for clean energy and access enacted;
- Private investment and commercial lending leveraged.

42. In addition, the project will track the following key SREP core indicators for each Component separately: (i) Annual electricity output from RE, as a result of SREP interventions; (ii) Number of people, businesses and community services benefitting from improved access to electricity and fuels, as a result of SREP interventions; (iii) Increased public and private investments in targeted subsectors as a result of SREP interventions; (iv) Greenhouse gas emission reductions (tons of CO2 equivalent). Additional intermediate indicators, as well as gender-related and citizen engagement indicators are included in Annex 1.

43. The project will establish a baseline using the Multi-Tier Framework global survey, and will measure progress against this baseline.

III. PROJECT DESCRIPTION

44. **The proposed Renewable Energy for All Project is based on the SREP Investment Plan**, approved by the SREP sub-committee in May 2015. It is split in two main components, each a SREP standalone project, as follows:

- Component 1: Grid-Connected Distributed RE (or SREP Renewable Energy for Metropolitan Area - XSREHT050A); and
- Component 2: Off-grid Distributed Renewable Energy (or SREP Renewable Energy and Access for All - XSREHT047A).

45. The Project will be co-financed by (i) SREP, (ii) IDA PRELEN Project, which is being restructured to focus on clean energy and access, (iii) CTF-funded Modern Energy for All Project, which has established the Off-Grid Energy Fund (OGEF) for commercially viable off-grid energy investments, (iv) private capital, and (v) several TA providers. [23] See Annex 3 for detailed break-down of co-financing sources.

46. The Project proposes a comprehensive investment and capacity building program to unlock the most promising RE investment opportunities in Haiti. The objective is to use renewable energy to drive energy access expansion and to improve quality of electricity service provision. Considering the fragmented nature of Haiti's electricity system (nine isolated grids operated by EDH, over 30 municipal grids and 500MW estimated in self-generation), investments in

[23] Technical assistance and capacity building is further co-financed by ESMAP, Korea Green Growth Fund, Schneider Foundation and the French Ministry of Education. Additional contributions from other development partners (e.g. UAE, EIB and IDB) are under discussion

distributed renewables have in particular been prioritized[24]. Three user / off-taker segments with the strongest potential for near- and medium-term private sector investments were identified: (i) small and medium-sized EDH grids, (ii) municipal village grids, and (iii) individual off-grid systems for productive and household uses – see table 1.

Table 1. Distributed RE access expansion options – electrification potential

Distributed RE access expansion option	Theoretical max. potential of segment (population)	Recommended SREP target (population)
RE retrofit, upgrade, and expansion of EDH grids	1,500,000	100,000
Small and medium village grids (retrofit and greenfield)	300,000	60,000
Stand-alone systems (households, social users, SMEs)	>5,000,000	600,000

A. Project Components

Component 1 Grid-Connected Distributed Renewable Energy: US$ 17 million (*SREP $12.5 million, IDA $4 million, others $0.5 million)*

47. **Component 1 will initiate the scaling up of on-grid RE investments in Haiti**, by demonstrating the feasibility and benefits of injecting solar PV generation into EDH grids and building supporting policy and regulatory environment for private sector-driven RE investments. The Component aims at building 6-12 MW of Renewable Energy (RE) capacity (solar PV + battery), which would hybridize 2-3 EDH isolated grids, currently running on diesel power, resulting in 5-10 GWh of annual renewable energy generation, and improved access for at least 100,000 people and 1,000 enterprises/community uses. Given the tremendous generation capacity deficit and high costs of thermal generation by EDH, the replication and scale-up potential is enormous. The Component will engage private sector in the construction and operation of the PV plants and build a path towards attracting commercial investments in solar PV generation. It will demonstrate the potential of solar PV energy to simultaneously reduce costs of electricity generation for EDH, while improving service quality for EDH users. It will be the first grid-connected solar PV investment in Haiti.

- Technology: The Component will support solar PV technology with battery storage. Solar PV was selected over other potentially viable RE technologies (hydro, wind, biomass) due to the applicability of this technology to all potential sites, and due to its modularity, which makes it suitable for both larger-scale and smaller-scale investments. The decision to complement solar PV generation with battery storage is driven by the following considerations: (i) proven economic viability in the Haitian context (see Economic

[24] The SREP Investment Plan originally also contemplated a larger scale grid-connected RE investment serving the largest of EDH grids (Port-au-Prince metropolitan area). This project, however, had to be abandoned due to the current transmission bottlenecks that for the time do not allow an integration of a large scale RE investment into the grid. In addition, demonstration impact would be diluted due to significant technical losses in the system, which will prevent users from experiencing any visible service improvement.

Analysis in Annex 6), (ii) imperative to demonstrate service availability and reliability improvements in addition to the cost reduction benefits, and (iii) scale-up effect—considering that the continued technology and price trends will likely favor "PV with storage" over "PV only" investments in the coming years in Haiti.[25] The least cost proven battery technology, such as lithium ion, will be used for storage.

- Business model: The Component design is aimed at enabling private sector investments in solar PV generation in Haiti. The team explored using part or all of the funds allocated to Component 1 as a guarantee to support the mobilization of private capital considering (i) the lack of creditworthiness of EDH as the potential off-taker and (ii) the lack of private sector-led renewable energy project precedents in Haiti. Further analysis and private sector consultation, however, revealed that while guarantees could eventually be used to mobilize private capital for solar PV investments in Haiti, more work is required today in the power sector before a private sector-led projects could be undertaken and deemed bankable by the private sector. To make a solar PV project bankable (i) EDH will have to be supported with more capacity building, (ii) the collection of revenues in the targeted EDH grid should be ring-fenced and outsourced to an independent entity and (iii) the feasibility of solar projects should be demonstrated through one or several pilot projects in order to test and fine-tune an integration of solar PV and batteries in the context of EDH's weak grids and overcome EDH's aversion to solar PV technology due to its intermittency.

Sub-component 1.a: Demonstration solar PV project

48. This Sub-component will finance solar PV + battery storage plants to feed 2-3 EDH isolated grids. The Sub-component aims at building 6-12 MW of RE. The final generation capacity depends on the final site selection, completion of feasibility studies determining the final absorption capacity of the selected grid, decision on how much battery storage and the degree of private sector participation.

49. The Sub-component will be implemented in a phased approach through which the first solar investment would be publicly financed to demonstrate the feasibility of connecting mid-size solar PV plant with storage to the relatively small and weak grid in Haiti. Subsequently, upon successful development of publicly-financed solar investment, private investment will be sought if feasible. In such a case, the project may be restructured, to allow a part of Component 1 funding to be used as a guarantee.

50. The first sub-project will be public-sector financed and private-sector implemented (through Engineering, Procurement and Construction (EPC) and Operation & Maintenance (O&M) contracts). The subsequent investments will seek increased private sector participation if feasible. An Independent Power Producer (IPP) approach, backed by a guarantee, will in particular be explored.[26] After the first demonstration, leveraging private sector would be a priority, but if not feasible, others options will be considered including: (i) expanding the demonstration project

[25] See for example: IRENA: Rethinking Energy, 2017

[26] The approach is not described in detail here, as the exact nature of the PPP approach and the associated guarantee will need to be designed based on what is feasible at that time. The project will actively explore this option and if feasible, it will be restructured to turn a part of SREP funds into a guarantee. The guarantee design will be presented in the Restructuring Paper and associated documents.

(either the same grid or an additional grid) or (ii) reallocating funds to Component 2 if that component is performing well.

51. Site selection and resource optimization. Five small and medium-sized EDH grids (2-12MW) were prioritized (out of a total of nine) as suitable off-takers for the solar PV plants: Jeremie, Les Cayes, Petit Goave, Jacmel and La Gonave. Selection criteria for the EDH sites include size, likely technical compatibility with the solar PV + battery plant, status of local grid and generation, logistics of PV and battery installations, availability of public land for the PV plant, potential for demonstration effects in post project scale-up, and ability to generate revenues to cover O&M costs. Priority was given to areas devastated by Hurricane Matthew. Final sites will be selected by MTPTC Energy Cell in consultation with EDH and MEF and in agreement with the World Bank, based on the confirmation of the selection criteria and taking into account the emerging economic development priorities of the GOH[27]

52. System design. A broad set of pre-feasibility modelling tools (Homer, PVSyst, Mathematica-based mixed integer linear optimization, and Excel-based Sensitivity and Monte Carlo Analysis) were run to determine the most promising mix of system designs and sizes for these 5 sites, based on estimated pre-feasibility Capex, Opex for a broad range of capacities for the solar PV generator and battery storage. For discussion, and in light of data and modelling uncertainty inherent to pre-feasibility stage, the resulting array of economically viable system designs was then simplified into three main village grid categories, by “PV Share”: low, medium and high solar PV penetration (see Annex 2 and Annex 6).

53. Contractual arrangements. MTPTC Energy Cell (with the assistance of the technical advisor funded under Sub-component 2) will competitively procure an EPC contractor, who will be in charge of the detailed design and installation of the solar PV + battery plant. The plant will be operated by the private sector under an O&M contract (expected to be the same as the EPC contractor), expected to be awarded for 4 years. The O&M contractor will also be required to build EDH capacity for the future operation and maintenance of the plant. The O&M contractor will be paid by EDH through an escrow account. EDH will be required to isolate administratively the selected isolated grid from the rest of EDH and to establish an escrow account, to which an agreed amount will be paid annually per an automatic transfer from a share of revenues collected on the grid. The monthly O&M amount will cover the O&M contractor payment plus the contribution for the spare parts and equipment replacement.

Sub-component 1.b: Technical assistance and enabling framework for RE scale-up

54. This component will finance technical assistance to the Energy Cell, EDH, the Ministry of Economy and Finance, and other key stakeholders for the design, implementation and monitoring of the demonstration projects, including safeguards aspects, and for development of solutions for increased private sector participation (PPA, guarantee design, transaction advice, billing and collection outsourcing etc.).

[27] The list is not binding. To facilitate integration and promote maximum use of solar PV power, only EDH grids with EDH-owned diesel generators are considered. This may exclude Les Cayes and Petit Goave from the list, considering the uncertainty about the future of the existing IPP, which has been supplying these two grids, but is currently operating without a contract. Additional sites could be considered as long as meeting criteria (i) to (iv) identified above.

55. In addition, the Sub-component will finance development of a broader enabling policy and regulatory framework to support renewable energy investments and private sector participation in the long term, including fiscal incentives for renewables such as customs duty and tax exemptions, development of a realistic RE grid integration plan and targets, grid code, design of auctions and other competitive procurement processes and standard PPAs.

56. In addition to the TA provided under this Sub-component, the Government officials, EDH and other key stakeholders will also benefit from training on renewable energy technologies, integration issues, PPP models, and design of guarantees and other risk mitigation instruments, developed under the broader capacity-building program under Sub-component 2.d.

<u>Component 2: Off-grid Distributed Renewable Energy:</u> US$ 51.5 million *(SREP $10 million, IDA $20 million, CTF $16 million, others[28]$25.5 million)*

57. Component 2 (inclusive IDA and CTF co-financing) will extend access to clean and modern energy services to households, communities and enterprises that are not served by EDH. The Component will provide (mostly) first-time access to at least 800,000people and 10,000 enterprises and community service institutions, such as schools, health centers and community water pumping services. The Component will deploy a wide range of off-grid electrification options: village grids[29], larger stand-alone systems for productive and community uses, and smaller solar home and pico-PV systems for households.

58. While the household system segment is the most dynamic and has the potential to reach the highest number of households (see Table 1 above), mini-grid and productive/community use Sub-components are prioritized to ensure that the newly acquired electricity access is also used to drive economic transformation in rural Haiti. All renewable energy sources -- solar PV, biomass, wind and micro-hydro power, including hybrid RE technologies with battery storage and/or diesel, will be eligible. The Component will leverage private sector dynamism and innovation, learning and applying successful business models from more advanced off-grid energy markets, such as East Africa and South Asia. Significant private sector leveraging (US$60 million) is anticipated.[30]

59. **The Component will have four Sub-components, covering different market segments and capacity building needs.** Project Operations Manual will include detailed provision for the design and execution of all Sub-components.

Sub-component 2.a: Renewable energy village grids

[28] Includes $23 million of private sector financing out of the total of $60 million leveraging that will directly contribute to the project's targets – see table 3 Project Financing below for all co-financing sources.

[29] Village grids in the context of Haiti SREP are understood as decentralized micro- or mini-grids (each, which are defined as decentralized power systems, consisting of a generation source and a low voltage distribution grid infrastructure), typically ranging between 10kW and 1MW, and serving from a few dozens to a few tens of thousands of customers. Some of them have existing distribution grids (in Haiti these tend to be the >30 relatively larger existing municipal "mini-grids", as discussed below), others are "greenfield" projects. By contrast, the "EDH isolated (small) grids" of component 1 discussed in the previous section are larger (by factors of ten and more).

[30] Of these $60 million, $13 million are expected to come as direct co-financing needed to reach the proposed project targets, while the remaining $47 million will be for an additional scale-up (e.g. additional investment in off-grid businesses initially supported by OGEF, which is expected to materialize in the lifetime of the Project). This additional investment is expected to fuel further growth of the market, expected to result in at least 2 million people with access through off-grid and mini-grid solutions by 2025.

60. This Sub-component will provide grants for village grids developed under a public-private partnership (PPP) arrangement involving the MTPTC Energy Cell, municipalities and private sector village grid operators. The grants (covering generally the costs of the distribution network) will be used to bring down the village grid investment costs so that the resulting tariff is in line with the affordability levels of rural Haitians. The Sub-component is expected to provide electricity access to at least 100,000 people.

61. The Sub-component will build on an already existing model applied in Haiti, in which village grid service providers sign concession/service agreements with the municipalities to build and operate village grids on their territories for over a pre-determined period (the length currently varies case by case but typically exceeds 10 years). This modality is consistent with the Decentralization Law of 2006, and therefore allows village grid companies to operate within the Haitian legal framework. In addition, the partnership with municipalities strengthens the local participation and ownership, supporting longer-term sustainability and social acceptance of the (usually private) village grid operators.

62. The Sub-component will further develop and regularize this model by creating a standard tri-partite agreement among the MTPTC Energy Cell, Municipality and Village Grid Service Providers, which will define the length and key terms of the concession.[31] The grants will be awarded to the private sector, which will build and operate the grid on behalf of the municipality, and transfer it back to the municipality at the end of the concession period. The private sector will be required to invest in the generation equipment, as well commercialization (including smart meters) for which it can access OGEF equity/loan funding if needed. Generation assets will remain in private ownership. Users will pay small connection charges and tariff[32], which will be collected mainly through pre-paid smart meters.

63. Two types of village grid PPPs will be pursued – (i) hybridization of the existing municipal grids, and (ii) green-field investments. For the first model interested municipalities will be invited to participate in the hybridization project. The private sector will be invited to hybridize these mini-grids with renewable energy, fix the distribution network, install meters, improve energy efficiency and operate them under the tri-partite agreement. Energy Cell will competitively award tri-partite contracts, based on the lowest subsidy required to hybridize, refurbish and operate the municipal diesel village grids.

64. For green-field village grids, the site selection will be left up to the village grid operators. The Sub-component will establish a per-connection grant, which will be partly results-based, disbursed against milestones, including actual customer connections and verification of the service provided. This per-connection grant will be awarded to the eligible village grid service providers through periodic calls for proposals.

[31] The term "concession" is understood here as a broader term for a service arrangement, which will give a right to the mini-grid operator to operate a village grid for a defined number of years under defined service quality and tariff terms.
[32] The village grid operators will be allowed to set the differentiated, cost-reflective tariff (including return on capital but excluding the investment costs covered by the grant). The resulting offgrid tariffs will be typically US$0.20 to US$0.50/kWh (depending on system size, site and tariff structure) or roughly equivalent monthly flat fees, reflecting revealed willingness to pay, substitutable energy expenditures from project preparation surveys, actual cost of the remnant fuel share during operation (which depends on PV share), and costs minimum returns assumed for financial analysis (10-20 percent wacc).

65. For both modalities, the connections and the service provision (at adequate quality) will be independently verified before the final tranche of the grant is paid.

Sub-component 2.b: Renewable energy for productive and community use

66. This Sub-component will support productive uses of off-grid renewable energy in order to support rural economic development in Haiti. Considering the Government's strong emphasis on improving productivity and value added of agriculture enterprises, the Sub-component will place specific emphasis on supporting renewable energy solutions for agribusinesses. The Sub-component will be developed jointly with the Bank's Agriculture and Trade and Competitiveness Global Practices (GPs), and Water GP for RE-based irrigation solutions. This collaboration will ensure that energy solutions are considered in the context and as an inherent part of the overall value chain analysis (key lesson emerging from other similar engagements worldwide), and that proposed solutions are financially, environmentally and socially sustainable.

67. This off-grid energy sector segment is relatively less developed, compared to mini-grids and household systems, with a few enterprises focused on serving primarily the larger business clients in urban areas. The Sub-component will establish a challenge grant facility, which will provide innovation grants to energy enterprises or other integrators presenting viable business plans for sustainable provision of renewable energy for agriculture and other rural enterprises (e.g. adaptation of PAYG business models for the enterprise sector). The focus will be on piloting and developing economically, financially and socially viable solutions which could then be included in OGEF financing. Special focus will also be on supporting female entrepreneurs.

68. Based on the initial analysis of rural productive value chains in Haiti and emerging successful worldwide experiences, the following promising applications have been identified:

i) <u>Electrification of agricultural activities</u> to unlock rural economic development and improve food security in Haiti, such as:

- Electrification of agricultural activities to unlock rural economic development and improve food security in Haiti;
- Powering processing local production to secure the domestic market supply, such as processing of perishable food into a storable form, e.g. transforming breadfruit into chips and flour, solar-drying facilities to process fruits etc.;
- Powering processing cacao and coffee to boost exports in quantity and quality, e.g. solar-powered dry mill facilities;
- Solar-powered storage / cooling for mangoes and avocados for export, e.g. solar-powered cold storage at the fruit collection site can significantly improve quality of these export products;
- Ice production for fishermen: e.g. to avoid the. 40 percent of harvested seafood that is lost due to insufficient facilities and handling on board fishing boats.; and

- Solar-water pumping for irrigation: The fast evolution of the solar-water pumping sector enables customized solutions that match local needs and adjust to local constraints (e.g. site's topography, aquifer resources).

ii) Electrification of small-scale industrial activities and businesses to boost economic growth and employment, such as:

- Lighting, electricity and water heating for hotels and other tourism facilities;
- Oven cooking for bakeries and cooking and water heating for small restaurants and food kiosks;
- Beer brewing;
- Refrigeration, freezing and lighting for convenience stores;
- Use of computers and printers in cyber cafes;
- Use of electrical cosmetic appliances for barbers;
- Use of grinders, compressors and welding for vehicle repair;
- Use of power looms and sewing machines for clothing and outlets; and
- Drilling, cutting, welding and use of lathes and mills for metal workshops

iii) Community uses: In addition, through technical assistance, the Sub-component will leverage synergies with other World Bank operations in Haiti. The Project will provide technical assistance to these operations for integrating off-grid electrification solutions for community installations, including schools, health posts and water community pumps. The SREP and IDA financing will be used for providing TA and piloting of approaches aimed at ensuring quality of installations and sustainable operation and maintenance.[33]

Sub-component 2.c: Household Systems

69. The Sub-component 2.c aims at unlocking the enormous market potential for distributed energy service companies (DESCO) to provide solar home system and pico-PV solutions to households and small businesses, using new technologies and business models, such as PAYG, expected to reach a total of 700,000 people. To do so, in line with emerging best practices from the more advanced off-grid energy markets in East Africa and South Asia, the Sub-component will blend OGEF equity/debt funding with limited, well-targeted grants provided by SREP to launch and support early growth of DESCOs. Three types of grants will be eligible.

[33] The list of World Bank projects for which SREP will provide TA/financing for agri-businesses and community uses include:
Agriculture: Relaunching Agriculture - Strengthening Agriculture Public Services II Project (GAFSP - IDA) (P126744)
Competitiveness: Haiti Business Development and Investment Project (P123974)
Education: Haiti - Education for All Project - Phase II (P124134)
Water: HT Sustainable Rural and Small Towns Water and Sanitation Project (P148970)

- Start-up grants, available to companies which demonstrate scalable and sustainable business models, which are new to the Haiti market.

- Results based grants for early stage growth of off-grid businesses. The grants will be disbursed based on pre-determined milestones, and will be applied in conjunction with the OGEF equity investments in early stage off-grid businesses.

- Results-based grants for Lighting Global quality verified solar products to support penetration of higher quality products in the Haitian market and building customer confidence in these products. These grants will be provided against verified sales/installations of quality-certified products/systems.

70. Table 2 summarizes how SREP (and IDA co-financing) grants and CTF commercial financing are expected to leverage and complement each other.[34]

Table 2. Leveraging SREP, IDA and CTF financing to support off-grid businesses

	SREP + IDA grants	CTF equity and loans
1. Village grids	Grants for distribution grid (will remain in municipal ownership)	Equity and loans to support RE generation investments
2. Productive uses	Innovation grants for potentially financially viable and scalable business models	Replication and scale up of successful business models through OGEF
3. Individual households	Grants to support early stage businesses and introduction of high quality products	Equity and loans for off-grid businesses

Sub-component 2.d: Capacity building and Technical Assistance

71. RE scale-up therefore requires comprehensive and systematic efforts to eliminate these barriers nationally for all types of RE investments. For that reason, the SREP Project would include a specific component for these crosscutting issues, focusing both on immediate TA activities needed to carry out the SREP Component 2 and broader capacity building to support renewable energy and off-grid access scale-up in Haiti. The key TA activities include:

- Support to developing a Sustainable Energy Access Strategy and Master Plan, including a comprehensive geospatial least-cost electrification planning tool

[34] Sub-component 2.c will expand the volume of OGEF Fund from $14.5 to $17.5 million, allowing greater proportion of grant financing than available under CTF-funding alone. The CTF-funded Modern Energy for All projects foresaw provision of limited grant funding, but given that CTF is extended as a loan to GOH, the focus has been on supporting investments that will create return allowing GOH to repay the loan to the World Bank. The grants were therefore kept to a minimum ($1 million). However, based on the analyzed trajectory path of the off-grid companies in other countries, it is estimated that $3-4 million of grant funding will be needed to support the launching and early growth of off-grid businesses, and to shift the market towards higher quality products. US$3 million are therefore added to OGEF for grant financing, allowing CTF to focus on equity investments and lending.

- Support to developing enabling regulatory framework for independent village grids, including the tripartite contracts

- Reach out and technical support for municipalities to manage/concession municipal grids

- Feasibility studies and technical/transaction advisors for mini-grid and productive use grant awards.

- Quality assurance (QA) framework for individual PV systems – e.g. adoption and enforcement of Lighting Global standards, and development/adoption of a QA framework for larger systems

- Fiscal incentives for off-grid renewables

- Market intelligence gathering and dissemination

- Consumer awareness – development and implementation of gender-sensitive consumer awareness campaigns

- Gender mainstreaming – ensuring that project activities are gender-informed

- Verification, monitoring and evaluation (including face-to-face and phone surveys), and environmental and social safeguards monitoring

72. The longer-term capacity-building program will be gender-balanced and will focus on the following areas:

- Professional education about RE (partnering with universities), e.g. improving curricula and supporting on-the-job training of RE professionals; facilitate dialogue and collaboration between RE private sector and universities;

- Training on renewable energy of Government officials, EDH, FDI and other key stakeholders;

- Vocational training, expanding upon existing programs already in place – the premise is to unite dispersed efforts and develop a comprehensive vocational training program for solar technicians with updated curricula, in collaboration with other development partners, private and non-governmental entities already active in this space (e.g. French Government, Schneider Electric Foundation, SELF and local universities). This will also include supporting gender mainstreaming, including provision of technical assistance and training for integrating women in supply chains.;

- TA and training for off-grid energy businesses, including for environmental and social safeguards aspects; and

- South-South exchanges.

B. Project Financing

73. This is an Investment Project Financing (IPF) project. The project is financed from the Scaling Up Renewable Energy Program (SREP). The SREP funding is US$22.5 million, which will be extended in the form of a grant. Co-financing sources are shown in Table 3. A detailed version of the table with Sub-component financing break-down is included in Annex 2.

Table 3. Project financing

In US$ million	IDA PRELEN	Other IDA[35]	SREP	CTF (OGEF)	Others	Private sector	Total
Component 1: Grid-connected distributed RE	4		12.5		0.5	0-8	17-25
Component 2: Off-grid distributed RE	17	3	10	16	2.5	70	118.5
Total SREP Project	**21**	**3**	**22.5**	**16**	**3**	**70-78**	**135.5-143.5**

74. Private sector leveraging on Component 1 will only materialize if on-grid solar investments are found to be feasible for Phase II. Private sector leveraging on Component 2 will take the form of private equity and commercial loans. First, all private sector projects supported from OGEF and grant facilities managed by the Energy Cell will need to have private co-financing, which will mostly be in the form of private equity. It is estimated that to achieve the project targets, US$23 million will need to come directly from the private sector. In addition, the project expects that the seed funding provided through OGEF (grants, equity and loans) will support off-grid businesses growth, creating opportunities for further investments and commercial lending for these companies. For example, the PAYG companies in East Africa, initially supported by donors and impact investors are now (3-4 years later) attracting private investments and commercial loans. The same pattern is expected to be followed in Haiti, and it is estimated that at least additional $47 million will be invested in these companies during the lifetime of the project, allowing these companies to operate and grow beyond the life-time of the project and beyond the project's targets.

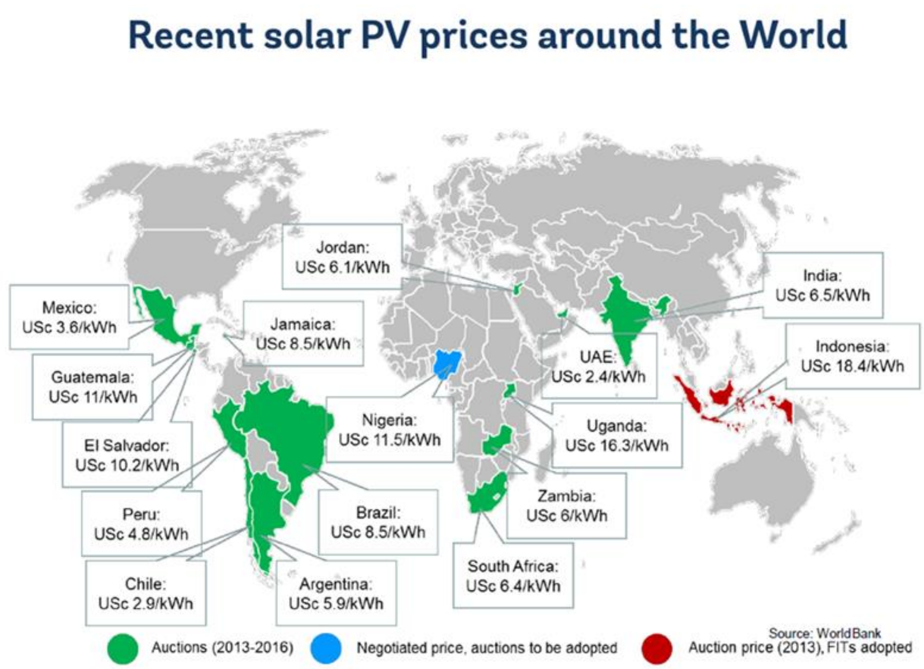
C. Lessons Learned and Reflected in the Project Design

75. **For grid-connected distributed renewables**: Solar PV has been the fastest evolving energy technology of the recent years, benefiting from dramatic cost reductions due to improving technology, increasing supply and competitive pressures (see Figure 2). As of recently, the parallel improvements in energy storage technologies, such as large scale lithium ion or flow batteries, allow for efficient integration of solar PV and batteries in utility-scale solar PV projects. This integration is in particular, a promising development for smaller and weaker grids, allowing for a larger penetration of solar PV and improving service quality on the grid.

[35] Agriculture, Private sector development, Education, and Water projects

76. Recent experience from solar PV auctions show that private sector can plan an important role for scaling up solar PV technology and offer competitive prices, but enabling conditions for private sector participation must exist, including a credible off-taker, stable regulatory requirement, absence of grid absorption issues, and a well-designed PPA. Where such conditions are not fully in place, sufficient protection needs to be provided through offering guarantees to cover the country, regulatory and off-taker risks. The case of the WBG Scaling Solar program in Zambia, resulting in a winning offer of 6 USc/kWh demonstrates that even small low income countries can attain attractive prices if they build enabling environment, if the transaction is well structured, favorable environment in place and if the risks are appropriately managed through the provision of guarantees.

Figure 2: Global results from solar auctions



77. Projects involving small investments in high risk countries, however, may not attract private sector (or result in very high tariffs to compensate for the high risk) even if guarantees are offered. A careful market sounding is necessary to evaluate private sector interest to invest, and to ascertain what minimum conditions need to be in place to attain the desired results. Based on such an analysis, for example, several IDA-financed projects in Sub-Saharan Africa (Burkina Faso, Comoros) have opted for demonstrating potential of solar PV first with public sector investments, in order to remove technology/grid integration barriers and build conditions for attracting larger private sector funding in the future.

78. **For off-grid distributed renewables:** For generic lessons, see Terrado, Cabraal, Mukherjee: Operational Guidance for World Bank Group Staff: Designing Sustainable Off-Grid Rural Electrification Projects: Principles and Practices (2008). The last decade, however, has seen tremendous developments in mini-grid and off-grid electrification that have changed some of the past paradigms. A combination of parallel technology advancements has allowed dramatic improvements in (i) costs, (ii) energy efficiency, (iii) variety and (iv) usability of off-grid

electrification products, which in turn has paved the way for (v) the emergence of new private sector business models and (vi) fundamental changes in the menu of options for national off-grid electrification planning.

79. This new off-grid electrification dynamic has several direct implications for "modern" mini-grid/off-grid electrification program design and hence also for the Haiti SREP program:

- There is an opportunity and a need to support a much wider range of solutions and flexible business models in one country (in parallel or sequentially) that respond to the diverse needs of varied population Most off-grid electrification projects of the early 90s (technology demonstration) and 2000s (initial scale-up of individual technology solutions) typically focused on 1-2 locally promising technologies (e.g. SHS), each with one "pre-wired" business case (e.g. MFI-backed dealer sales). Today however, national off-grid programs are realizing that there is an opportunity to reach a much wider spectrum of population by catering to a much broader range of technology options, business approaches and intervention mechanisms at once. This also allows leveraging transaction costs over larger disbursement volumes, and to scale-up off-grid project ambition – universal access to electricity now becoming an achievable goal.

- Given the extremely dynamic (take off-) phase of several off-grid market segments, and the resulting continued stream of technology and business model innovations, it is important to design national access programs with enough flexibility to allow users to benefit from the best available options at any given time, and private sector to bring forth innovations during one project cycle. For instance, specifications should not overprescribe technical parameters, and credit or grant vehicles should remain open to innovative proposals - but without sacrificing qualification criteria and quality standards.

- The emerging service-oriented approaches and payment schemes provide an opportunity to link incentives more closely to the level of services provided rather than the traditional "input-focused" generator (nameplate) capacity approach, which in turn will encourage more energy efficiency improvements, both on the system and appliances side.

- There is an opportunity to leverage increasing volumes of private sector investments. Even though public support remains essential for the time being, project design should maximize this opportunity, better incentivizing private sector involvement as opposed to crowding out existing private sector efforts, and create conditions for gradual phasing out of the public support in favor of private investments, as market gains more confidence in the new off-grid electricity solutions and business models.

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

80. The project will have two implementing agencies: (i) MTPTC Energy Cell, and (ii) OGEF Fund Manager**.**

81. **MTPTC, through its Energy Cell** will be in charge of implementing both Project components with the exception of Sub-component 2c (Household systems). Energy Cell will also be in charge of the overall project coordination and oversight, as well as monitoring and evaluation.

82. MTPTC created the Energy Cell in 2012, to support energy sector development. Originally comprised of one coordinator and two technical staff, the Energy Cell is now composed of 7 additional technical professionals, including a renewable energy expert/coordinator for SREP and CTF programs and other competent specialists in renewable energy, energy access and regulatory issues. While the Energy Cell is sufficiently staff to initiate the implementation of the Project, it will require additional strengthening to be able to effectively implement both SREP components at the same time, including in aspects of environmental and social safeguards.

83. The Energy Cell will also use services of the Project Implementation Unit (PIU), which has been implementing also World Bank IDA PRELEN project. The PIU in particular will be in charge of procurement and financial management, but will also provide expertise for managing the environmental and social aspects of the project. MTPTC created the Energy Cell in 2012, to support energy sector development.

84. **OGEF Fund Manager** will be in charge of implementing Sub-component 2c (Household Systems), given that this Sub-component is closely interrelated with the equity and debt financing provided by OGEF under the parallel CTF-funded Modern Energy Services for All Project (scheduled for the World Bank Board approval on July 13, 2017). OGEF Fund Manager will also provide advisory services to the Energy Cell for the implementation of other Component 2 activities, particularly for the review of business plans and award of grants for mini-grids and productive uses.

85. OGEF Fund Manager is composed of a partnership between the Fonds de Développement Industriel (FDI), an autonomous fund established under the auspices of the Haitian Central Bank, and an international fund manager with global off-grid energy investment experience, to be competitively selected by the Energy Cell and FDI.[36] OGEF will be supervised by the Advisory Committee, which will include representation of the Energy Cell, MEF, as well as local renewable and financial industry, and the Global Off-Grid Lighting Association (GOGLA).

86. Other key stakeholders involved in Project implementation are EDH and MEF, in particular its PPP unit. EDH will be closely involved in the design and implementation of Component 1. MEF PPP unit will advise Energy Cell on transactions involving private sector participation and PPP arrangements for both Components 1 and 2.

[36] The selection process will start once the Modern Energy Services for All Project is approved by the World Bank Board.

87. Operations Manual will clearly specify the implementation arrangements, including division of roles and reporting and communication channels among the Energy Cell, :PIU, and FDI, as well as coordination mechanisms which other key partners, including EDH and MEF.

B. Results Monitoring and Evaluation

88. **The project will use the indicators and mechanisms defined in Annex 1** for monitoring and evaluation (M&E) of results and intermediate outcomes. Overall responsibility for M&E lies with the Energy Cell, including compliance with environmental and social safeguards. The Energy Cell will provide quarterly reports to the World Bank, including implementation progress and progress in meeting key project indicators. The Energy Cell will also have the overall responsibility for monitoring and evaluation of OGEF activities – both those financed by SREP and CTF. It will consolidate M&E reporting based on updates provided in the Fund Manager's reports.

89. The SREP Operational Manual and OGEF Operating Guidelines will include a description of M&E responsibilities, data collection requirements and frequency, and (in the case of OGEF) division of the roles between MTPTC, FDI and the International Fund Manager; each provided with adequate budgets to diligently carry out their roles. The Mid-Term Review (MTR) will be conducted to assess the project's implementation progress. Impact evaluation will be carried out using the MTF survey.

90. **The project will also seek citizen engagement and beneficiary feedback in its implementation.** The project will carry out annual household surveys (by cell phones and follow up home visits where required), which will cover both beneficiaries and non-beneficiaries.

91. **The project will establish mechanisms for citizen engagement and grievance redress.** A free text messaging/hotline will be enabled to allow consumers to seek information, submit inquiries or file complaints about their service providers. The village grid tripartite agreements will include provisions for capturing and resolving consumer grievances. For OGEF activities, consumer feedback will be discussed between the Advisory Committee and Fund Managers and corrective actions will be taken to respond to the key issues raised. Citizen engagement indicators are included in the Results Framework (Annex 1).

C. Sustainability

92. **The project will promote sustainable solutions. For Component 1**, the project will engage private sector to build and operate the solar PV plant. The isolated grid on which the plant will be built will also be administratively isolated from EDH financing in order to ensure that (i) a part of the savings from reduced fuel spending can be used to finance solar PV plant O&M, and (ii) that impact in terms of reduced costs/improved EDH finances can be adequately monitored. In addition, EDH will establish an escrow account, which will collect contribution for O&M, including for the eventual replacement of the equipment, such as batteries. EDH will receive long-term capacity building that would allow it eventually to take over the plant operation.

93. The Government is currently exploring the way to improve performance of EDH, including the isolated grids, including a possibility to outsource collection and billing or to concession the grid operation to private sector. The project will contribute to this process by

improving the administrative and financial transparency on the demonstration project grid. The grid will be isolated administratively from the rest of EDH and its performance closely monitored. Moving to the next phase, which foresees greater private sector participation, additional measures will be required, including outsourcing billing and collections on the grid or concessioning the grid to the private sector.

94. **For Component 2**, the project will finance only those businesses that present viable business plans, which will increase the likelihood of sustainable operations. The project design and the business plan evaluation procedures will address common sustainability issues in village grids and off-grid systems, including: poor technical quality of systems/components, inadequate tariffs in village grids, low capacity to operate village systems, lack of after-sales services and lack of financing for spare parts. The Project (under Sub-component 2d) will also support other World Bank projects investing in off-grid electrification – e.g. education, and water projects, to ensure that their designs are following best practices for quality and sustainability for their off-grid solar energy installations.

95. **Sustainability criteria will also include environmental and social sustainability**, as defined in the environmental and social screening, assessment and mitigation measures, detailed in the ESMF and RPF (see section VI, E).

V. KEY RISKS

96. **The overall risk of the project is assessed as "High."** Key project level risks and related mitigation measures are as follow.

A. Overall Risk Rating and Explanation of Key Risks

Table 4. Systematic Operations Risk-Rating Tool (SORT)

Systematic Operations Risk-Rating Tool (SORT)	
Risk Category	**Rating**
1. Political and Governance	High
2. Macroeconomic	Substantial
3. Sector Strategies and Policies	High
4. Technical Design of Project or Program	Substantial
5. Institutional Capacity for Implementation and Sustainability	High
6. Fiduciary	Substantial
7. Environment and Social	Moderate
8. Stakeholders	Substantial

OVERALL	**High**

B. SECTOR POLICY AND GOVERNANCE.

97. Worsening EDH performance may prevent the project from reaching its development objectives and targets. This risk is primarily affecting on-grid investments under Component 1. This risk is mitigated at two levels. At the sector level, the World Bank is engaged in a policy dialogue with the Government about improving EDH performance. At the project level, the focus is on hybridizing one or two smaller isolated grids, which, at least to some extent, can be isolated from larger EDH issues. The selection criteria include the ability to demonstrate financial sustainability – a revenue stream that would cover O&M costs, which would be ring-fenced in an escrow account. The scale-up, however, will require stronger measures in order to allow for private sector participation – such as outsourcing billing and collection, the concession of the grid or a broader reform at the EDH level. If Component 1 cannot scale-up, resources could be reallocated from Component 1 to Component 2, supporting mini-grid and off-grid investments that are not affected by the EDH situation.

98. Clean energy and energy access may not be a Government priority. The new Government Roadmap for Energy puts strong emphasis on the needs to diversify the current EDH generation mix and on expanding access. For the first time, off-grid access is included as a specific objective, with smart mini-grids and solar PV systems highlighted as priorities. Nevertheless, these policy objectives can change. The mitigation measure is to build a broader consensus about the importance of energy access across all stakeholders – Government, Parliament, municipalities, civil society etc. This consensus building started through extensive consultations that led to the formulation of the SREP Investment Plan and will continue under the Project's sub-component 2d.

C. IMPLEMENTATION CAPACITY

99. Project implementation may be delayed due to implementation constraints at the Government, municipal and/or private sector level. Building capacities for renewable energy and access scale-up is at the core of the SREP Project. This is done at several levels. First, the MTPTC Energy Cell, the key implementing agency for the project, will be strengthened with additional staff/consultants, and the PIU already experienced with the implementation of World Bank projects will be used for procurement and other fiduciary matters. FDI capacity to evaluate investments in off-grid businesses will also be strengthened by partnering with an experienced international fund manager. The Project' sub-component 2d will finance both specific TA and training needs of various stakeholders, including EDH, municipalities and entrepreneurs, as well as broader capacity building campaigns partnering with universities and vocational training centers, as a mitigation mechanism for low capacity.

D. PRIVATE SECTOR INTEREST

100. Considering that Haiti is a relatively high country and sector risk, the private sector may not be willing to invest. The Project has carried out extensive consultations with the private sector, and the current project design is taking into account the opportunities and constraints for private

sector investments in Haiti. Currently, the off-grid energy sector presents more opportunities, with several off-grid businesses already operating in Haiti and seeking funding for the expansion of their activities. Some of them have already attracted outside investors, but their current level of funding is insufficient for their intended scale-up plans. The project funding, therefore, can be seen as seed funding to take the Haiti off-grid market through the critical early stage period in order to unlock larger investments in the sector (which has been the path of more advanced markets such as East Africa). On the on-grid side, the project is cautious about the ability to attract significant private sector investment at this time, due to the high off-taker risk, and therefore a phased approach is recommended. The first phase will focus on a publicly financed demonstration project, while engaging the Government in developing enabling conditions that will attract private sector interest.

E. TECHNICAL – vRE GRID INTEGRATION

101. There may be technical problems with integrating larger volumes of variable RE to EDH's small and weak grids. The phased approach will help dealing with vRE integration issues. The first demonstration project will test the proposed approach of integrating solar PV + battery storage with the current diesel systems, and fine-tune possible technical issues before the approach will be scaled up. The preliminary analysis based on the prioritized southern grids has developed various scenarios of lower, medium and higher PV capacity (with varied storage capacity), which appear to be both technically and economically feasible. This optimization will be fine-tuned once a detailed feasibility study is concluded.

F. REGULATORY CONSTRAINTS

102. Regulatory uncertainties will deter the potential investors and businesses in engaging in the village grid operations in Haiti. Several companies are already operating village grids in Haiti under the provisions of the Decentralization Law of 2006. The project will, however, regularize this arrangement, first through a tri-partite agreement and then through a broader regulatory framework. In line with the emerging global best practices, this regulatory framework should be light-handed, so as not to impose an excessive compliance burden on the village grid operators.

VI. APPRAISAL SUMMARY

A. ECONOMIC AND FINANCIAL (IF APPLICABLE) ANALYSIS

103. All proposed project components and considered RE "system types" have Economic Internal Rate of Return (EIRR) well above Haiti's hurdle rate of 2 percent (according to the latest World Bank method – see Annex 6), which are also sufficiently robust against the vast majority of scenarios, even in the no-carbon case. Therefore, the total project benefits will also be above threshold, even if the exact share of system types is still unknown. The same is true for the full SREP Program (which includes the CTF and IDA projects' co-financing costs and benefits that have been analyzed for the SREP IP and are also positive and sufficiently robust).

104. The EIRRs including carbon benefits are even higher (from 11 to 54 percent) than the no carbon case (from 10 to 52 percent). Following World Bank standard procedure, we have calculated both.

105. The main benefit type under Components 1 and 2 is the reduced spending on diesel fuel for electricity generation, thanks to the "with project" least cost "hybrid" RE-diesel generation, compared to the baseline fuel use in the existing village generators and co-generation gensets. Given that the majority of Component 1 and 2 sites already have existing distribution infrastructure and several diesel generators,[37] the net cost of adding PV (and storage) is much lower than in green-field cases, so that the economic Net Benefits would be positive even when discounted at much higher hurdle rates. For the (fewer and smaller) green-field sites expected under Component 2, all-in Capex are obviously higher, but Net Benefits are still positive.

106. The benefits for the vast range of off-grid electrification systems that will be covered by the combined OGEF-SREP overall program umbrella (from 1 Wp Pico PV systems all the way to >10MWp component 1 EDH grids) can be approximated best - depending on their typical baseline situation in Haiti - by: (i) estimating the economic cost of saved diesel fuel, where a "no project case" generator exists (the minimum "with project" benefits are than the operational benefits based on in situ economic diesel cost, as described above for Component 1+2), or (ii) estimating consumers' willingness to pay for the RE-generated kWh and the related consumer surplus (as described in the SREP IP). Users' present substitutable spending (as per project preparation surveys and tariffs in comparable isolated grids – both EDH and private operators) typically ranges from 20 to 40 US cents per kWh and about US$10 to US$30 per month. Where the baseline situation includes both cases (say, green-field sites where some users may have small gensets and others do not), we have applied both methods. For overall readability of the analysis, we have then used a conservative estimate for each system type as BASE CASE, so that the calculated EIRR and NPV are also conservative. Given that (i) actual WTP is not only equal, but usually higher than present expenditures (as actual WTP includes today's consumer surplus and a whole set of difficult to quantify benefits such as health and education impacts), and (ii) revealed WTP in Haiti's many cogeneration diesel gensets can be as high as US$2/kWh, we have also run the analysis for all sites with higher values for fuel and kWh WTP equivalents. Needless to say, the resulting EIRR for those runs are even higher than the ones quoted above.[38] Finally, we have run optimizations of most village grid cases with already existing grids and diesel (and in some cases hydro) generators both (i) with and (ii) without taking the latter into account for NPV and LEC optimization, to make them comparable to literature values. Naturally, only the marginal cost and benefit of the "with project" retrofit (added PV and battery = cost; saved diesel fuel from this = benefits) are relevant for the least cost and hurdle rate tests.

107. **Reflecting the high EIRR, financial analysis also shows high internal rates of return** for typical Component 1 and 2 projects[39] (between 10 and 40 percent, but depending strongly on

---

[37] The characteristics of the existing generators and the LV grid and nodal models of all 5 Component 1 "short list" sites have been collected in site visits and from EDH during preparation and used for our analysis, so that heat rates and load curves are more exact than for the component 2 sites, where we have to work with data from Earth Spark, Sigora and others for a few typical village grids, from a much larger pool.

[38] Due to (i) the front-loaded nature of RE investments at relatively stable benefits (growing in the case of carbon), and (ii) the fast falling Capex for PV and batteries (which make replacement a minor issue to older RE CBA), we would like to point out that even higher rates of return would result from applying longer time horizons for the discounted cash flow (both for costs and benefits) than the standard duration of around 20 years! This is obviously a direct effect of the very low country hurdle rate of only 2 percent: While the residual value of benefits (and costs) after year 15 was insignificant at the typical EIRRs used in World Bank CBA over the last decades, this is no longer the case for today's low interest rate environment! We have therefore added 25-year cash flows to the standard 20 years for all village grid cases we have analyzed (but not for the over the small "over the counter" systems covered by CTF PAD and SREP IP which are repeated below for completeness sake).

[39] And also for the many types of single-user PV systems of the overall OGEF+SREP umbrella program, as discussed in the SREP

many assumptions - tariff, exact site, business model, etc. - which are unknown as of today because of the private sector-led selection), so that they can be potentially attractive for private investors. However, it is difficult to estimate the wacc (hurdle rate for individual FIRR) of actual real-life investors, because the risk premium for offtaker and country risks is hard to estimate in a nascent market like Haiti. Yet it is crucial in light of the RE-typical long time span till breakeven - especially in combination with the fast falling capex of PV and batteries, which increase the risk of anchor client defection over time, and weaken the negotiation position of "captive solar suppliers", be IPPs or ESCOs. In addition, the taxation of RE projects is presently in flux, thanks to energy cell TA under the parallel IDA project and SREP project preparation, so that after tax returns are hard to pin at this stage. However, the example of Earth Spark and Sigora prove that interested RE-hybrid grid investors do exist in Haiti (just not how many) - even at the higher capex prevalent in 2015-2016, so that 2017+ FIRR (which is significantly higher due to the fast falling capex) should attract some more. However, the risk of private sector uptake (of a Project Guarantee offer) remains and is thus raised in the risk section (it would be mitigated by the fallback option of structuring Component 1+2 projects more like the initial Jeremie site described above, where the off-taker risk is taken out of the transaction).

108. See Annex 6 for more detail.

B. TECHNICAL

109. **The project will support proven technologies.** For Component 1, solar PV is now a mature and proven technology. Although the application of large-scale batteries for electricity storage is relatively recent, proven technologies have been applied in both developed and developing markets, such as lithium ion batteries. The project will review performance and track record of different battery option and use only such technologies that already have a demonstrated track record. For Component 2, the project will apply a quality assurance framework, building on examples such as those currently being developed by US Department of Energy/NREL in particular for village grids. For individual off-grid systems, the Project will only support lanterns and solar kits, which are Lighting Global certified (or equivalent). Technical specifications ensuring quality for larger Standalone Home Systems (SHSs) not covered by Lighting Global will be established and regularly updated.

C. FINANCIAL MANAGEMENT

110. The financial responsibilities of the project will be managed by the project implementation unit (PIU) established for IDA PRELEN project, which will be brought into the Energy Cell, as a result of the IDA PRELEN project restructuring. The fiduciary aspects of Sub-component 2c (OGEF Market Development Support) will be managed by FDI with the competitively selected International Fund Manager, who will manage the Fund under the oversight of the Advisory Committee and based on the Operating Guidelines approved by the World Bank for use of CTF resources. The World Bank has completed the MTPTC financial management assessment and proposed arrangements for the project to ensure they meet the minimum fiduciary requirements

IP.

under OP/BP10.00. The assessment of FDI and the International Fund Manager will be carried out after the Fund Manager's selection during project implementation.

D. PROCUREMENT

111. Procurement for the Project will be carried out in accordance with the "World Bank Procurement Regulations for Borrowers under Investment Project Financing", dated July 1, 2016, hereafter referred to as "Procurement Regulations". The project will be subject to the Bank's Anticorruption Guidelines, dated July 1, 2016.

112. As per requirement in the Procurement Regulations, a Project Procurement Strategy for Development (PPSD) is under development. The Procurement Plan (PP) sets out the selection methods to be followed by the borrower during project implementation in the procurement of goods, works, non-consulting and consulting services financed by the Bank. The Procurement Plan will be updated at least annually or as required to reflect the actual project implementation needs and improvements in institutional capacity.

113. PPSD will be completed before appraisal and summarized in Annex 2.

E. SOCIAL (INCLUDING SAFEGUARDS)

114. **The project is expected to have socio-economic benefits from** increased access to electricity including alleviating poverty through cheaper sources of power for households, job creation and new economic opportunities, particularly in rural areas. Design of financial mechanisms under the project will take affordability and willingness to pay into account, supported by information, education, and communication campaigns. In addition, the Project will include specific actions to help Haitian women and girls to access these benefits and opportunities.

115. **Some project activities may lead to resettlement** (particularly of squatters), land acquisition and loss of economic livelihood. As the exact locations of sub-projects are unclear, a Resettlement Policy Framework (RPF) is being prepared and consultations will take place before Appraisal. The RPF will be disclosed on the World Bank's and Government's website. The RPF will include guidance on the application of OP 4.12. Special attention will be given to the eligibility of potentially affected persons to ensure that the rights of those without formal legal rights to land are recognized in the RPF and subsequent RAPs, per OP 4.12. For land purchases through willing-seller willing-buyer approach, land acquisition must occur by mutual agreement in exchange for a notarized purchase contract based on the market price at the date of acquisition.

116. The Energy Cell of the MTPTC (for Sub-component 1a & 1b, Sub-component 2a & 2b) and the government established Off-Grid Energy Fund (OGEF for Sub-component 2c) will be responsible for site-specific screening of sub-projects for social impacts, and monitoring Resettlement Action Plans (RAPs) as needed. The RAP preparation and implementation, including compensation, will be the responsibility of the Energy Cell and OGEF Fund Manager (for Sub-component 2c) in the case of public investments and private companies (in the case of private investments) and Public Private Partnership (PPP) structure (in the case of PPPs). Beyond resettlement aspects, social impact screening will cover labor safety and standards, community health and safety issues, and potential violence and security risks in the proposed sites. Within the Energy Cell and OGEF Fund Manager, the social specialist will be trained on social screening and

monitoring of sub-projects and on the design/ implementation of the Grievance Redress Mechanism as needed. In addition, entities implementing sub-projects will be provided with support and training during the course of the project to ensure adequate impact monitoring. The Energy Cell and OGEF Fund Manager will need to submit all sub-project safeguards for the Bank's non-objection in the first two years of project implementation.

F. ENVIRONMENT (INCLUDING SAFEGUARDS)

117. **Environmental and social impacts under the project are expected to be moderate, and easily mitigated**. The environmental and social safeguard policies triggered are: OP 4.01 Environmental Assessment, OP4.12 Involuntary Resettlement, OP 4.04 Natural Habitats, OP 4.37 Physical Cultural Resources, and OP 4.37 Safety of Dams. The project is rated category B. Because the exact nature and location of investments is unknown at appraisal, the project chose the framework approach, in which a screening procedure is applied to every subproject before financing can be approved. The Environmental and Social Management Framework (ESMF) was prepared by the Government, and will be submitted to consultations before Appraisal.

118. Potential impacts include health and safety; production of waste (batteries and other wastes from small businesses); and impacts to the land, water and biodiversity (from wind, hydro and biomass). Mitigation measures include appropriate siting of RE generation units (away from known bird/Bat areas including migration routes, wetlands, etc.). OP 4.04 is triggered to evaluate potential impacts on biodiversity and natural habitats (e.g., impacts on birds and bats from wind turbines). While the project is not expected to have negative impact on natural habitats and any activities with impacts on natural habitats will be screened out using the ESMF. The OP on physical cultural resources is triggered to outline chance finds procedures in the case of any construction activities. The ESMF includes procedures to be followed for chance findings when installing infrastructure. The project may support small hydro, which may trigger OP 4.37. The ESMF will outline the necessary steps to be taken if a subproject triggers this policy; review by a qualified engineer if the dam is less than 15 m high. Projects with dams higher than 15 m will not be eligible under the Project. No use of pesticides (herbicide, insecticide) will be permitted under the project.

G. WORLD BANK GRIEVANCE REDRESS

119. Communities and individuals who believe that they are adversely affected by a World Bank (WB) supported project may submit complaints to existing project-level grievance redress mechanisms or the WB's Grievance Redress Service (GRS). The GRS ensures that complaints received are promptly reviewed in order to address project-related concerns. Project affected communities and individuals may submit their complaint to the WB's independent Inspection Panel which determines whether harm occurred, or could occur, as a result of WB non-compliance with its policies and procedures. Complaints may be submitted at any time after concerns have been brought directly to the World Bank's attention, and Bank Management has been given an opportunity to respond. For information on how to submit complaints to the World Bank's corporate Grievance Redress Service (GRS), please visit http://www.worldbank.org/GRS. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

HAITI: Renewable Energy for All

ANNEX 1: RESULTS FRAMEWORK AND MONITORING

Project Development Objectives

PDO Statement: The Project Development Objective is to scale-up renewable energy investments in Haiti in order to expand and improve access to electricity for Haitian households, businesses and community services.

Project Development Objective Indicators (including IDA, CTF[40], and private sector[41] co-financing)

Indicator Name	CRI	Unit of Measure	Base-line	Cumulative Target Values							Frequency	Data Source/ Methodology	Responsibility for Data Collection
				YR1	YR2	YR3	YR4	YR5	YR6	**End Target**			
People provided with new or improved electricity service	☒	Number		0	50,000 (of which 25,000 female)	165,000 (of which 82,500 female)	500,000 (of which 250,000 female)	700,000 (of which 350,000 female)	900,000 (of which 450,000 female)	**900,000 (of which 450,000 female)**	Bi-annual	Progress Reports	Energy Cell, with OGEF inputs
Enterprises and community services with new or improved electricity service		Number		0	500	1,200	3,000	7,000	11,000	**11,000**	Bi-annual	Progress reports	Energy Cell, with OGEF inputs
Enabling policy and regulatory framework for clean energy and access enacted		Number	0	RISE score 11	RISE score 11	RISE score 20	RISE score 20	RISE score 35	RISE score 35	**RISE score 35**	Biennial	RISE report	World Bank RISE report
Private investment and other commercial financing leveraged		Number	0	0	2	10	30	58	**70**	**70**	Annual	Project Progress Reports capturing data from investments	Energy Cell with OGEF inputs

[40] Component 1 does not include CTF co-financing. For Component 2, CTF and SREP (including its IDA co-financing) contribute to the results jointly. Given the integration of instruments supported through CTF (mostly equity and loans) and grants from SREP, it is not possible to separate the results of each project. However, given that each contributes about equal amount of financing for off-grid subprojects ($14 million for actual investments), it can be assumed that their share of results is also approximately equal (50% in each). To avoid double-reporting to CIF, each project will therefore report 50% of results – see SREP Annex 7.

[41] Only private sector co-financing directly contributing to the SREP targets is counted here (estimated $23 million). The project, however, anticipates to attract additional private sector financing ($47-55), particularly into off-grid businesses initially supported by the project, which will be used for their further growth and scale-up. It is expected that about $47 million for Component 2 and up to $8 million for Component 1 of such private sector financing may materialize during the project execution

Intermediate Results Indicators

Component 1

Indicator Name	CRI	Unit of Measure	Base-line	Cumulative Target Values							Frequency	Data Source/ Methodology	Responsibility for Data Collection
				YR1	YR2	YR3	YR4	YR5	YR6	End Target			
Generation capacity of energy constructed or rehabilitated	☒	MWp	0	0	1	1	5.5	5.5	6	**6**	Bi-annual	Progress reports	Energy cell with EDH inputs
Annual electricity output from RE, as a result of SREP interventions	SREP core	GWh	0	0	1	1	9	9	9	**9**	Annual	Progress report	Energy Cell with EDH inputs
Annual greenhouse gas emission reductions	SREP core	tCO2	0	0	1,595	1,595	10,600	10,600	10,600	**10,600**	Annual	Progress report	Energy Cell
Number of people, benefitting from improved access to electricity and fuels, as a result of SREP interventions (of which female)	SREP core	Number	0	0	15,000 (of which 7,500 female)	15,000 (of which 7,500 female)	100,000 (of which 50,000 female)	100,000 (of which 50,000 female)	100,000 (of which 50,000 female)	**100,000 (of which 50,000 female)**	Annual	Progress report	Energy Cell with EDH inputs
Number of businesses and community services benefitting from improved access to electricity and fuels,	SREP core	Number	0	0	200	200	1,000	1,000	1,000	**1,000**	Annual	Progress report	Energy Cell with EDH inputs

as a result of SREP interventions													
Increased public and private investments in targeted subsectors as a result of SREP interventions	SREP core	Number		0	0	6	9	15	**15**	**15**	Annual	Progress report	Energy Cell
Incentives and regulatory clarity for grid-connected RE are in place		Yes/no	no	no	No	yes	Yes	yes	**yes**	**yes**	Bi-annual	Progress reports	Energy Cell

Component 2

Indicator Name	CRI	Unit of Measure	Base-line	Cumulative Target Values							Frequency	Data Source/ Methodology	Responsibility for Data Collection
				YR1	YR2	YR3	YR4	YR5	YR6	End Target			
Number of mini-grid and off-grid enterprises benefitting from the SREP grant support		Number	0	0	4	8	10	12	12	**12**	Bi-annual	Progress report	Energy Cell with OGEF
Generation capacity of energy constructed or rehabilitated	☒	MWp	0	0	1	4	12	18	23	**23**	Bi-annual	Progress report	Energy Cell with OGEF inputs
Annual electricity output from RE, as a	SREP core	GWh	0		1	6	17	25	34	**34**	Annual	Progress report	Energy Cell

result of SREP interventions													
Annual greenhouse gas emission reductions	SREP core	tCO2			3,926	16,826	44,869	67,304	89,739	**89,739**	Annual	Progress report	Energy cell
Number of people, benefitting from improved access to electricity and fuels, as a result of SREP interventions (of which female)	SREP core	Number	0	0	35,000 (17,500 female)	150,000 (75,000 female)	400,000 (200,000 female)	600,000 (300,000 female)	800,000 (400,000 female)	**800,000 (400,000 female)**	Annual	Progress report	Energy Cell
Number of businesses and community services benefitting from improved access to electricity and fuels, as a result of SREP interventions	SREP core	Number	0	0	300	1,000	2,,000	6,000	10,000	**10,000**	Bi-annual	Progress report	Energy Cell with OGEF inputs
Increased public and private investments in targeted subsectors as a result of SREP interventions	SREP core	Number	0	0	10	20	40	75	100	**100**	Annual	Progress report	Energy Cell with OGEF inputs
Enabling framework for mini-grids, including tri-partite agreements in place		Yes/no	no	yes	yes	yes	yes	yes	yes	**yes**	Annual	Progress report	Energy Cell

Number of people trained in renewable energy		Number	0	50	200	500	1,000	2,000	3,000	**3,000**	Bi-annual	Progress report	Energy Cell
Number of consumer awareness activities implemented		Number	0	2	4	6	8	10	10	**10**	Bi-annual	Progress report	Energy Cell
Number of female jobs and female-headed (micro-) enterprises created		Number	0	0	0	100	500	800	1,000	**1,000**	Annual	Progress report	Energy Cell with OGEF inputs

Citizen engagement and beneficiary feedback

Indicator Name	CRI	Unit of Measure	Base-line	Cumulative Target Values							Frequency	Data Source/ Methodology	Responsibility for Data Collection
				YR1	YR2	YR3	YR4	YR5	YR6	End Target			
Responses to and corrective actions taken based on beneficiary feedback from phone surveys and household visits		n/a	n/a	25%	40%	60%	60%	60%	80%	**80%**	Annual	Progress Reports	Energy Cell with EDH and OGEF inputs
Percentage of users reporting mini-grid or off-grid electricity service provided according to the advertised performance		n/a	n/a	60%	60%	70%	80%	80%	80%	**80%**	Annual	Progress Reports	Energy Cell (based on cell phone surveys)

•

Description of indicators

Project Development Objective Indicators	
Indicator Name	Description (indicator definition etc.)
People provided with new or improved electricity service	The indicator measures the number of people that have received new or improved electricity service through the Project. This is measured by a number of household connections multiplied by the average household size.
Enterprises and community services with new or improved electricity service	The indicator measures the number of enterprises and community services such as schools, health clinics, government offices, and community centers that have received new or improved electricity service through the Project.
Private and other commercial financing leveraged	Private financing leveraged under the project. This includes additional equity or lending to businesses supported by OGEF/SREP funding, as well as additional contributions to OGEF from financiers other than CTF and SREP.
Enabling policy and regulatory framework for clean energy and access enacted	This indicator reflects Haiti's progress in enacting an enabling framework for clean energy and access. It is measured through the composite indicator for energy access, renewable energy and energy efficiency of the Regulatory Indicators for Sustainable Energy (RISE), a report published semi-annually by the World Bank/ESMAP (rise.esmap.org).

Intermediate Results Indicators	
Generation capacity of energy constructed or rehabilitated	Installed capacity for power generation calculated in MW under the Project. It includes capacity of renewable energy as well as battery capacity installed by the Project.
Annual electricity output from RE, as a result of SREP interventions	This indicator measures GWh of electricity generation. It is primarily focused on grid-connected RE systems. However, it can include mini-grid or off-grid electricity generation as long as data are readily available.
Annual greenhouse gas emission reductions	This indicator measures the amount of GHG emission displaced or avoided from the provision of off-grid electricity annually, as well as over the CBA lifetime of the project-supported systems

Number of people, benefitting from improved access to electricity and fuels, as a result of SREP interventions (of which female)	SREP aims to improve access to modern energy services in two ways: i) by providing improved access to modern energy services for businesses, communities, and households; ii) by increasing the supply of renewable energy to communities that already have access, thereby improving the quality of access. To be able to claim energy access benefits from increasing centralized RE supply (i.e. grid-supplied electricity) there would need to be a clear demonstration of causality.
Number of businesses and community services benefitting from improved access to electricity and fuels, as a result of SREP interventions	
Increased public and private investments in targeted subsectors as a result of SREP interventions	This indicator assesses how SREP interventions led to greater investments in renewable energy necessary for large scale replication. It is also probably a proxy indicator for changes in the enabling environment for investments in renewable energy. Particularly a significant increase in private sector investments might be an indication for a 'healthy' business environment.
Incentives and regulatory clarity for grid-connected RE are in place	This indicator assesses changes to the regulatory framework with particular attention to (i) the creation of a level-playing field for renewable energy and fossil fuels alternatives (e.g. through import/VAT duty exemptions) and (ii) to the development of a clear policy and regulatory framework for integrating RE into the energy mix.
Number of mini-grid and off-grid enterprises benefitting from the SREP grant support	This indicator includes the number of mini-grid and off-grid enterprises that have accessed SREP grants under Component 2 (for mini-grids, productive uses or individual systems).
Enabling framework for mini-grids, including tri-partite agreements in place	This indicator assesses whether an enabling framework to scale-up mini-grids, including the tri-partite contract to be developed under Component 2, are in place.
Number of people trained in renewable energy, of which female	This indicator summarizes the number of people that have benefitted from renewable energy training (Government officials, university students, entrepreneurs, local technicians and other beneficiaries)
Number of consumer awareness activities implemented	This indicator counts the number of awareness building activities directed at existing or prospective entrepreneurs towards the development of a larger pipeline of companies seeking support from the credit facility provided under the project.
Number of female jobs and female-headed (micro-) enterprises created	This indicator estimates the number of female jobs and female-headed (micro-) enterprises that were created thanks to the project support. This includes (i) entrepreneurs and female

	staff in the energy service provision supply chain (to be reported by enterprises benefitting from the project support), and (ii) entrepreneurs and female staff jobs created due to improved service provision (measured through MTF surveys)
Citizen engagement and beneficiary feedback	
Corrective actions taken based on beneficiary feedback from phone surveys and household visits	The issues found in the phone/household surveys are communicated to the Advisory Committee and FDI/the Fund Manager, which prepares and executes a plan for addressing the key issues.
Percentage of users reporting systems working according to the advertised performance	Percentage of respondents in the representative phone-based survey of beneficiaries who report their off-grid systems are working according to the advertised performance.

HAITI: Renewable Energy for All

ANNEX 2. DETAILED PROJECT DESCRIPTION

A. PROJECT DEVELOPMENT OBJECTIVE AND BENEFICIARIES

1. The Project Development Objective is to scale-up renewable energy investments in Haiti in order to expand and improve access to electricity for Haitian households, businesses and community services.

2. The proposed SREP project initiates a transformation from Haiti's presently underdeveloped, unreliable, and expensive fossil fuel-based power generation mix to a modern and sustainable energy system relying on diverse sources of power. Harnessing the country's RE potential will enhance energy security (by reducing Haiti's dependency on imported oil), alleviate poverty (by providing households cheaper sources of power), create jobs and generate new economic opportunities (by providing a more reliable electricity and by creating a new clean energy industry). The project will providing new or improved electricity services to at least 900,000 people and at least 11,000 enterprises, adding new renewable energy capacity of nearly 30MW.[42] Women, in particular, will benefit as energy users, as entrepreneurs and as employees of the newly created off-grid businesses. The project includes specific actions to ensure that the gender-differentiated benefits materialize and are properly tracked (see Annex 1 for gender-related indicators and Annex 5 for gender assessment and actions).

B. SCOPE AND FINANCING SOURCES

3. The proposed Renewable Energy for All Project is based on the SREP Investment Plan, approved by the SREP sub-committee in May 2015. It is split in two main components, each a SREP standalone project, as follows:

- Component 1: Grid-Connected Distributed Renewable Energy (or SREP Renewable Energy for Metropolitan Area - XSREHT050A); and

- Component 2: Off-grid Distributed Renewable Energy (or SREP Renewable Energy and Access for All - XSREHT047A).

4. As anticipated in the SREP Investment Plan, the Project is co-financed by (i) IDA Rebuilding Energy Infrastructure and Access Project (PRELEN), which is being restructured to strengthen its focus on clean energy and energy access; (ii) CTF-funded Modern Energy Services for All Project, which has established the Off-Grid Energy Fund (OGEF), (iii) private capital, and additional financiers for technical assistance/training (ESMAP, Korean Green Growth Trust Fund, Schneider Foundation, French Ministry of Education). In addition, the Project leverages synergies and co-financing with other World Bank operations in Haiti in agriculture, private sector development, education, and water sectors (See Table A2.1 SREP other).

5. There are ongoing discussions with other potential financiers, such as the Government of

[42] Targets are inclusive of SREP, CTF and IDA co-financing.

the United Arab Emirates.

Table A2.1. SREP Program financing (US$ million)

	IDA PRELEN	Other IDA[43]	SREP	CTF (OGEF)	Others	Private sector	Total
Component 1: Grid-connected distributed RE	4		12.5		0.5	0-8	17-25
- ***PV and battery (investment+ potentially a guarantee***			*12*			*0-8*	
- ***On-grid investments supporting vRE integration***	*3*						
- ***Technical Assistance***	*1*		*0.5*		*0.5*[44]		
Component 2: Off-grid distributed RE	17	3	10	16	2.5	70	118.5
- ***Mini-grids***	*2*		*4*	*3*		*9*	
- ***Productive and community uses***	*10*	3	*2*	*2.5*	*1.5*[45]	*21*	
- ***Households Systems***			*3*	*7*		*40*	
- ***Technical Assistance and Capacity Building***			*1*	*1.5*	*1*[46]		
- ***OGEF Fund Manager and Operating expenses***				*2*			
Total SREP Project	**21**	**3**	**22.5**	**16**	**3**	**70-78**	**135.5-143.5**
Additional: small hydro rehabilitation (IP Component 4)[47]	*4*						*4*

[43] The list of World Bank projects for which SREP will provide TA/financing for agri-businesses and community uses include:
Agriculture: Relaunching Agriculture - Strengthening Agriculture Public Services II Project (GAFSP - IDA) (P126744)
Competitiveness: Haiti Business Development and Investment Project (P123974)
Education: Haiti - Education for All Project - Phase II (P124134)
Water: HT Sustainable Rural and Small Towns Water and Sanitation Project (P148970)
[44] ESMAP TA support for vRE integration and Korea Green Growth Trust Fund
[45] Electricity Without Borders (NGO) - thanks to a solar PV in-kind contribution from EDF Energies Nouvelles -, for school solar PV electrification with ICT solutions (smart boards)– see Annex2.
[46]France (Ministry of Education) and Schneider Foundation RE training program and ESMAP TA support for minigrids and Lighting Global.
[47] While not a part of the SREP project, the restructured IDA PRELEN project is also providing US$4 million for rehabilitation of a small hydro plant Drouet, which is a part of the broader SREP Investment Plan and one of the Government priorities for RE generation.

Total SREP IP	***25***	***3***	***22.5***	***16***	***3***	***70-78***	***139.5-147.5***

6. Private sector leveraging on Component 1 will only materialize if private investments into on-grid renewables are feasible in Phase II, e.g. through using SREP funds as a guarantee. Private sector leveraging on Component 2 will take the form of private equity and commercial loans. First, all private sector projects supported from OGEF and grant facilities managed by the Energy Cell will need to have private co-financing, which will mostly be in the form of private equity. It is estimated that to achieve the project targets, US$23 million will need to come directly from the private sector. In addition, the project expects that the seed funding provided through OGEF (grants, equity and loans) will support off-grid businesses growth, creating opportunities for further investments and commercial lending for these companies. For example, the PAYG companies in East Africa, initially supported by donors and impact investors are now (3-4 years later) attracting private investments and commercial loans. The same pattern is expected to be followed in Haiti, and it is estimated that at least additional $47 million will be invested in these companies during the lifetime of the project, allowing these companies to operate and grow beyond the life-time of the project and beyond the project's targets.

C. Approach

7. SREP Renewable Energy for All Project proposes a comprehensive investment and capacity building program to unlock the most promising renewable energy investment opportunities in Haiti. The objective is to use renewable energy to drive energy access expansion and to improve quality of electricity service provision. Considering the fragmented nature of Haiti's electricity system (nine isolated grids operated by EDH, over 30 municipal grids and 500MW estimated in self-generation), investments in distributed renewables have in particular been prioritized.[48] Three user / off-taker segments with the strongest potential for near- and medium-term private sector investments were identified: (i) small and medium-sized EDH grids, (ii) municipal village grids, and (iii) individual off-grid systems for productive and household uses (see Table A2.2).

Table A2.2. Distributed RE access expansion options

Distributed RE access expansion option	Theoretical max. potential of segment (population)	Recommended SREP target (population)
RE retrofit, upgrade, and expansion of EDH grids	1,500,000	100,000

[48] The SREP Investment Plan originally also contemplated a larger scale grid-connected RE investment serving the largest of EDH grids (Port-au-Prince metropolitan area). This project, however, had to be abandoned due to the current transmission bottlenecks that for the time do not allow an integration of a large scale RE investment into the grid. In addition, demonstration impact would be diluted due to significant technical and commercial losses in the system, which will prevent users from experiencing any visible service improvements.

Small and medium village grids (retrofit and greenfield)	300,000	60,000
Stand-alone systems (households, social users, SMEs)	>5,000,000	600,000

Source: Navigant (2015) and iiDevelopment (2015) for SREP Investment Plan.

8. The Project aims at attracting private sector investments into these three RE segments. This is done in three parallel ways.

- The project will demonstrate impact of vRE technologies on reducing costs and improving availability and reliability of electricity service provision -- two major issues facing electricity users in Haiti. This demonstration impact is essential due to the very nascent stage of renewable energy industry in Haiti, continued distrust in variable RE technologies such as solar and wind, lack of successful investment precedents, and a plethora of policy, regulatory, financing and capacity constraints. This is particularly relevant for on-grid renewables – Component 1. It is anticipated that the demonstration effect will lead to replication and eventually will be able to attract increasing private sector investments.
- The project identifies those distributed RE segments, which can attract commercial sources of funding in the nearer term. This in particular includes village grid and off-grid energy enterprises, which have a potential to grow into profitable businesses, attracting additional commercial sources of finance if appropriate business development support is provided to them. This is the rationale for Component 2 financing.
- In parallel, the SREP project will build a better enabling and regulatory environment and capacities supporting further investments in clean energy and energy access. This is an urgent priority, considering that Haiti scored second from the bottom (only after Somalia) out of 111 countries in the latest Regulatory Indicators for Sustainable Energy (RISE) report, co-published by the World Bank/ESMAP and SEforALL.[49]

9. Given the multitude of uncertainties of developing the first sizable renewable energy investments in the challenging environment of a very fragile country, the Project is designed in a flexible manner, allowing resources to be allocated efficiently to those areas that show the best promise of success.

Component 1 Grid-Connected Distributed RE generation: ***US$17 million (SREP $12.5 million, IDA $4 million, others $0.5 million)***

10. Component 1 will initiate the scaling up of on-grid RE investments in Haiti, by demonstrating the feasibility and benefits of injecting solar PV generation into EDH grids and building supporting policy and regulatory environment for private sector-driven RE investments. The Component aims at building 6-12MW of RE capacity (solar PV+battery), which would hybridize 2-3 EDH isolated grids, currently running on diesel power, resulting in 5-20 GWh of additional annual renewable energy generation, and improved access for at least 100,000 people

[49] The report ranks countries based on their policy and regulatory environment for energy access, renewable energy and energy efficiency. See rise.esmap.org.

and 1,000 enterprises. Given the tremendous generation capacity deficit and high costs of thermal generation by EDH, the replication and scale-up potential is enormous. The component will engage private sector in the construction and operation of the PV plants and build a path towards attracting commercial investments in solar PV generation. It will demonstrate the potential of solar PV energy to simultaneously reduce costs of electricity generation for EDH, while improving service quality for EDH users. It will be the first grid-connected solar PV investment in Haiti.

Background

11. EDH operates (i) one main "interconnected" grid serving the capital Port au Prince and surrounded areas and (ii) nine smaller isolated grids, with a total of about 250,000 "active" (= legal) customers, and many more illegal/informal connections. Of these, 90,000 active customers are spread out through the nine isolated grids, serving secondary cities and larger rural towns. These isolated grids are generally supplied intermittently by diesel units and some small hydropower, in all cases with peak demand outstripping the available supply. Most of them have between 0.5 and 10 MW peak demand, and between 500 and 20,000 "active" customers, some of them, however, are serving areas with a population well above 100,000 (see Table A2.3).

Table A2.3. EDH's grids[50]

Town	Grid name	Department	Installed capacity (kW)	Effective capacity (kW)	Peak load (kW)	Active Customers	Inactive Customers	Total Customers
Cap Haitien	Cap-Haïtien	Nord	14400	11500	16500	16,050	19,093	35,143
Chevry	Nord-Est	Nord-Est	7090	3000	4000	3,658	770	4,428
Gonaives	l'Artibonite	Artibonite	19200	13200	16000	13,523	16,284	29,807
Les Cayes	**Cayes**	Sud	**11600**	**7200**	**8000**	**18,546**	**16,574**	**35,120**
Jacmel	Jacmel	Sud-Est	5150	4450	5000	10,719	7,355	18,074
Jérémie	**Jérémie**	Grand Anse	**3650**	**2800**	**1700**	**3,181**	**3,557**	**6,738**
Port-de-Paix	Port-de-Paix	Nord-Ouest	3700	1100	2500	4107	4908	9015
Petit Goave/ Aquin/ Miragoane	**Petit Goave**	Ouest/Sud/ Nippes	**10600**	**6000**	**7500**	**9,942**	**8,321**	**18,263**
Arcahaie	l'Arcahaie	Ouest	2000	1700	2500	2,556	5,857	8,413

12. The distribution infrastructure, with a few exceptions, is in poor shape due to lack of maintenance and frequent natural disasters. The latest – hurricane Matthew – in October 2016 hit the South of the country and left a path of destruction, including the EDH grids in the South and South-West. Les Cayes, Jérémie and Aquin/Petit Goâve all sustained severe damages to lines and generation units, leaving over 10,000 EDH customers without power. The GOH is presently exploring options for financing the rehabilitation of the southern grid with various development partners, opening up opportunities for integrating additional RE generation into the newly

[50] The list does not include a grid on La Gonave island which has about 0.5MW installed capacity and 1,000 customers.

refurbished grids.

13. The average tariff is relatively high, particularly for industrial and commercial consumers (US$0.30/kWh), but EDH commercial performance is weak due to high losses and low rate of billing and collections. In addition, many industrial and commercial clients have left EDH with the preference to self-generate due to the low reliability of EDH power. Strengthening commercial performance, while improving reliability, is therefore the main challenge for electricity service provision on these isolated grids, and in EDH at large.

Key design features

14. Component 1 aims at helping EDH to improve its financial sustainability, by replacing expensive diesel generation with lower cost RE technologies, and by improving service availability and reliability for EDH clients. It is expected that the improved reliability will lead to the widening of its customer base and greater customer satisfaction, which in turn may allow EDH to take a more aggressive stance towards increasing collections and reducing theft. The visible service improvement benefits for the users and cost reductions for EDH are hoped to trigger demand for replication throughout the remaining EDH grids.

15. **Technology:** The Component will support solar PV technology with battery storage. Solar PV was selected over other potentially viable RE technologies (hydro, wind, biomass) due to the applicability of this technology to all potential sites, and due to its modularity, which makes it suitable for both larger-scale and smaller-scale investments. The decision to complement solar PV generation with battery storage is driven by the following considerations: (i) proven economic viability in the Haitian context (see Economic Analysis in Annex 6), (ii) imperative to demonstrate service availability and reliability improvements in addition to the cost reduction benefits, and (iii) scale-up effect—considering that the continued technology and price trends will likely favor "PV with storage" over "PV only" investments in the coming years in Haiti.[51] The least cost proven battery technology, such as lithium ion, will be used for storage.

16. **Business model**: The Component design is aimed at enabling private sector investments in solar PV generation in Haiti. The team explored using part or all of the funds allocated to Component 1 as a guarantee to support the mobilization of private capital considering (i) the lack of creditworthiness of EDH as the potential off-taker and (ii) the lack of private sector-led renewable energy project precedents in Haiti. Further analysis and private sector consultation, however, revealed that while guarantees could eventually be used to mobilize private capital for solar PV investments in Haiti, more work is required today in the power sector before a private sector-led projects could be undertaken and deemed bankable by the private sector. To make a solar PV project bankable (i) EDH will have to be supported with more capacity building, (ii) the collection of revenues in the targeted EDH grid should be ring-fenced and outsourced to an independent entity and (iii) the feasibility of solar projects should be demonstrated through one or several pilot projects in order to test an integration of solar PV and batteries in the context of EDH's weak grids.

17. The Component will therefore be implemented in a phased approach through which the first solar investments would be publicly financed to demonstrate the feasibility of connecting mid-

[51] See for example: IRENA: Rethinking Energy, 2017

size solar PV plant with storage to the relatively small and weak grid in Haiti. Subsequently, upon successful development of publicly-financed solar investments, private investment will be sought if feasible. In such a case, the project may be restructured, to allow a part of Component 1 funding to be used as a guarantee.

Sub-component 1.a: Demonstration solar PV project

18. This Sub-component will finance solar PV+battery storage plants to feed 2-3 EDH isolated grids. The Sub-component aims at building 6-12MW of RE capacity (solar PV+battery). The final generation capacity and renewable energy generation depend on the final site selection, completion of feasibility studies determining the final absorption capacity of the selected grid, decision on how much battery storage and the degree of private sector participation.

19. The Sub-component will follow a phased approach. The first sub-project will be public-sector financed and private-sector implemented (through EPC and O&M contract – same contractor is expected for both). The subsequent investments will seek increased private sector participation if feasible. An IPP approach, backed by a guarantee, will in particular be explored.[52] After the first demonstration, leveraging private sector would be a priority, but if not feasible, other options will be considered including: (i) expanding the demonstration project (either the same grid or an additional grid) or (ii) reallocating funds to Component 2 if that component is performing well.

20. The Sub-component investments will be co-financed by SREP, IDA and potentially private sector (if feasible). SREP funds will be used for financing the generation equipment (solar PV panels, batteries, convertors, grid interconnection), IDA funds will be used to finance additional grid-related improvements needed to facilitate interconnection and maximize the use of solar PV power on the grid. This may include dispatch-related investments, as well as user-facing measures -- metering and energy efficiency/demand side management (DSM) measures. EDH will finance O&M and/or PPA payments (if IPP approach is taken).

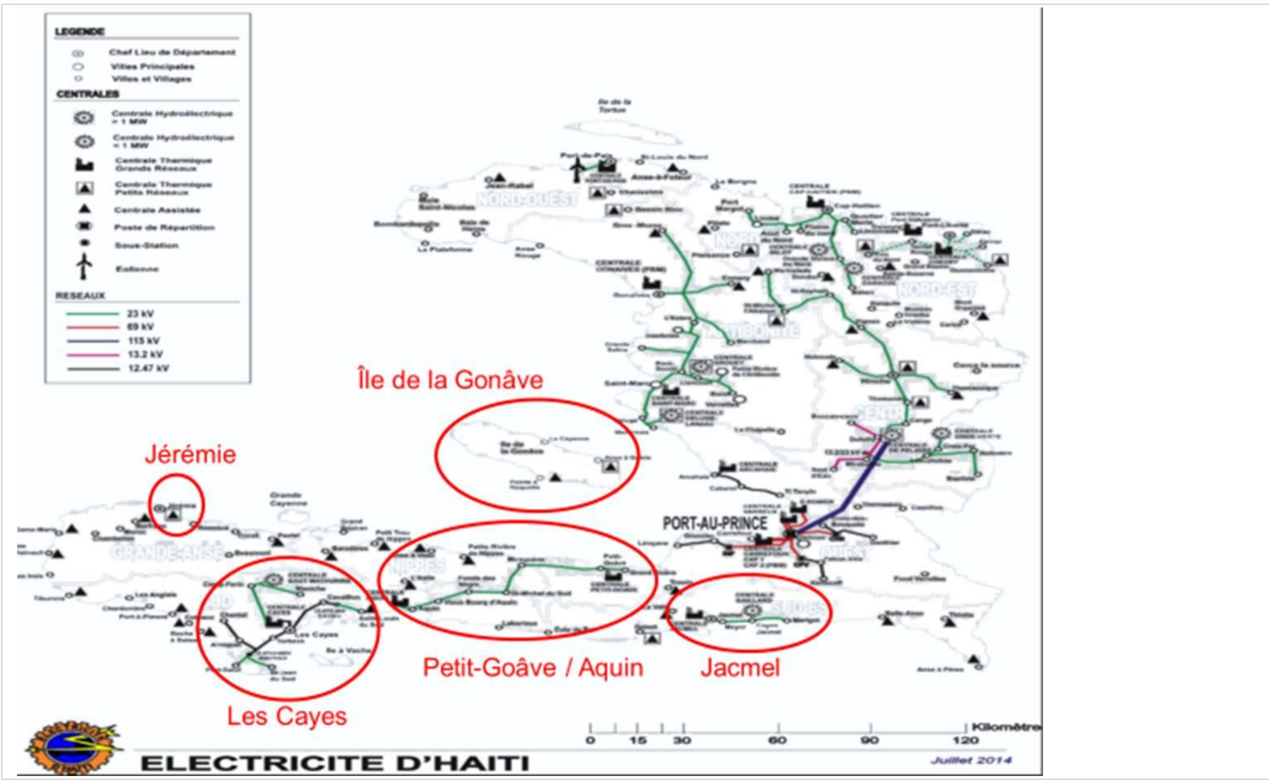
21. **Site selection**: Five small and medium-sized EDH grids (1-12MW) were prioritized out of a total of nine: Jeremie, Les Cayes, Petit Goave, Jacmel and La Gonave (see Figure A2.1. below and Table A2.3 above), as suitable off-takers for the solar PV plants. A broad set of pre-feasibility modelling tools (Homer, PVSyst, Mathematica-based mixed integer linear optimization, and Excel-based Sensitivity and Monte Carlo Analysis) were run to determine the most promising mix of system designs and sizes for these five sites, based on estimated pre-feasibility Capex, Opex for a broad range of capacities for the solar PV generator and battery storage. For discussion, and in light of data and modelling uncertainty inherent to pre-feasibility stage, the resulting array of economically viable system designs was then simplified into three main village grid categories, by "PV Share": low, medium and high solar PV penetration (see Table A2.5 and Annex 6 for more details).

22. Selection criteria for the EDH sites include size, likely technical compatibility with the

[52] The approach is not described in detail here, as the exact nature of the PPP approach and the associated guarantee will need to be designed based on what is feasible at that time. The project will actively explore this option and if feasible, it will be restructured to turn a part of SREP funds into a guarantee. The guarantee design will be presented in the Restructuring Paper and associated documents.

solar PV + battery plant, status of local grid and generation, logistics of PV and battery installations, availability of public land for the PV plant, potential for demonstration effects in post project scale-up, and ability to generate revenues to cover O&M costs. Priority was given to areas devastated by Hurricane Matthew. Final sites will be selected by MTPTC Energy Cell in consultation with EDH, MEF, and in agreement with the World Bank, based on the confirmation of the selection criteria and taking into account the emerging economic development priorities of the GOH.[53]

Figure A2.1. Prioritized EDH grids



23. **Solar generation and storage optimization:** For each prioritized site, models have been developed to optimize solar PV and battery performance for likely load and grid integration scenarios (see Annex 6). The optimization has resulted in several possible investment scenarios, resulting in varied combination of PV and battery capacity and public-private investment ratios that can fit in US$12 million (see Table A2.5) [54]. Example B is taken as the probable scenario for the Sub-component – first one public project and subsequent private sector investments.

Table A2.5. Solar PV+battery capacity scenarios

[53] The list is not binding. To facilitate integration and promote maximum use of solar PV power, only EDH grids with EDH-owned diesel generators are considered. This may exclude Les Cayes and Petit Goave from the list, considering the uncertainty about the future of the existing IPP, which has been supplying these two grids, but is currently operating without a contract. Additional sites could be considered as long as meeting criteria (i) to (iv) identified above.

[54] The readers should be aware though, that this is a simplification of a much larger number of possible combinations of solar PV and battery sizes.

	Site 1	Site 2	Site 3	Thus, 3 typical Investment Cases Component 1 that fit a US$12 M budget [Capex]:
	Les Cayes Peak demand 11 MW (incl existing hydro)	**Petit Goave** Peak demand 10 MW	**Jeremie** Peak Demand 3 MW (3-6k users)	
HIGH PV SHARE	For example PV capacity ca. **11 MWp*** **+ battery 11MWh** Unit Cost: 4$/Wp Capex ca 44M$ If Guarantee → ca 22M$	**PV 10 MWp + LiIon 10 MWh** 4 $/W Capex 44M$ Guarantee 22M$	**PV 3 MWp + battery 3 MWh** 4 $/W all-in conservative cost (PV + bat) **Capex 12M$** Guarantee 6M$	*Example A* 1. **Site #3 High PV Share and large storage** and no Guarantee possible (first project site) 2. No Other Sites can be funded in Component = 12M$ Component 1 Budget Need
MEDIUM PV SHARE	**PV 5 MWp + very small or no battery**** 3 $/W Capex 15M$ If Guarantee → ca 7.5M$	**4 MWp** 3 $/W Capex 12M$ Guarantee 6M$	**1.4 MWp** 3 $/W Capex 4M$ Guarantee 2M$	*Example B* 1. **Site 1 LOW** Share PV with Guarantee 2. **Site 2 MEDIUM** Share PV with Guarantee 3. **Site 3 MEDIUM** Share PV no Guarantee → 4+6+2 **= 12M$**
LOW PV SHARE	**PV 2 MWp + no battery** 2 $/W Capex 4 M$ If Guarantee → ca 2M$	**2 MWp** 2 $/W Capex 4M$ Guarantee 2M$	**0.7 MWp** 2 $/W Capex 1.4M$ Guarantee 0.7M$	*Example C* 1. **Site 1 LOW** SHARE + no Guarantee 2. **Site 2 LOW** SHARE + no Guarantee 3. **Site 3 MEDIUM** Share PV + no Guarantee → 4+4+4 **= 12M$**

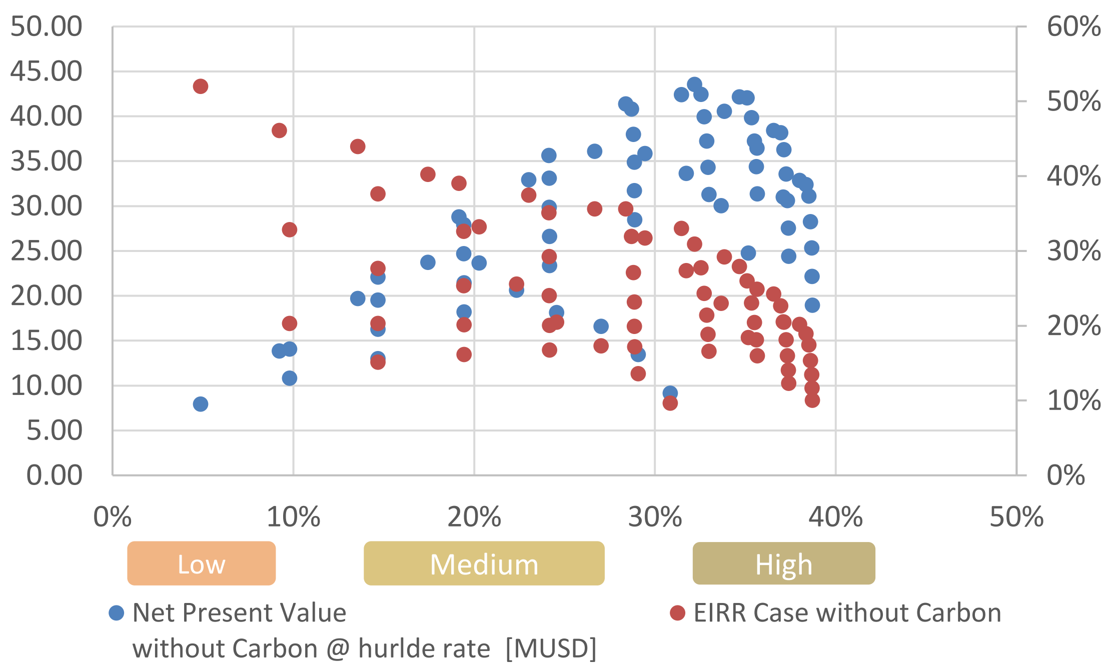
**Caveat: As illustrated by our Jeremie sensitivity analysis (ANNEX 6), the actual PV "nameplate capacity" for the HIGH SHARE case and also the related optimal battery size will vary significantly with: (i) Load Factor of site (for "urban load curves" a much high PV share is possible without battery) and (ii) the number and nature of diesel gensets in situ, as well as Project Sponsor wacc and preferred strategy for automated dispatch and DSM. Thus, 11 MWp is only a typical average capacity.*

*
* *In the same vein, for medium share systems - depending on load curve and provider strategy at feasibility, there may be no need for a battery, again depending on actual load curve, diesel genset number and type in situ, and "dispatch strategy" cum PV.*

24. For a detailed example of optimization scenario development – see the case of Jeremie in Annex 6 (results presented below).

			I. CBA ASSUMPTIONS FOR TYPICAL CT					II. RESULTING ECONOMIC INDICATORS WITHOUT CARBON							
	RE SHARE	P Share	PV size (MWp)	Li-Ion bat. (1 MW)	CapEx [MUSD]	Present Value OpEx [MUSD]	excess generation (MWh)	Present Value COST [MUSD]	Present Value BENEFITS ex Carbon high WTP [MUSD]	Net Present Value without Carbon @ hurlde rate [MUSD]	EIRR Case without Carbon	Switching Value Capex in % of assumed cost	Annual Value BENEFITS cum Carbon Base Case [USD]	Net Present Value WITH Carbon BASE CASE @ hurlde rate [USD]	EIRR with Carbon Base Case [USD]
Low Share	9%	33%	1	0	1.8	1.3	103.3	3.1	17.0	13.9	0.5	4.1	17.8	14.7	0.5
Medium Share	19%	67%	2	1	4.6	3.5	51.2	8.1	37.0	28.8	0.4	3.3	38.8	30.8	0.4
High Share	29%	100%	3	3	8.5	6.7	31.0	15.1	56.0	40.8	0.3	2.6	58.8	43.8	0.3

Jeremie: NPV and EIRR Vs RE Share



25. **Grid integration:** The investment costs are inclusive of grid integration costs – funded through a combination of SREP and IDA, including IDA-financed investments into grid improvements to facilitate absorption and impact of solar PV generation (improving dispatch, user-facing DSM-type measures etc.) will be determined based on detailed feasibility studies and will be eligible for IDA financing

26. **Contracting arrangements:** MTPTC Energy Cell (with the assistance of the technical advisor funded under Sub-component 1b) will competitively procure an EPC contractor, who will be in charge of the detailed design and installation of the solar PV+battery plant. The same

contractor will be awarded an operation and maintenance (O&M) contract for the expected period of 4 years. The O&M contractor will also be required to build EDH capacity for the future operation and maintenance of the plant. The O&M contractor will be paid by EDH through an escrow account, (see below sustainability arrangements).

27. **Sustainability arrangements:** EDH will be required to isolate administratively the selected isolated grid from the rest of EDH in order to ensure that (i) a part of the savings from reduced fuel spending can be used to finance solar PV plant O&M, and (ii) that impact in terms of reduced costs/improved EDH finances can be adequately monitored. In addition, EDH will be required to establish an escrow account, to which an agreed amount for O&M will be paid annually as an automatic transfer from revenues collected on the grid. The monthly O&M amount will cover the O&M contractor payment plus the contribution for the future equipment replacements. Such an arrangement is financially feasible for EDH, even assuming that the current level of commercial losses continue, given that the O&M payment is relatively small compared to the current O&M costs of running a diesel generation plant. (O&M payment lower than value of saved fuel). See Annex 6 for more details. Establishing, maintaining and contributing to the escrow account with the agreed amount will be a Project's legal covenant.

28. The Government is currently exploring the way to improve performance of EDH, including the isolated grids, including a possibility to outsource collection and billing or to concession the grid operation to private sector. The project will contribute to this process by improving the administrative and financial transparency on the demonstration project grid. The grid will be isolated administratively from the rest of EDH and its performance closely monitored. Moving to the next phase, which foresees greater private sector participation, additional measures will be required and promoted by the project, including outsourcing billing and collections on the grid or concessioning the grid to the private sector.

Sub-component 1.b: Technical assistance and enabling framework for RE scale-up

29. This component will finance technical assistance to the Energy Cell,[55] EDH, MEF (including its PPP unit) and other key stakeholders for the design of the proposed investments and contractual arrangements for both potential PPP arrangements (EPC+O&M contract or PPA), and for developing arrangements for ensuring sustainable revenues for O&M/PPA payments (establishing an escrow account to prioritize O&M/PPA payments and/or outsourcing billing and collections) and for the actual transaction advice, including safeguards aspects.

30. For the first demonstration project, specifically, the component will finance technical and transaction advisors to the Energy Cell for the more detailed assessment of potential site, design, procurement, contracting, supervision of works and commissioning of the demonstration project, as well as support for supervision of the O&M contractor, and assistance with fine-tuning of technical and operational issues, as well as a very close monitoring of plant operations and financial and service improvement impacts.

31. The Sub-component will also finance development of a broader enabling policy and

[55] The Energy Cell is well situated to start implementing the project, hiring TA support etc. Additional reinforcements, however, will be needed to implement the project – both in terms of additional staff and consultants to support it.

regulatory framework to support renewable energy investments and private sector participation in the long term, including fiscal incentives for renewables such as customs duty and tax exemptions, development of a realistic RE grid integration plan and targets, grid code, design of auctions and other competitive procurement processes and standard PPAs.

32. In addition to the TA provided under this Sub-component, the Government officials, EDH and other key stakeholders will also benefit from training on renewable energy technologies, integration issues, PPP models, and design of guarantees and other risk mitigation instruments, developed under the broader capacity-building program under Sub-component 2.d.

Component 2: Off-grid Distributed Renewable Energy Generation: ***US$ 51.5 million (SREP $10 million, IDA $20 million, CTF $16 million, others[56] $25.5 million)***

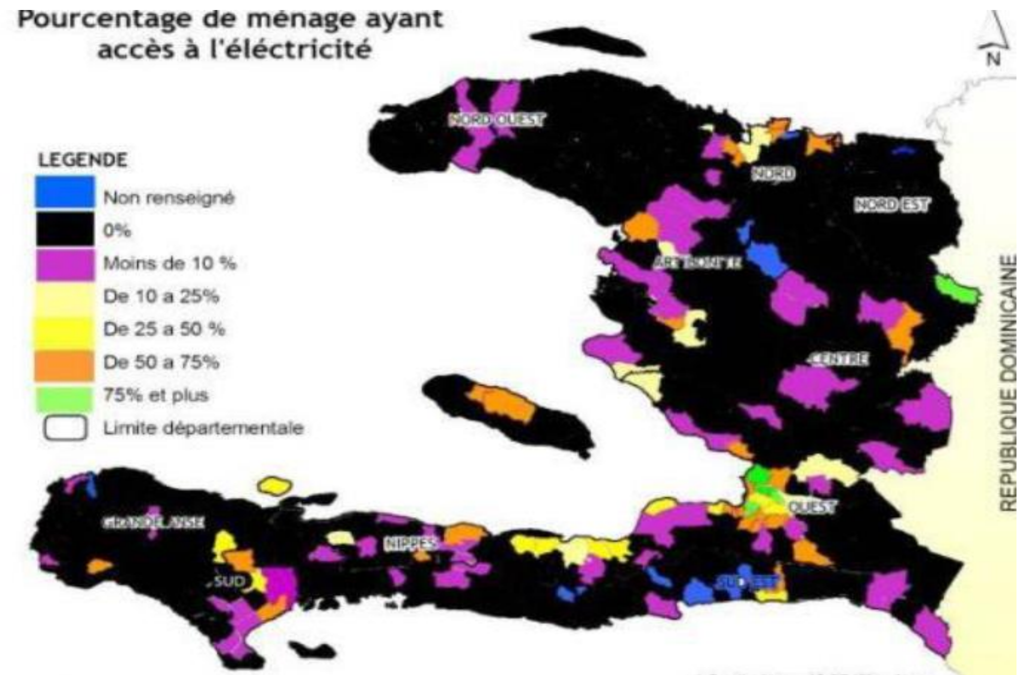
33. Component 2 will extend access to clean and modern energy services to households, communities and enterprises that are not served by EDH. The Component will provide (mostly) first-time access to at least 800,000 households and 10,000 enterprises and community service institutions, such as schools, health centers and community water pumping services. The Component will deploy a wide range of off-grid electrification options: village grids, larger stand-alone systems for productive and community uses, and smaller solar home and pico-PV systems for households. The Component will leverage private sector dynamism and innovation, learning and applying successful business models from more advanced off-grid energy markets, such as East Africa and South Asia. Significant private sector leveraging (US$60 million) is anticipated.[57] The Component is expected to lay foundations for sustained market growth, expected to provide access to at least 2 million Haitians by the year 2025.

Background

34. Two-thirds of the Haitian population have no access to electricity. As Figure A2.2 shows, electricity access is sparse and sporadic throughout the country and absent in most of rural Haiti. Electrification rate is only 15 percent in rural areas versus 56 percent in urban areas.[58] Off-grid electrification is beginning to fill in the access gap in rural areas, but the off-grid sector is still in its infancy, constrained by barriers typical to the early stage of off-grid energy development -- lack of financing, regulatory constraints and lack of knowledge and trust in off-grid technologies.

[56] Includes ESMAP, French Ministry of Education and Schneider Foundation, as well as $13 million of private sector leveraging needed to contribute to the project's targets. Additional $47 million of private sector leveraging is expected as additional equity and commercial lending to companies originally supported by the project, which will allow these companies to expand and growth beyond the targets and time-frame of the project.
[57] Of these $60 million, $13 million are expected to come as direct co-financing needed to reach the proposed project targets, while the remaining $47 million will be for an additional scale-up (e.g. additional investment in off-grid businesses initially supported by OGEF, which is expected to materialize in the lifetime of the Project). This additional investment is expected to fuel further growth of the market, expected to result in at least 2 million people with access through off-grid and mini-grid solutions by 2025.
[58] Per latest household survey data as of 2014 (World Bank/SEforALL: Global Tracking Framework, 2017).

Figure A2.2. Haiti Electrification Map (black= no access)



Key design features

35. The Component will drive energy access expansion in order to promote economic growth and alleviate poverty. The Component will therefore promote electrification solutions suitable for different market and income segments: (i) village grids[59] for rural towns and larger villages (ii) individual household systems of varied sizes to support electrification of remote households and (iii) larger RE-based systems able to power productive (e.g. agribusiness) and community loads to support provision of essential public services such as water, health and education. While the household system segment is the most dynamic and has the potential to reach the highest number of households (see Table A2.2 above), mini-grid and productive/community use Sub-components have also been prioritized to ensure that the newly acquired electricity access is used to drive economic transformation in rural Haiti.

36. All renewable energy sources -- solar PV, biomass, wind and micro-hydro power, including hybrid RE technologies with battery storage and/or diesel, will be eligible, although per the renewable energy resource assessment and the current trends, solar PV (including hybrid technologies with storage and/or diesel) is expected to be by far the most widely deployed technologies. The recently released Government's Roadmap for Energy Sector also highlights importance of expanding energy access through smart mini-grids and solar PV systems.

37. The project aims at leveraging private sector participation through promoting public-private partnerships. Private sector is understood broadly to include enterprises, cooperatives and

[59] Village grids are understood as micro- or mini-grids, which are defined as decentralized power systems, consisting of a generation source and a grid infrastructure, typically ranging between 10kW and 1MW, serving from a few dozens to tens of thousands of customers.

NGOs.

38. Component 2 is complemented and co-financed by a parallel CTF-funded Modern Energy Services for All Project, which has established the Off-Grid Energy Fund (OGEF) to finance commercially viable off-grid electrification businesses through equity investments and loans. Table A2.6 summarizes how SREP (and IDA co-financing) grants and CTF commercial financing are expected to leverage and complement each other.

Table A2.6. Leveraging CTF, SREP and IDA financing to support off-grid businesses

	SREP + IDA grants	CTF equity and loans
1. Village grids	Grants for distribution grid (will remain in municipal ownership)	Equity and loans to support RE generation investments
2. Productive uses	Innovation grants for potentially financially viable and scalable business models	Replication and scale up of successful business models through OGEF
3. Individual households	Grants to support early stage businesses and introduction of high quality products	Equity and loans for off-grid businesses

Sub-component 2.a: Renewable energy village grids

39. This Sub-component will provide grants for village grids, developed under a public-private partnership arrangement involving the MTPTC Energy Cell, municipalities and private sector village grid operators. The grants will be used to bring down the village grid investment costs so that the resulting tariff is in line with the affordability levels of rural Haitians. The Sub-component is expected to provide electricity access to at least 100,000 people.

40. The grants are expected to cover approximately the costs of distribution network, while private sector will be expected to invest in the generation equipment. The typical village grids are expected to be between 50kWp and 500kWp (serving between 500 and 5,000 households)[60] but the project may finance smaller or larger village grids if economically viable.

41. **Business model**: The Sub-component will build on an already existing model applied in Haiti, in which village grid service providers sign concession/service agreements with the municipalities to build and operate village grids on their territories for over a pre-determined period (the length currently varies case by case but typically exceeds 10 years). This modality is consistent with the Decentralization Law of 2006,[61] and therefore allows village grid companies to operate within the Haitian legal framework. In addition, the partnership with municipalities strengthens the local participation and ownership, supporting longer-term sustainability and social acceptance of the (usually private) village grid operators.

42. Currently, three village grid companies are operating under this framework. EarthSpark and Sigora are private mini-grids, operating with a concession from a municipality, both with

[60] Typical lower range for green-field village grids, and upper end for the existing municipal grids
[61] The law allows municipalities to build and operate municipal diesel grids.

nation-wide scale-up ambitions. Separately, NRECA International has successfully piloted a cooperative model. See Box A2.1 for the description of these three village grids, which are to serve as prototypes for further expansion. All three mini-grids charge cost-reflected tariffs and use smart meters and energy efficiency measures to minimize the costs and maximize the service to their customers.

Box A2.1 Smart micro-grids in Haiti
EarthSpark, a non-profit working as an incubator for clean energy enterprises, is leading an innovative approach to delivering sustainable energy services in off-grid Haiti. They launched an exemplary micro-grid in the town of Les Anglais in 2012 and by 2015 they had expanded 24/7 electricity service to 450 households and businesses—representing the majority of Les Anglais downtown area. The grid is powered by a hybrid generation system including 90 kWp of PV capacity, 400 kWh of battery capacity and a small diesel backup generator. EarthSpark is using the SparkMeter technology as a pre-pay system that has enabled improved access for their micro-grid customers. In addition, EarthSpark is also enabling access by supporting what they call "deep efficiency" – encompassing end-use, grid management, and power generation – establishing high-quality energy services at low generation costs. EarthSpark has ambitious scale-up plans with a commitment to build 80 micro-grids in Haiti by 2020. In addition to the Les Anglais micro-grid, EarthSpark anticipates to have not only it's 2nd grid (in Tiburon) complete but also two more 'starter grids' launched by mid-2017. Just recently, EarthSpark received funding from USAID to build out the 'investable plan' for their next 40 grids in Haiti.
Sigora Haiti serves as a premier provider of pay-as-you-go electricity and is the only private utility in the country. It's also part of parent company Sigora International's broader mission to deploy smart grid technology around the globe to those who are still without access to modern electricity. Sigora is spearheading a micro-utility business model tailored for frontier markets. The startup is designing, installing, owning and operating a system of interconnected microgrids, which are designed to scale quickly and cost-competitively. Sigora has been powering with 24/7 electricity the Northwestern Haitian community of Môle-Saint-Nicolas and neighboring Presqu'île with two 100-kilowatt diesel generators and a small-scale solar project. In early 2017, Sigora Haiti, raised US$2.5 million from the Electrification Financing Initiative (ElectriFI) to expand its existing grid network of 1,000 accounts serving 5,000 people, to a network that will serve tens of thousands. The funding will also go toward the build-out of a 200-kilowatt solar array.
NRECA International has pioneered safe and affordable rural electric service in countries by designing and building distributed power generation-distribution systems, designing and installing renewable energy systems and creating community owned and operated sustainable utilities. In southwestern Haiti, NRECA International helped to establish the Cooperative Electrique de l'Arrondisement des Coteaux (CEAC), an electric cooperative providing member-owners in Coteaux, Port-a-Piment, and Roche-a-Bateau with affordable and reliable power. NRECA International has also partnered with Solar Electric Light Fund (SELF) to design and construct a 140kW solar-diesel hybrid system for the co-op, which serves 53,000 consumers.

43. **Contractual arrangements**: The Sub-component will further develop and regularize this model by creating standard tri-partite agreement among the MTPTC Energy Cell, Municipality and Village Grid Service Providers, which will define the length and terms of the concession,[62] including tariff levels and tariff adjustment processes, connection charges, subsidy levels and disbursement procedures, technical and service quality standards, environmental and social safeguards, reporting requirements, penalties for non-compliance and other key provisions, such

[62] The term "concession" is understood here as a broader term for a service arrangement, which will give a right to the mini-grid operator to operate a village grid for a defined number of years under defined service quality and tariff terms.

as compensation mechanism in case the village grid is absorbed by EDH grid before the end of the concession period and reporting requirements, and what technical assistance will be provided to village grids by the Energy Cell – e.g. support for energy efficiency measures, training of technicians etc.[63] The tri-partite agreements should also include actions to promote gender-sensitive approaches (e.g. provide opportunities for female employment, ensure consultation with female users etc.) and will include provisions for user grievance mechanisms.

44. SREP grants will cover approximately the cost of the distribution network. The grants will be competitively awarded to the private sector, which will build and operate the grid on behalf of the municipality, and transfer it back to the municipality at the end of the concession period. The private sector will be required to invest in the generation equipment, as well commercialization (including smart meters) for which it can access OGEF equity/loan funding if needed. Generation assets will remain in private ownership. Users will pay small connection charges (e.g. US$10-15) and tariff, which will be collected through pre-paid smart meters.

45. In absence of the regulatory entity, the village grids will be regulated by the Energy Cell, with the local support from the municipality, following the provision of the tri-partite agreement. The experience with the tri-partite agreement will be used to build more permanent regulatory structures under Sub-component 2d.

46. **Technology/technical standards:** All renewable energy technologies, including hybrid RE systems with diesel and/or batteries are permissible. Given the current technology trends, population and load patterns, RE resource availability and emerging local business models, it seems likely that the vast majority of village grid will be powered by solar PV energy (with diesel and/or battery back-up). The distribution grid will be built with technical standards that will allow eventual integration with EDH grid after the end of the concession period. Technical and service quality standards will be included in the tri-partite agreements.

47. Two types of village grid PPPs will be pursued – (i) hybridization of the existing municipal grids and (ii) green-field investments. For both PPP modalities, the detailed eligibility criteria, grant award processes, contractual modalities, and monitoring and verification processes will be established in the Project's Operations Manual.

48. **PPP model to hybridize the existing municipal diesel grids**. There are over 30 diesel-powered village grids operated by municipalities under the Decentralization Law of 2006.[64] (or informally). These village grids vary in terms of size and performance, but typically serve loads between 100kW and 1MW. They are supplied by diesel generators, which, however, in most cases are not correctly sized, and as a result are costly to operate. A recent study[65] of 36 municipal diesel mini-grids found that all 36 diesel mini-grids operated for far fewer hours than their nominal operating schedules (which are typically anyway only three to four hours a night for four to five

[63] Such tri-partite agreements are currently being pursued also in other countries for mini-grid development, where regulatory agencies do not exist or do not have capacity or authority to oversee mini-grid operators – e.g. Myanmar and Nigeria. There is, therefore, potential to learn from these countries.

[64] The 2006 Decentralization Law gives rights to municipalities to provide energy services on their territories, which have resulted in municipalities investing in their own diesel mini-grids, and more recently signing concessions with the private sector to build and operate mini/micro-grids.

[65] Schnitzer D., Microgrids and High-Quality Central Grid Alternatives: Challenges and Imperatives: Elucidated by Case Studies and Simulation.

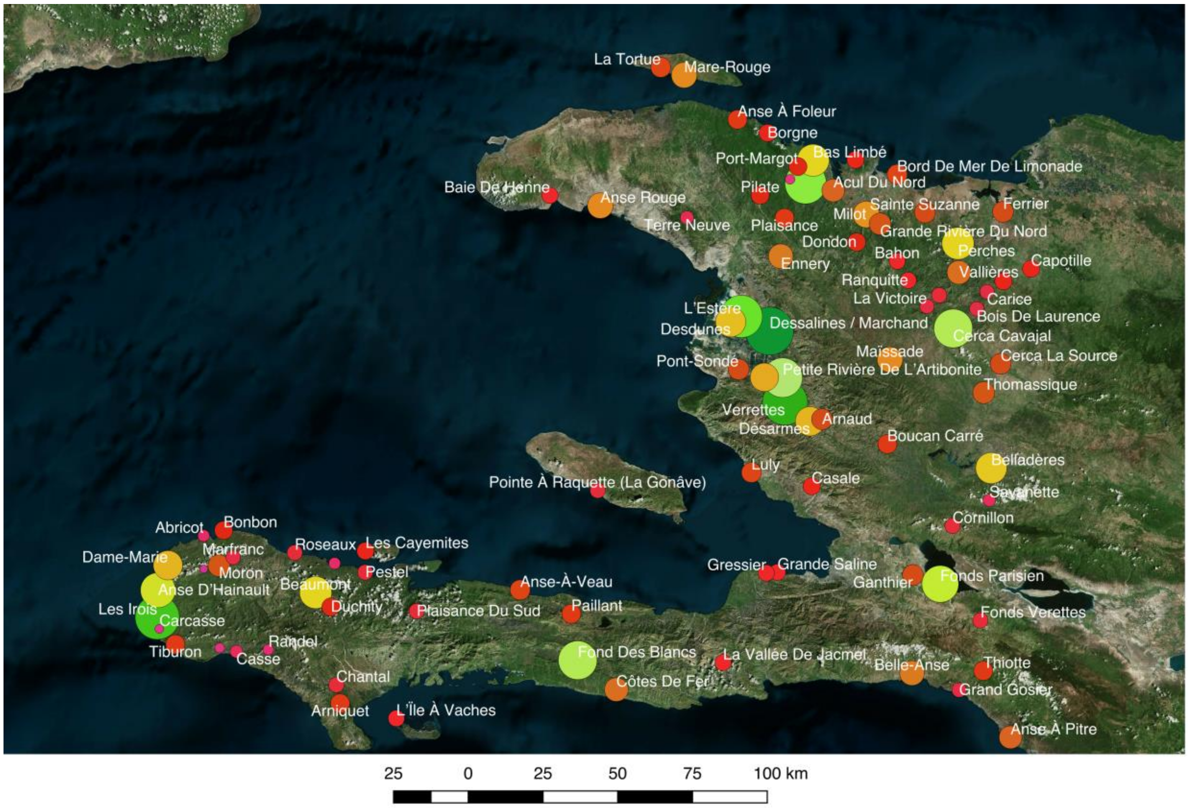
nights per week). Customers are typically not metered but rather charged a flat tariff based on lights used and appliances. The tariff, however, tended to be set below operating costs, preventing them from operating at their scheduled output. In addition, the study found that the municipal grid operators lacked working capital to make up for gaps in untimely customer tariff payments. Many of them, therefore, have already ceased to operate. Most of these grids, however, have relatively complete distribution networks, and could therefore become operational if efficient and sustainable generation supply was available and power was adequately commercialized. The costs of operation could be significantly reduced by solar PV hybridization and introduction of energy efficiency measures, such as replacement of incandescent light bulbs with CFLs or LEDs. The municipal grids are not required to apply the EDH tariffs, and tariffs therefore could be set at cost-recovery levels.[66]

49. Interested municipalities will be invited to participate in the hybridization project. The Energy Cell, with the support of ESMAP, is carrying out a detailed assessment of these municipal grids, which will be followed by feasibility studies carried out under Sub-component 2d. The private sector will be invited to hybridize these mini-grids with renewable energy, fix the distribution network, install meters, improve energy efficiency and operate them under the above-mentioned tri-partite agreement. Energy Cell will competitively award these contracts to the private sector, based on the lowest subsidy required to hybridize, refurbish and operate the municipal diesel village grids. To the extent possible, the sites will be bundled into geographic lots to support economies of scale.

50. **PPP model for green-field RE village grids.** Most of the Haitian rural towns currently have neither EDH, nor municipal grid. The development of these towns is constrained by the lack of access to reliable and affordable electricity. Significant potential therefore exists for scaling up village grids for rural towns and larger villages. A recent USTDA-financed study[67] reconfirms this potential. The study analyzed 80 rural towns for potential minigrid sites, of which 41 towns were prioritized as suitable sites for solar PV/hybrid mini-grids, based on the combination of criteria such as total population, density, productive load/economic development potential, state of infrastructure, accessibility etc. The results are depicted in Figure A2.3 (large green circles identify the best sites). The full list of mini-grid-able communities will be determined as a result of the geospatial least cost electrification planning, which will be carried out under Sub-component 2d.

[66]The same study also concluded that in some cases a tariff increase may not even be necessary if efficiency measures were executed. For example, a detailed study of one of the 36 mini-grid shows that replacing incandescent light bulbs with CFLs and using a smaller diesel generator or a hybrid PV-diesel system halves operating costs relative to the existing system and would allow the grid to double its operating hours while yielding a positive return on investment within the existing tariffs.
[67] Carried out by EarthSpark and Energy and Security Group in 2015.

Figure A2.3. The map of potential mini-grid



51. Given that the private sector is best-suited to evaluate the financial viability of individual sites, the site selection will be left up to the village grid operators. The Sub-component will establish a per-connection grant, which will be partially results-based, disbursed against milestones,[68] including actual customer connections, which will be available to all village grid service providers that (i) comply with pre-determined eligibility criteria, including demonstrated experience to operate village grids, (ii) present a sound business plan, including a credible financing plan for the non-grant investments, and (iii) are in agreement with the municipal governments -- both parties willing to sign the tri-partite agreement with the Energy Cell. This per-connection grant will be awarded to the eligible village grid service providers through periodic calls for proposals. The village grid operators will be allowed to set the differentiated, cost-reflective tariff (including return on capital but excluding the investment costs covered by the grant). Project Operations Manual will include detailed provision for the design and execution of the RBF payments. For both modalities, the connections and the service provision (at adequate quality) will be independently verified before the final tranche of the grant is paid.

Sub-component 2.b: Renewable energy for productive and community uses

52. This Sub-component will support productive and community uses of off-grid renewable

[68] A portion of the grant will be provided upfront to provide village grid operators a sufficient working capital. The rest will be disbursed through milestone, with the last tranche disbursed only after the actual connections are made.

energy in order to support rural economic development in Haiti. Considering the Government's strong emphasis on improving productivity and value added of agriculture enterprises – and the very limited market serving rural productive uses in Haiti – the Sub-component will place specific emphasis on supporting renewable energy solutions for agribusinesses.

53. The Sub-component will be developed jointly with the Bank's Agriculture and Trade and Competitiveness Global Practices (GPs), and Water GP for RE-based irrigation solutions. This collaboration will ensure that energy solutions are considered in context and as an inherent part of the overall value chain analysis (key lesson emerging from other similar engagements worldwide),[69] and that proposed solutions are financially, environmentally and socially sustainable.

54. The Sub-component will establish a challenge grant facility, which will provide innovation grants to energy enterprises or other integrators presenting viable business plans for sustainable provision of renewable energy for agriculture and other rural enterprises (e.g. adaptation of PAYG business models for the enterprise sector) – therefore the challenge grant facility is proposed to provide seed funding for this market segment. The focus will be on piloting and developing economically and financially viable solutions which could then be included in OGEF financing. The challenge grant facility will be managed by the Energy Cell, which will be supported by technical/transaction advisors hired under Sub-component 2d. The Energy Cell will in particular seek to leverage the existing in-country capacity with the administration of innovation grants in Haiti (e.g. PanAmercan Foundation had a successful innovation grant program that the productive use facility can build on).

55. In addition, OGEF Fund Manager, private sector, as well as user sector representatives/experts will also participate in the evaluation of the proposals. The Project's Operations Manual will include detailed eligibility and selection criteria, grant amounts and disbursement procedures, as well as composition of the selection committee. The evaluation criteria will incorporate gender-inclusiveness.

56. Based on the initial analysis of rural productive value chains in Haiti and emerging successful worldwide experiences, the following promising applications have been identified:

a) Electrification of agricultural activities to unlock rural economic development and improve food security in Haiti

57. Agriculture is the source of livelihoods for more than 60 percent of Haitians.[70] It however only counts for 16 percent of the GDP in 2015.[71] Agriculture in Haiti today mostly involves smallholder farms, with a subsistence orientation.

58. Electricity, along with investments in complementary infrastructure and services (e.g., roads, access to market, and access to finance), is a critical ingredient of the agricultural value

[69] Energy, Water, Agriculture Nexus – findings from emerging studies and innovations presented at the Energy and Extractives Week, April 3, 2017.
[70] USAID: https://haitileveproject.org/activity-sectors/
[71] UNSTAT - Agriculture, hunting, forestry, fishing (ISIC A-B)

chain from on-farm activities to post-harvest and processing activities.

Examples of electric agricultural needs in rural development

- Drip-feed / sprinkler irrigation
- Grain milling
- Oil pressing
- Drying (e.g. fruits, vegetables, coffee, tea, meat, fish, spices)
- Smoking (e.g. fish, meat, cheese)
- Food and drink cooling (e.g. milk chilling/ pasteurization)
- Ice-making (fish storage)
- Water heating (e.g. separating nut kernels)
- Sawmilling
- Electric fencing
- Fish farms (e.g. water circulation and purification)
- Lighting (e.g. to enable processing activities at night, to increase night growth in nurseries)

59. By increasing productivity and income, electricity allows a more market-oriented agriculture and enables to reduce food spoilage. Key agricultural activities could therefore benefit from electrification in Haiti:

60. *Solar-water pumping for irrigation:* In 2013, 4 percent of Haiti's total agricultural land was irrigated.[72] However, by allowing farmers to grow more crops a year, access to water improves livelihoods, and increases social welfare (poverty alleviation, emissions reduction). Considering the setting of Haiti's agricultural land and the favorable solar radiation conditions, solar-powered irrigation solutions can provide reliable, cost-effective and environmentally sustainable energy for decentralized irrigation services. The fast evolution of the solar-water pumping sector enables customized solutions that match local needs and adjust to local constraints (e.g. site's topography, aquifer resources).

61. Different successful approaches have been implemented in developing countries (e.g. Bangladesh with the Bangladesh RERED II program, Morocco, Kenya). Private-sector players such as SunCulture offer innovative solutions that provide full solar-powered irrigation kits (incl. access to market, information and training, inputs as fertilizers etc.) to farmers, and that can increase farm yields by up to 300 percent. Pilot initiatives could be launched in Haiti targeting smallholder farmers growing vegetables.

62. *Powering processing local production to secure the domestic* market supply: Supplying power to process local crops enables farmers to save time from manual processing, unreliable diesel milling, manual separation, and manual threshing, and to improve the quality of end products. Haiti imports 60 percent of the food that it consumes, while significant amount of local production is spoiled due to lack of processing.73 The development of processing activities makes particularly sense in regions poorly connected to markets (e.g. Southern Haiti). Some initiatives have been already implemented and could be expanded to other areas. The EKo Pwòp mini-grid in Les Anglais powers for instance processing units that turn breadfruit into chips and flour, extending therefore its shelf life from 3 days to at least 6 months. The development of solar-drying facilities to process fruits (e.g. mangoes, guavas, passion fruits, and pineapples), cassava,74 maize

[72] World Development Indicators
[73] EarthSpark International, 2013
[74] 3rd crop produced in quantity in 2014, after sugar cane and mangoes (FAOSTAT)

or nuts (peanuts, cashew nuts) could allow for a faster drying process and reduce the risk of contamination or aflatoxins, in the case of corn. The rice value chain could also benefit from two energy intensive activities - irrigation and processing (drying, milling), especially in the Artibonite Valley. It is the main food item imported by Haiti, and it is also the most important staple of the population's diet. Producers that are currently in the rice businesses are supporting national food security. Production is however currently taking place at a very small scale (with an average holding of less than one hectare) and with important post-harvest losses. Most rice farmers use diesel or an unreliable grid connection. Affordable and reliable power supply could be scaled up in quantity and quality and become therefore more competitive. *Powering processing cacao and coffee to boost exports in quantity and quality:* More export-oriented crops could also benefit from on-site solar-powered drying. Cocoa and coffee beans are respectively the 3rd and the 4th Haiti's exports in value,[75] and these crops' quality and export volumes could be significantly improved thanks to a drying process eliminating delays and protecting them against rains, re-wetting and other environmental contaminants. Affordable[76] materials are now available on the market and equipment evolve very quickly to match local needs (e.g. mobile dryers, disassembled systems to be store during off season). Successful use of solar-powered dry mill facilities has been seen in Central American countries (e.g. Guatemala, Honduras) where buyers pay a 15 percent premium to producers for coffee beans processed using solar dryers.

63. *Solar-powered storage / cooling for mangoes and avocados:* Smallholder farmers need proper cold storage to preserve the quality or extend the shelf-life of the products, to target export markets, and to increase therefore their revenues.[77] However, in developing countries, 40 percent of food is lost or wasted at the post-harvest and processing stages, mainly due to lack of cold storage.[78]

64. In Haiti, two major cash crops – mangoes and avocados – could benefit from cold storage in l'Artibonite and le Plateau Central. In remote production areas (where no grid power is available), the conventional solution of powering refrigeration with diesel gensets often fails because of significant operating costs and logistical challenges. In this context, off-grid solar-powered cold storage appears as an adequate affordable supply solution which could also avoid GHG emissions. Collection points providing solar-powered cold rooms to groups of farmers could enable costs' mutualization and logistical optimization. Innovative business models have been successfully tested in sub-Saharan Africa (e.g. Uganda, Nigeria) and could be rolled out in Haiti. The new cold chain logistics services offer an opportunity for producers in this sector and others to access promising markets (e.g. fishing, pineapples, and oils).

65. Ice production for fishermen: In Haiti, traditional fish processing methods such as sun drying and smoking are widely used resulting in considerable post-harvest losses. 40 percent of harvested seafood is lost due to insufficient facilities and handling on board fishing boats, mainly due to limited use of ice and refrigeration.[79] As with other foods, fish is imported to meet national demand. The lack of adequate means of storage represents therefore a major handicap in terms of

[75] FAOSTAT, 2013
[76] US$400 for materials
[77] Standard mango is sold to JMB S.A (mango exporter) for US$1.02 to US$1.50 per dozen vs US$1 per dozen for second-class mangoes sold to ORE (Camp Perrin) for dry processing
[78] FAO, 2011
[79] Institute of Research and Application of Development Methods (IRAM), 2007

economic development and food security. Given Haiti's coastline (1,750km) and marine resources, the demand to scale up ice and refrigeration capabilities exists. It would enable fisheries activities to grow from artisanal and medium and large-scale farming and support the activities and incomes of about 50,000 fishermen who operate from 400 fishing communities.[80] *Powering a cleaner and more efficient vetiver distillation process:* Haiti is the world's leading producer of vetiver essential oil, responsible for 80 percent of global production. In value, vetiver essential oil is the second most important export value chain in Haiti, after mangoes.[81] However, medium and large scale distillation processes currently rely on imported, polluting and expansive fossil fuels (mainly charcoal). Given the quantity of vetiver waste, there is an untapped potential of encouraging waste-to-energy process for on-site energy needs. Beyond improving operational efficiency and reducing operating costs, it would also drastically reduce greenhouse gas emissions.

b) Electrification of small-scale industrial activities and businesses to boost economic growth and employment

66. Powering hotels and other tourism establishment. Haiti is developing its tourism sector. Most of the tourism sites are outside of the capital, without access to electricity or with access to a very unreliable electricity from one of EDH's small grids. The hotels therefore rely on expensive diesel generators. There is an opportunity to displace or hybridize diesel generators with renewable energy, reducing costs, improving service and hotel attractiveness for their guests, and reducing local and global pollutants.

67. *Powering sewing workshops:* In 2013, the apparel sector employed 29,000 workers, accounted for nearly one-tenth of GDP,[82] and produced 90 percent of exports. Although the sector is dominated by mass industrial value chain oriented to exports, it also relies on several small-scale sewing workshops. These workshops currently have intermittent access to electricity and usually use diesel generators for the machines that require stable power supply. More reliable power would enable them to scale up their activities and to increase their production and income. Electricity could also improve the working conditions in the workshops by powering A/C units.

68. *Powering small-scale commercial businesses*: Electrification is an important enabler for the development of small businesses and for generating economic growth locally; going however hand in hand with other key factors such as access to markets, finance and roads83. Business use of electricity can be:

- Oven cooking for bakeries
- Cooking and water heating for small restaurants and food kiosks
- Beer brewing
- Refrigeration, freezing and lighting for convenience stores
- Use of computers and printers in cyber cafes
- Use of electrical cosmetic appliances for barbers
- Use of grinders, compressors and welding for vehicle repair
- Use of power looms and sewing machines for clothing and outlets

[80] Institute of Research and Application of Development Methods (IRAM), 2007
[81] FAOSTAT, 2013: US$12.7 million from vetiver essential oil exports, US$13.5 million from mangoes exports
[82] CFI Haiti
[83] https://www.usaid.gov/news-information/frontlines/march-april-2017/making-better-living-one-solar-sale-time

- Drilling, cutting, welding and use of lathes and mills for metal workshops

c) Community uses

69. In addition, through technical assistance, the Sub-component will leverage synergies with other World Bank operations in Haiti which finance off-grid electrification solutions for schools, health posts and water community pumps. The SREP and IDA financing will be used for providing TA and piloting of approaches aimed at ensuring quality of installations and sustainable operation and maintenance. Example of an innovative school electrification program, combining solar PV and information and communication technologies (ICT) investments, piloted by IDA PRELEN, is described in Box A2.2.

Box A2.2. Off-grid Electrification for Community Uses

The IDA-financed Rebuilding Energy Infrastructure and Access Project (PRELEN) (2012) will expand an innovative pilot for using off-grid renewable energy for improving education outcomes, currently carried out by an NGO Haiti Futur. The World Bank team visited a school in the Southern Province of rural Haiti in November 2014. The school is equipped with a Smart Board, solar panels and a battery bank funded by the NGO Haiti Futur. The Smart Board is an interactive white board that functions as a computer screen providing digital contents to pupils in rural schools. The digital contents are in French, soon to be translated into Creole, and are aligned with the requirements of the Ministry of Education.

All courses are available online, free of charge (open source). The cost of one system is estimated at US$3,000. The challenge for the smooth operation of the Smart Board connected to a projector is reliable electricity. Most of the schools (85percent) in Haiti are private and typically do not have electricity. Therefore, electricity from solar energy will be essential to the success of the scale-up. Haiti Futur has trained technicians to maintain the systems and has set-up a contents team in Port-au-Prince. The contract for O&M is with the Ministry of Education.

Interviews with teachers where the systems have been installed during the pilot phase point to two main benefits: increased interest in learning by the children; and greater confidence among teachers as a result of better access to education materials, which in effect leads to a greater variety of subjects covered.

Based on positive experiences from Haiti Futur, PRELEN is scaling this model in up to 500 schools.

Sub-component 2.c: Household systems

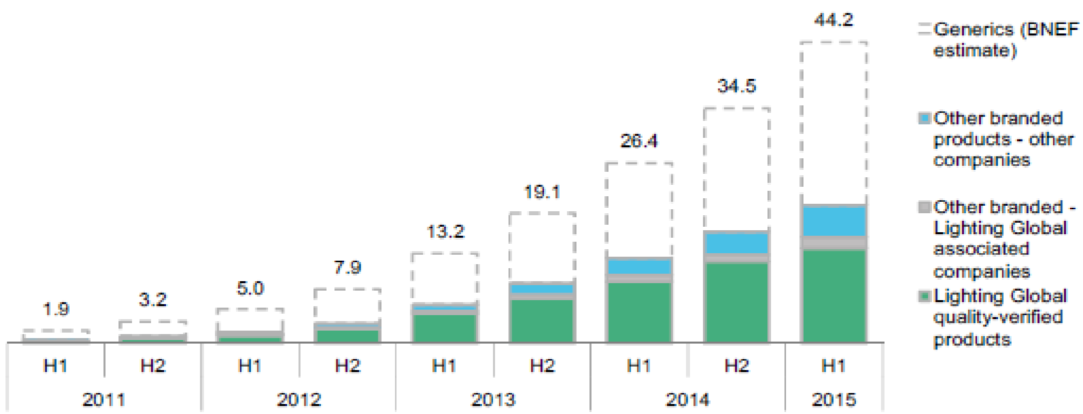
70. The majority of unelectrified households in Haiti are relatively dispersed or live in small settlements where village grid solutions are not economically viable. For these households, individual systems, such as solar home systems or smaller pico-PV systems are the least-cost electrification option. It is estimated that over 5 million people in Haiti could be reached through such solutions. The Sub-component, through the joint SREP and CTF co-financing under OGEF), aims at providing electricity access to 700,000 Haitians.

71. Globally, solar lantern and solar home system market is the most dynamic off-grid electrification segment. The Global Off-Grid Lighting Association (GOGLA) estimates that over 93 million people today live in households served by at least one “branded” off-grid lighting

product[84] -- a solar lantern or a solar home system.

Figure A2.4. Estimated cumulative sales of pico-solar lighting products in Sub-Saharan Africa and Asia (millions of unit)

BNEF, Lighting Global, GOGLA: Off-grid Solar Markets Trends Report, 2016



Source: Bloomberg New Energy Finance, Lighting Global, GOGLA. Note: These figures comprise branded and generic solar lanterns and small solar home systems of 10W or less.

72. The pace of progress is remarkable, as indicated in Figure A2.4. 10 years ago, the global sales of off-grid solar products were counted in thousands. In FY16 alone, 8.4 million branded products were sold globally, with an increasing share of larger/higher value products.[85] Every year, the industry gr ows more diverse in terms of number and type of products, companies and business models. In 2008, there were only eight products that passed Lighting Africa (now Lighting Global) quality standards. Today, Lighting Global features, over 100 products from more than 40 manufacturers. The products come in different sizes, designs and functionalities, and are increasingly bundled with DC-powered energy efficient appliances, including cell phone chargers and USB drives, radios, TVs, fans, and most recently refrigerators.

73. This fast market growth is driven by several policy and technology trends. On the policy side, the increased focus on energy access as an important development goal has led to an improving enabling environment (e.g. some governments have waived custom duties and VAT on solar products), and many development partners and impact investors have started channeling funds into this nascent sector. Much of the expansion, however, is due to favorable cost and innovation trends, especially the emergence of LEDs and super-efficient appliances, such as TVs and fans, and reductions in costs of components, such as solar PV panels and batteries. In turn, the telecommunications advances which have enabled the remote control of solar home systems (ability to switch the power on and off remotely) and the spread of mobile money applications, gave rise to the new "pay-as-you-go" business models described in Box A2.3, which are now rapidly expanding across the globe, having overcome the key consumer affordability barrier.

---

[84] Counting only "branded" products sold by GOGLA members, which are also in majority Lighting Global certified

[85] BNEF: Off-grid and mini-grid market outlook, Q1 2017

Box A2.3. Pay As You Go (PAYG) / Distributed Energy Service Company (DESCO) model

The PAYG business model (also referred to as DESCO model) has successfully developed in East Africa in the last five years and is now expanding to other geographies.

There are many variations of the PAYG models, but the basic principle is the same. PAYG companies install rooftop solar PV systems in households or small businesses. Using mobile communications and locking mechanisms (such as meters with GSM chips) to remotely control the energy assets, PAYG companies can accept small payments every day, week or month from customers who can pay with mobile money.

There are two basic variations of the PAYG model: (1) The 'lease finance' variation where customers lease the systems until they repay their value, when the ownership passes to them or (2) the "services", 'utility', 'pay-per-use', 'pure lease' variation, where a customer pays either for the time it uses the assets or based upon the energy services (light, phone charging, radio, TV etc.) utilized. In either variation, the PAYG companies monetize the energy assets provided to the customer's use over time.

This model allows off-grid energy companies to service thousands of customers – or hundreds of thousands of customers – profitably, once reaching a certain scale. It also makes solar off-grid products more affordable – it enables customers to receive more energy services (lights, mobile phone charging, TVs, fans, radios) than they could afford on a cash retail purchase basis. The approach also supports confidence-building – customers do not need to commit themselves to significant purchase amounts until they are satisfied that the systems work properly and meets their needs.

PAYG companies in East Africa are reported to serve more than a million households now. In Kenya – the birthplace of this business model – products sold on a PAYG basis now account for over a quarter of quality-verified products – some 700,000 solar home systems are estimated to have been sold through PAYG platforms.

74. Haiti is beginning to catch up with these trends. The relatively high penetration of solar lanterns in Haiti (about 15 percent) shows that Haitians are appreciating these new technologies. Most of the lanterns on the market, however, are not quality certified and do not provide sustainable access. More recently, several companies have started to experiment with PAYG solutions. Three Haitian companies are currently in the process of launching, piloting or scaling up PAYG business models. Re-volt is most advanced, having already piloted its products (developed in partnership with D-Light – major global pico-PV manufacturer), and is now scaling up this business model across Haiti, installing about 2,000 systems a month (see Box A2.4).

Box A2.4. Re-Volt - service approach with individual PV systems

Re-Volt, an innovative start-up "off-grid utility", aims at providing a highly efficient Direct Current (DC), pay-as-you-go, solar-powered, energy service to Haiti's residents at affordable prices. Re-volt was conceived in 2012 and the first two years were spent refining the concept and visiting successful international programs of similar intent (OMC in India, Off-Grid Electric, M-Kopa, M-Power, and d.Light Design in East Africa). In 2014, Re-volt began piloting the program in Haiti and after seeing great success during the pilot phase have since entered into a commercial roll out plan. To-date, Re-Volt has sold over 5,000 products. In 2016, 2,600 units were sold and 2017 projections are to sell 3,000.

Re-Volt has a Memorandum of Understanding signed with Digicel, the main telecommunications provider in Haiti, to integrate with their TchoTcho mobile payments system and use their Machine-to-Machine (M2M) SIM cards in the Re-Volt Systems to allow monitoring of the performance of the units and to track the amount of energy credit purchased and used.

Re-Volt differentiates itself from common Solar Home System businesses by providing a service rather than a "box" – Re-Volt customers are guaranteed 98 percent availability of their systems, have access to a 24/7 call center, will benefit from promotions and upgrades, and will get access to highly efficient DC powered appliances and devices. Currently, Re-Volt offers a 2-year lease of the systems, after which the system is repaid and passed on to the customer's ownership.

The initial Re-Volt product is a solar powered "DC Energy System" that features 3 LED light fixtures and a charging plug for mobile phones and other small device. As a result of demand, Re-Volt has plans to release a larger system with capacities to power a T.V. in 2017. Post-installation customers will receive a lifetime "utility like" service from the DC Energy Systems. Partnership with Digicel provides an opportunity to offer integrated electricity and telecom services.

How it works: Customer sign up to the service at one of many "Re-Volt Power Agent locations" or are approached on a door-to-door basis by Re-Volt Agents. Re-Volt will charge a small deposit or "connection fee" which includes the installation of the System and basic training on how to use it efficiently. Currently this cost is set at US$10.

Once the system is installed at the home of the customer, they are able to "top up" the credit on their system in a similar fashion to buying pre-paid credit on a mobile phone.

Re-Volt as a company expects to grow significantly in the next 5 years. Based on their initial estimates, the company sees potential for up to 150,000 units to be installed during the first 5 years of operation in Haiti. By year 5, Re-Volt expects production costs to decrease and revenue per user per month to increase as additional services are launched on the solution, such as Internet/communications, entertainment, refrigeration, and a range of other DC appliances.

75. Two more Haitian off-grid energy companies (Ekotek and Digital Kap) are now also introducing a PAYG product to the market. However, Haiti's relative isolation from the main markets in Africa and South Asia, as well as a number of domestic barriers (high import duties and VAT, high level of spoilage by low quality products, difficulty to access financing etc.) slow down the market development. The Sub-component 2c aims at unlocking the enormous market potential for distributed energy service companies (DESCOs) to provide solar home system and pico-PV solutions to households and microenterprises, using new technologies and business models, such as PAYG.

76. To do so, in line with emerging best practices from the more advanced off-grid energy markets in East Africa and South Asia, the Sub-component will blend CTF-funded OGEF equity/debt funding with limited, well-targeted grants provided by SREP, to launch and support early growth of DESCOs. Three types of grants will be eligible:

- Start-up grants, available to companies which demonstrate scalable and sustainable business models, which are new to the Haiti market. These grants will provide much needed seed capital to test business models and start operations in Haiti.
- Grants for early stage growth of off-grid businesses. The grants will be partially results-based, disbursed based on pre-determined milestones, and will be applied in conjunction with the OGEF equity investments in early stage off-grid businesses.
- RBF for Lighting Global quality verified solar products to support penetration of higher quality products in the Haitian market and building customer confidence in these products. These grants will be provided against verified sales/installations of quality-certified products/systems.

77. Due to the close linkages between SREP grants and OGEF equity/debt funding (See Box A2.5), this component will be implemented directly by OGEF Fund Manager, with a close oversight of the Energy Cell through the OGEF Advisory Committee. Sub-component 2.c will expand the volume of OGEF Fund from $14.5 to $17.5 million, allowing greater proportion of grant financing than available under CTF-funding alone. The CTF-funded Modern Energy for All projects foresaw provision of limited grant funding, but given that CTF is extended as a loan to GOH, the focus has been on supporting investments that will create return allowing GOH to repay the loan to the World Bank. The grants were therefore kept to a minimum ($1 million). However, based on the analyzed trajectory path of the off-grid companies in other countries, it is estimated that $3-4 million of grant funding will be needed to support the launching and early growth of off-grid businesses, and to shift the market towards higher quality products. US$3 million are therefore added to OGEF for grant financing, allowing CTF to focus on equity investments and lending.

78. Detailed description, thresholds, eligibility and selection criteria are included in the OGEF Operating Guidelines, which will be annexed to the SREP Project Operations Manual.

Box A2.5. Off-Grid Energy Fund (OGEF)

OGEF is designed to provide flexible financing in the form of equity, loans[86], and limited grant financing[87] modalities, to meet the investment needs of off-grid energy enterprises serving different consumer segments in the off-grid electricity market. OGEF will be structured as a technology-neutral investment vehicle, supporting off-grid businesses offering a variety of off-grid systems.

- Equity and grant financing for DESCOs[88] . This business line will be used for financing equity, startup, and results-based grants for DESCOs. Small start-up grants will be available for launching new DESCOs. Results-based grants, linked to the equity investments, will aim at providing incentives for early stage results, leading to the growth of these companies.
- Medium-term loans for DESCOs. Business expansion will require debt financing to allow companies to grow. The loans will be granted on commercial terms to start building a proof of viability for local commercial banks expected to enter in this market post-CTF project.
- Working capital and results-based grants for premium quality solar lanterns. Local distributors will receive access to short-term working capital, which would allow them to (i) import quality products at scale, and (ii) provide better financing terms to retailers and/or final users. In addition, this business line will provide time-based limited “pump priming”-type support in terms of results-based financing for premium quality (e.g., Lighting Global certified) pico-PV products to increase the share of high quality products on the market.[89]

OGEF is managed by OGEF Fund Manager, composed of a partnership between the Fonds de Developpement Industriel (FDI) and a competitively selected international fund manager.

Sub-component 2.d: Capacity building and Technical Assistance

79. RE scale-up therefore requires comprehensive and systematic efforts to eliminate these

[86] Financed by CTF
[87] Financed by SREP
[88] DESCOs here include both PAYG companies and mini-grid companies.
[89] Pico-PV products are generally understood as small solar PV products, such as solar lanterns and small solar kits up to 10-20Wp capacity.

barriers nationally for all types of RE investments. For that reason, the SREP Project would include a specific component for these crosscutting issues, focusing both on immediate TA activities needed to carry out the SREP Component 2 and broader capacity building to support renewable energy and off-grid access scale-up in Haiti. The key TA activities include:

- Support to developing a Sustainable Energy Access Strategy and Master Plan, including a comprehensive geospatial least-cost electrification planning tool

- Support to developing enabling regulatory framework for independent village grids, including the tripartite contracts

- Reach out and technical support for municipalities to manage/concession municipal grids

- Feasibility studies and technical/transaction advisors for mini-grid and productive use grant awards.

- Quality assurance (QA) framework for individual PV systems – e.g. adoption and enforcement of Lighting Global standards, and development/adoption of a QA framework for larger systems

- Fiscal incentives for off-grid renewables

- Market intelligence gathering and dissemination

- Consumer awareness – development and implementation of gender-sensitive consumer awareness campaigns

- Gender mainstreaming – ensuring that project activities are gender-informed

- Verification, monitoring and evaluation (including face-to-face and phone surveys), and environmental and social safeguards monitoring

The longer-term capacity-building program will be gender-balanced and will focus on the following areas:

- Professional education about RE (partnering with universities), e.g. improving curricula and supporting on-the-job training of RE professionals; facilitate dialogue and collaboration between RE private sector and universities;

- Training on renewable energy of Government officials, EDH, FDI and other key stakeholders;

- Vocational training, expanding upon existing programs already in place – the premise is to unite dispersed efforts and develop a comprehensive vocational training program for solar technicians with updated curricula, in collaboration with other development partners, private and non-governmental entities already active in this space (e.g.

French Government, Schneider Electric Foundation, SELF and local universities). This will also include supporting gender mainstreaming, including provision of technical assistance and training for integrating women in supply chains.;

- TA and training for off-grid energy businesses, including for environmental and social safeguards aspects; and

- South-South exchanges.

HAITI: Renewable Energy for All

ANNEX 3. IMPLEMENTATION ARRANGEMENTS

A. PROJECT INSTITUTIONAL AND IMPLEMENTATION ARRANGEMENTS

1. The project will have two implementing agencies: (i) MTPTC Energy Cell, and (ii) OGEF Fund Manager.

2. **MTPTC, through its Energy Cell,** will be in charge of implementing both Project components (Component 1 and Component 2), with the exception of Sub-component 2c (Household systems). Energy Cell will also be in charge of the overall project coordination and oversight, as well as monitoring and evaluation.

3. MTPTC created the Energy Cell in 2012, to support energy sector development. Originally comprised of one coordinator and two technical staff, the Energy Cell is now composed of 7 additional technical professionals, including a renewable energy expert/coordinator for SREP and CTF programs and other competent specialists in renewable energy, energy access and regulatory issues.

4. The Energy Cell will also use services of the Project Implementation Unit (PIU), which has been implementing also World Bank IDA PRELEN project. The PIU in particular will be in charge of procurement and financial management, but will also provide expertise for managing the environmental and social aspects of the project.

5. While the Energy Cell and PIU is sufficiently staff to initiate the implementation of the Project, it will require additional strengthening to be able to effectively implement both SREP components at the same time (see section C below).

6. **OGEF Fund Manager** will be in charge of implementing Sub-component 2c (Household Systems), given that this Sub-component is closely interrelated with the equity and debt financing provided by OGEF under the parallel CTF-funded Modern Energy Services for All Project (scheduled for the World Bank Board approval on July 13, 2017). OGEF Fund Manager will also provide advisory services to the Energy Cell for the implementation of other Component 2 activities, particularly for the review of business plans and award of grants for mini-grids and productive uses.

7. OGEF Fund Manager is composed of a partnership between the Fonds de Développement Industriel (FDI), and an international fund manager with global off-grid energy investment experience, to be competitively selected by MTPTC Energy Cell, FDI and MEF.[90] FDI is a local, Government-owned financial intermediary, with an autonomous status.

8. Other key stakeholders involved in Project implementation are EDH and MEF, in particular its PPP unit. EDH will be closely involved in the design and implementation of Component 1. MEF PPP unit will advise Energy Cell on transactions involving private sector participation and

[90] The selection process will start once the Modern Energy Services for All Project is approved by the World Bank Board.

PPP arrangements for both Component 1 and 2.

9. Energy Cell will set up a coordination committee involving MTPTC Energy Cell, MEF, OGEF Fund Manager and EDH (and other stakeholders as needed) to support implementation of the project.

B. SPECIFIC RESPONSIBILITIES

Component 1

10. For Component 1, MTPTC, through its Energy Cell, and using services of the PIU, will be the sole implementing agency. MTPTC (using the services of the PIU) will be the procuring entity for the EPC contract, working closely with EDH, which will participate in the selection and supervision of the contractor. The O&M contract will be signed between EDH, contractor and MTPTC.

11. EDH will give an administrative autonomy to the grid which the demonstration project will feed energy to, and it will establish an escrow account, to which it will mandatorily contribute from collected revenues every month a specific amount for O&M (as an automatic transfer). This mandatory contribution will be Project's legal covenant.

12. In the case that in Phase II, private participation in investment is found feasible, the project will be restructured to allow a part of Component 1 funds to be used as a guarantee. The restructuring paper would describe the design of the guarantee instrument and the new implementation arrangement. .

13. The technical assistance activities (Sub-component 2b) will be also implemented by the Energy Cell, but will be closely coordinated with EDH and MEF to build a broad-based support for the proposed policy and regulatory measures.

Component 2

14. MTPTC through the Energy Cell and using the services of the PIU will be the implementing agency for Sub-components 2a (Village Grids), 2b (Productive uses), and 2d (Technical Assistance and Capacity Building).

15. For **Sub-component 2a**, Energy Cell will be in charge of promoting village grids in Haiti. For the existing municipal grids, this will include carrying out a comprehensive assessment of the existing grids, engaging with the municipal authorities to seek their interest to enter to tri-partite agreements, promoting the municipal PPP scheme with potentially interested village grid operators, designing the tri-partite agreements, carrying out a competitive process to select village grid operators and award grants, sign tripartite agreements, assist village grid operators with community engagement, consumer awareness, gender sensitive approaches and promotion of productive uses and energy efficient measures, as well as supervising and monitoring village grid performance and compliance with the provisions of the tri-partite agreements, including safeguards provisions.

16. For greenfield village grids, Energy Cell will carry out a market assessment and

identification of potential mini-grid sites (through the geospatial plan) and provide this information to the interested village grid operators, it will design the RBF grant and publicize it among the village grid operators, issue a call for proposals, evaluate the received proposals/business plans, award grants, sign tri-partite agreements, assist village grid operators with community engagement and consumer awareness and supervising and monitoring village grid performance and compliance with the provisions of the tri-partite agreements, including safeguards provisions.

17. For both the hybridization of the municipal grids and the green-field village grids, an evaluation committee will be set up, including apart from Energy Cell other experts, including OGEF Fund Manager.

18. For **Sub-component 2b**, Energy Cell will carry out a comprehensive assessment of productive use needs and business opportunities, design the challenge grant, call for proposals, evaluate proposals and business plans, award grants, monitor compliance, including for safeguards. The evaluation committee should include experts from productive use sectors (e.g. agriculture, tourism etc.), as well as OGEF Fund Manager, who is expected to finance scaling up of those business models that prove to be successful. In-country experience with similar challenge grants will be leveraged (e.g. PanAmerican Foundation has run a successful challenge grant program in Haiti).

19. Energy Cell will also be in charge of implementing the technical assistance and capacity building activities under Sub-component 2d. The TA activities should be discussed with key stakeholders, including OGEF and private sector to make sure that they are contributing to the desired energy access scale-up. The training/capacity building activities should be implemented in close coordination with other partners involved in trainings (Universities, Schneider Foundation and the French Ministry of Education, which are developing a training of trainers program, NGOs such as SELF carrying out vocational training etc.) The project will first carry out the need assessment to determine which are still the main training areas not covered by others and will channel resources into those areas.

20. **Sub-component 2c** will be implemented by the OGEF Fund Manager.

21. OGEF will be established by FDI as a separate financing window, with its own financing, management, and governance structure. It will be initially financed with CTF and SREP funds, but it will allow entry of future financiers. OGEF will be set up for 10 years, but CTF and SREP funds would need to disbursed within the first six years – before the Projects' closing dates. MEF will sign a Subsidiary Agreement with FDI to pass on the SREP funds (can be the same Subsidiary Agreement signed for CTF funds). OGEF operations will be overseen by the Advisory Committee, which is expected to comprise MEF, MTPTC, and three independent parties -- representatives of renewable energy sector, the financial sector, and the Global Off-Grid Lighting Association (GOGLA).

22. FDI and MTPTC will enter into an agreement with an International Fund Manager for the management of OGEF (OGEF Partnership Agreement), which will specify the roles of FDI and the International Fund Manager in the management of OGEF. FDI, with an investment track record in local start-up/SMEs, will provide knowledge of local financial and SME landscape. The International Fund Manager, with a proven track record in investing in off-grid businesses in

Africa, South Asia or other major off-grid electricity markets, will provide expertise in financing off-grid energy businesses. It is expected that FDI and IFM will jointly evaluate investments. IFM will also be tasked to build FDI capacity so that FDI could continue administering OGEF without the international fund manager.[91] Detailed arrangements will be included in OGEF Operating Guidelines, which will form a part of Project's Operational Manual.

23. The Operations Manual will clearly specify the implementation arrangements, including division of roles and reporting and communication channels among the Energy Cell, PIU, and FDI, as well as coordination mechanisms which other key partners, including EDH and MEF.

C. CAPACITY

24. **MTPTC Energy Cell.** The MTPTC is already an implementing agency for the IDA PRELEN project. The key MTPTC implementing units under IDA PRELEN project are Energy Cell and the PIU and both will be used for the implementation of the SREP-funded project. The Operational Manual will provide detailed roles for each and will streamline reporting and communications processes to minimize delays in procurement, which at times has been a challenge for IDA PRELEN.

25. Energy Cell and PIU are staffed with competent professionals, but as their responsibilities under SREP and CTF increase, they will need to be strengthened with additional staff and/or consultants to support their increased duties,

26. Acknowledging importance of the CTF/SREP renewable energy programs, MTPTC has appointed a dedicated SREP/CTF Program Coordinator and additional four technical staff. The new Government has expressed commitment to further strengthen the Energy Cell. The new Government's recently published National Roadmap, establishing the development priorities of the new administration, includes specific action items for strengthening the Energy Cell, including creating a specific unit for Renewable Energy and Energy Efficiency and provide it with adequate staff resources.

27. For the purposes of the SREP project, the Energy Cell will also be reinforced with a social expert (in addition to providing additional training to the environmental expert already engaged by the Energy Cell), and the current PIU of PRELEN project (currently serving both MTPTC and EDH) will also be integrated into the Energy Cell to streamline the communication and accelerate procurement processes.

28. The project will benefit from the extensive past safeguards experience of MTPTC's PIU. which managed safeguards of complex energy infrastructure investments in Haiti for the last ten years, both Government and donors financed (including World Bank's Rebuilding Energy Infrastructure and Access Project, and IDB's Peligre hydro project rehabilitation. On environmental and social safeguards, the Ministry is relying on transversal services, also solicited for public works and transport projects, and the power utility has a dedicated team to manage environmental issues for its projects and operation. The scope of environmental and social safeguards successfully overseen by PIU in the past also covered renewable energy projects, e.g.

[91] FDI may open a successor fund with or without IFM after the end of OGEF's investment period at year 6. (OGEF, however will remain open till year 11 under the partnership agreement between FDI and IFM

rooftop solar plant (100kW, in urban areas), large power storage, decentralized power storage, mini-hydro and large hydro projects. Moving forward, the Energy Cell will also be strengthened in the environmental and social safeguards aspects. The energy cell's environmental expert will receive further training, and a social expert will be hired. The social specialist will be trained on social screening and monitoring of sub-projects and on the design/ implementation of the project level Grievance Redress Mechanism as needed.

29. **OGEF Fund Manager:** The FDI is a specialized institution of the Central Bank of Haiti (BRH) created in 1981 with funding from the World Bank and the EU. The General Manager of the FDI is appointed by the BRH. Its financial and operational independence is sufficient to ensure an enhanced internal control environment. FDI currently manages approximately US$70 million in assets (double of US$35 million managed in 2010), and it has a good knowledge of the financial sector, local SME landscape and the overall business environment in Haiti. It is also managing a venture capital program, providing equity to SMEs, in addition to its lending and guarantee portfolio. It has in place a satisfactory internal control environment. FDI's institutional capacity is thus assessed as sufficient to play a role of the local FI partner in the management of OGEF. Its technical implementation capacity will be strengthened through entering into a partnership agreement with the International Fund Manager with a specific expertise in investing in off-grid businesses, a skill that FDI currently lacks.

30. Th**e** International Fund Manager (IFM) will be competitively procured. The minimum capability criteria include:

- The IFM should be capable of equity investment management.
- The IFM should have experience with early stage companies, start-ups and/or backing entrepreneurs.
- The IFM should have experience investing in and developing DESCOs in markets where DESCOs are already growing.
- The IFM jointly with FDI should have capacity to manage World Bank funds, as established through the FM assessment.

D. READINESS OF PROJECT TEAM

31. The MTPTC Energy Cell and PIU have the key staff necessary to start implementation. FDI has also staff available to be assigned to OGEF. The International Fund Manager will be competitively procured. In the recent years, several funds have been set up (or existing funds have expanded to) to invest in the emerging off-grid business market, in particular in the East African and South Asian markets. Some of these fund managers have already expressed a tentative interest in OGEF.

32. Adoption of the Project Operations Manual will be a condition of effectiveness for the Project. Execution of the Subsidiary Agreement between MEF and FDI, adoption of OGEF Operating Guidelines and signing of the Partnership Agreement between FDI and the International Fund Manager will be conditions of disbursement for Sub-component 2c.

E. FINANCIAL MANAGEMENT, DISBURSEMENTS AND PROCUREMENT

Financial Management (FM) *(to be updated by appraisal)*

33. *FM Assessment*: In line with the strategy of the Bank and other main development partners, the financial responsibilities of the project will utilize existing capacity as much as possible. As indicated, the fiduciary and technical aspects of the project will be managed by the Energy Cell within MTPTC. The World Bank has completed the FM assessment and proposed FM arrangements for the project to ensure they meet the minimum fiduciary requirements under OP/BP10.00.

34. *Staffing*: In the Energy Cell, staff capacity and structure are adequate for project FM purposes. However, the prospective increase in transactions may call for additional staff assistance, once the project becomes effective, which would be financed by the project.

35. *Budgeting Process*: The budget process will be clearly stipulated in the administrative, financial and accounting procedures manuals. Annual budgets and work plans will be coordinated and prepared by the Energy Cell within MTPTC, and with the help of the different actors of the project. It will be submitted to the Bank for its no objection at the beginning of the fiscal year. Any changes in the budget and work plans will also be submitted to the Bank on a no objection basis.

36. *Accounting Policies and Procedures*: The project will use Cash Basis Accounting for preparation of the project's semi-annual interim financial statements and audited annual financial statements, in accordance with the International Public Accounting Standards (IPSAS) and the national Accounting Standards. A financial management section will be prepared as part of the project's Operations Manual (OM) and will include appropriate accounting policies and financial reporting procedures.

37. *Accounting System*. The PIU established for PRELEN has a computerized accounting software (ACCPAC), which is already in use for the PRELEN project (P127203). An additional project code and chart of accounts should be easy to set-up in the system. The system meets the Bank's financial management requirements for project expenditures tracking and reporting. However, some technical adjustments are needed to update the system. The PIU was working in contracting a vendor to make those adjustments.

38. *Internal Controls and Internal audit*: The Energy Cell will maintain its strong system of internal controls and procedures that will be documented in the OM.

39. *Financial Reporting arrangements*: IFRs are regularly prepared and transmitted to the World Bank for the PRELEN project. Under the proposed project, the Energy Cell will prepare and transmit semi-annual IFRs to the World Bank. The IFRs will be submitted to the Bank no later than forty-five (45) days after the end of the semester. The format and content of the IFRs will be agreed by negotiations and reflected in the OM.

40. *Auditing Arrangements*: As for PRELEN, whose financial statements have been regularly audited, the proposed project will follow the same auditing requirements:

- Annual audited financial statements of the Project will be transmitted to the World Bank not later than six (6) months after the end of each recipient's fiscal year.
- The external audit will be undertaken by a private firm selected in accordance with independence and competency criteria acceptable to IDA.

41. *Fund Manager*: As mentioned, an International Fund Manager will be competitively hired to assist FDI to manage Component 2 and Sub-component 3b. The IFM capacity will therefore be evaluated jointly for FDI and the International Fund Manager. The capacity of the International Fund Manager will be included as a selection criteria during the hiring process and evaluated once the International Fund Manager is selected.

42. *Implementation Support*: As part of project implementation support, based on a risk-based approach, FM supervisions will be conducted approximately every six months. These will pay particular attention to: (i) project accounting and internal control systems; (ii) budgeting and financial planning arrangements; (iii) review of IFRs; (iv) review of audit reports, including financial statements, and remedial actions recommended in the auditor's Management Letter; and (v) disbursement management and financial flows. FM supervision will pay particular attention to any incidences of corrupt practices involving project resources for project implementation.

43. *Disbursement Arrangements and Flow of Funds*. The primary disbursement methods will be Advances and Direct Payments. Reimbursements and Special Commitments will also be made available. To facilitate timely disbursements for the project's eligible expenditures under Component 1 and Sub-components 2a,b and d (managed by MTPTC), the Recipient, through the PIU will open and operate a segregated Designated Account (DA) in US$ at the Central Bank (*Banque de la République d'Haïti*/BRH). Subsequently, another account (the operating account) denominated in Haitian Gourdes (HTG) will be opened at BRH and will also be managed by the PIU to process payments to vendors in local currency. The Energy Cell will be responsible for the appropriate accounting of the funds deposited into the designated account, for reporting on the use of these funds and for ensuring that they are included in the audits of the financial statements. Ceiling of the DAs and the Minimum Application size for Direct Payment or Special Commitment will be determined in the Disbursement Letter.

44. To facilitate timely disbursements for the project's eligible expenditures under Sub-component 2c (managed by FDI/International Fund Manager), the Recipient, will open and operate a segregated Designated Account (DA) in US$ at the Central Bank (*Banque de la République d'Haïti* /BRH). Subsequently, another account (the operating account) denominated in Haitian Gourdes (HTG) could be opened at BRH to process payments to vendors in local currency. The FDI/International Fund Manager will be responsible for the appropriate accounting of the funds deposited into the designated account, for reporting on the use of these funds and for ensuring that they are included in the audits of the financial statements. Ceiling of the DAs and the Minimum Application size for Direct Payment or Special Commitment will be determined in the Disbursement Letter. However, until the completion of the FM assessment of the FDI and the International Fund Manager and its satisfactory conclusion, the Advance method will not be available for these components.

45. Summary Sheets with Records and Statements of Expenditures (SOE) will be required for documenting eligible expenditures and reimbursements to be paid by the DA. Direct Payments

will be documented by Records. Applications documenting the advances to the DA will be made on a monthly basis.

46. SOE limits for expenditures against contracts for works; goods; consultant services for consulting firms; and individual consultant services will be determined in the Disbursement Letter. Documentation supporting expenditures claimed against SOEs will be retained by the implementing agency and will be available for review when requested by the World Bank supervision missions and the project's auditors.

47. The project will have a Disbursement Deadline Date (final date on which the World Bank will accept applications for withdrawal from the Recipient or documentation on the use of Grant proceeds already advanced by the World Bank) of four months after the Closing Date of the project. This "Grace Period" is granted in order to permit orderly project completion and closure of the Grant account via the submission of applications and supporting documentation for expenditures incurred on or before the Closing Date. Expenditures incurred between the Closing Date and the Disbursement Deadline Date are not eligible for disbursement. All documentation for expenditures submitted for disbursements will be retained at the Energy Cell during the lifetime of the project and be made available to the external auditors for their annual audit, and to the World Bank and its representatives if requested. After project closing, the relevant documentation will be retained for two years, following the Government's regulations on record keeping and archiving. In the event that auditors or the World Bank implementation support missions find that disbursements made were not justified by the supporting documentation, or are ineligible, the World Bank may, at its discretion, require the Recipient to: (i) refund an equivalent amount to the World Bank, or (ii) exceptionally, provide substitute documentation evidencing other eligible expenditures.

48. Before the World Bank closes the Grant account (two months after the Disbursement Deadline Date), the Recipient must provide supporting documentation satisfactory to the World Bank that shows the expenditures paid out of the DA, or refund any undocumented balance.

F. Procurement *(to be updated before the Decision Meeting)*

49. Procurement for the Project will be carried out in accordance with the "World Bank Procurement Regulations for Borrowers under Investment Project Financing", dated July 1, 2016, hereafter referred to as "Procurement Regulations". The project will be subject to the Bank's Anticorruption Guidelines, dated July 1, 2016.

50. As per requirement in the Procurement Regulations, a Project Procurement Strategy for Development (PPSD) is under development. The Procurement Plan (PP) sets out the selection methods to be followed by the borrower during project implementation in the procurement of goods, works, non-consulting and consulting services financed by the Bank. The Procurement Plan will be updated at least annually or as required to reflect the actual project implementation needs and improvements in institutional capacity.

51. PPSD will be completed before appraisal and summarized here.

G. ENVIRONMENTAL AND SOCIAL (INCLUDING SAFEGUARDS)

52. **Environmental and social impacts under the project are expected to be moderate, and easily mitigated**. The environmental and social safeguard policies triggered are: OP 4.01 Environmental Assessment, OP4.12 Involuntary Resettlement, OP 4.04 Natural Habitats, OP 4.37 Physical Cultural Resources, and OP 4.37 Safety of Dams. The project is rated category B.

53. Because the exact nature and location of investments is unknown at appraisal, the project chose the framework approach, in which a screening procedure is applied to every subproject before financing can be approved. The Environmental and Social Management Framework (ESMF) was prepared by the Government, and will be submitted to consultations before Appraisal.

54. Potential impacts include health and safety of workers and communities during construction and rehabilitation of small grids, solar panel arrays, electrical connections, wind/hydro turbines, etc.; production of waste (batteries and other wastes from small businesses); and impacts to land, water and biodiversity from wind, hydro and biomass projects. Mitigation measures include appropriate siting of RE generation units (away from known bird/bat areas including migration routes, wetlands, etc.), appropriate training of operators in H&S, appropriate consultation of local actors and NGOs regarding biodiversity, appropriate solutions for waste, etc.

55. The project will apply the ESMF prepared by a consultant for the Government, using the screening checklist in the ESMF to assess and mitigate any negative environmental impacts.

56. The ESMF was designed to address the most likely impacts under the project, specifically home/small business PV systems, which have relatively low environmental impacts. The most likely impact at project scale will be the disposal of large numbers of used Lithium-ion (Li-ion) batteries. The ESMF includes measures for battery storage and ultimate recycling. As the field is emerging, and standard procedures for recycling Li-ion batteries are not yet developed, the measures will reflect the emerging best international practice.

57. OP 4.04 is triggered to evaluate potential impacts on biodiversity and natural habitats (e.g., impacts on birds and bats from wind turbines). While the project is not expected to have negative impact on natural habitats and any activities with impacts on natural habitats will be screened out using the ESMF. The OP on physical cultural resources is triggered to outline chance finds procedures in the case of any construction activities. The ESMF includes procedures to be followed for chance findings when installing infrastructure. The project may support small hydro, which may trigger OP 4.37. The ESMF will outline the necessary steps to be taken if a subproject triggers this policy; review by a qualified engineer if the dam is less than 15 m high. Projects with dams higher than 15 m will not be eligible under the Project. No use of pesticides (herbicide, insecticide) will be permitted under the project.

58. Negative List: the project will exclude the following activities: any use of herbicide, insecticide or other pesticide, as defined in OP 4.09 – Pest Management, e.g., for chemical control of weeds;

59. Training (under Sub-component 2.d) will be provided to the Energy Cell, off-grid energy companies, municipalities, solar technicians, and to other stakeholders in the implementation of this ESMF. Training at many levels will be required as this is a very new field, with many of the

stakeholders (financers, entrepreneurs, municipalities) not being familiar with environmental impact procedures. Specific modules will be developed further, and a budget allocated specifically to them. Training is expected to be over the duration of the project, to ensure that staff turnover does not erode E&S knowledge.

60. In the event that the ESMF identifies more considerable impacts, for example in the case of micro-grid, biomass, wind turbine and micro-hydroelectric investments, the ESMF indicates a requirement for more detailed studies, for example a separate EA/EIA, as a condition for financing.

61. The ESMF will be consulted in-country in May 2017, with stakeholders, prior to disclosure prior to Appraisal. During implementation, the Energy Cell will benefit from an E&S Fund to cover some of the cost for the identification of impacts and preparation of mitigation measures. Costs for mitigation measures will be borne as part of each sub-project, by each subproject proponent.

62. Overall responsibility for ensuring that the ESMF is adequately implemented will be with the MTPTC and OGEF Fund Manager. The MTPTC's Energy Cell will also be responsible for monitoring and reporting on a regular basis, based on the information obtained through project implementation and information provided by the OGEF Fund Manager (integrated in the M&E requirements established in the Operating Guidelines). The MTPTC Energy Cell will be benefit from the experience of the MTPTC PIU, which has been coordinating safeguards aspects of the PRELEN project, as well as a larger hydro-rehabilitation project of IDB (See point C above on Capacity).

63. *Staffing:* Additional staffing is not expected under the project; the Energy Cell, OGEF Fund Manager (FDI jointly with the International Fund Manager), after receiving some training, will apply the ESMF for the "routine" subprojects (home/small business PV systems) without any specialized assistance; however, for subprojects that are more complex (mini-grids, biomass, wind turbines and micro-hydroelectric plants), Energy Cell and/or OGEF Fund Manager would hire the necessary experts, as needed. Additionally, for the first two years of operation, the Bank will require that the energy cell, FDI/International Fund Manager obtains a no objection from the Bank for all subprojects; thereafter FDI/International Fund Manager would obtain a no objection from the Bank only for large and/or complex projects (mini-grids, biomass, wind turbines and micro-hydroelectric plants.

64. The project is expected to have socio-economic benefits from increased access to electricity including alleviating poverty through cheaper sources of power for households, job creation and new economic opportunities, particularly in rural areas. Design of financial mechanisms under the project will take affordability and willingness to pay into account, supported by information, education, and communication campaigns. In addition, the Project will include specific actions to help Haitian women and girls to access these benefits and opportunities.

65. Some project activities may lead to resettlement (particularly of squatters), land acquisition and loss of economic livelihood. As the exact locations of sub-projects are unclear, a Resettlement Policy Framework (RPF) is being prepared and consultations will take place before Appraisal. The RPF will be disclosed on the World Bank's and Government's website. The RPF will include guidance on the application of OP 4.12 and the application of OP 4.03 Performance Standard 5.

Special attention will be given to the eligibility of potentially affected persons to ensure that the rights of those without formal legal rights to land are recognized in the RPF and subsequent RAPs, per OP 4.03 and OP 4.12. For land purchases through willing-seller willing-buyer approach, land acquisition must occur by mutual agreement in exchange for a notarized purchase contract based on the market price at the date of acquisition.

66. The Energy Cell of the MTPTC (for Sub-components 1a & b, Sub-components 2a & b) and the government established Off-Grid Energy Fund (OGEF for Sub-component 2c) will be responsible for site-specific screening of sub-projects for social impacts, and monitoring Resettlement Action Plans (RAPs) as needed. The RAP preparation and implementation, including compensation, will be the responsibility of the Energy Cell and OGEF Fund Manager (for Sub-component 2c) in the case of public investments and private companies (in the case of private investments) and Public Private Partnership (PPP) structure (in the case of PPPs). Beyond resettlement aspects, social impact screening will cover labor safety and standards, community health and safety issues, and potential violence and security risks in the proposed sites. Within the Energy Cell and OGEF, the social specialist will be trained on social screening and monitoring of sub-projects and on the design/ implementation of the Grievance Redress Mechanism as needed. In addition, entities implementing sub-projects will be provided with support and training during the course of the project to ensure adequate impact monitoring. The Energy Cell and OGEF will need to submit all sub-project safeguards for the Bank's non-objection in the first two years of project implementation.

H. MONITORING & EVALUATION

67. The project will use the indicators and mechanisms defined in Annex 1 for monitoring and evaluation (M&E) of results and intermediate outcomes. Overall responsibility for M&E lies with the MTPTC Energy Cell, which will consolidate M&E reporting based on updates provided from EDH's and OGEF's bi-annual reports. The Project Operations Manual will include description of M&E responsibilities, data collection requirements and frequency, and division of the roles between MTPTC, EDH and OGEF, each provided with adequate budgets to carry out their roles diligently.

68. The project will also carry out a baseline survey, using the SEforALL Multi-Tier Framework methodology,[92] and will use cell phone surveys (see below) to get regular updates on progress. The mid-term review will be conducted at project's mid-term to assess project's implementation progress. The regular M&E data, the survey data/beneficiary feedback and the MTR analysis will be used to assess project's implementation progress, whether the project design is still relevant and suited to the Haitian conditions (particularly considering the fast evolution of RE technologies and business models globally), whether beneficiaries are receiving adequate services, whether desired gender impacts are being produced and overall whether the project is on track meeting the PDO and the key indicators. Based on these assessments, modifications to the Operations Manual (and if necessary to the broader project design) will be proposed and discussed with the Government and implementation stakeholders. At Project closure, MTF survey will be repeated to capture impacts.

---

[92] World Bank/SEforALL:Beyond Connections: Energy Access Redefined (2015)

69. The project will seek citizen engagement and beneficiary feedback in its implementation.

70. The project will carry out annual household surveys (by cell phones primarily and complementary home visits when needed), which will cover both beneficiaries and non-beneficiaries to track (i) consumers' satisfaction with electricity services; (ii) performance/sustainability over time; (iii) emerging impacts (e.g. appliances used, income generating activities enabled etc.), (iv) reasons for not having access for households not served by the project. The feedback will also provide gender-disaggregated data to assess potential emerging gender issues and impacts.

71. Village grid tri-partite agreement will include mechanisms for addressing user grievances, and a free text messaging service /a hotline will be available to respond to customer queries. The success rate in resolving customer queries and complaints will be tracked throughout project implementation.

72. Citizen engagement indicators are included in the Results Framework (Annex 1): "Corrective actions taken based on beneficiary feedback from phone surveys and household visits" and "Percentage of users reporting systems working according to the advertised performance."

HAITI: Renewable Energy for All

ANNEX 4. IMPLEMENTATION SUPPORT PLAN

A. STRATEGY AND APPROACH FOR IMPLEMENTATION SUPPORT

1. The strategy for Bank Project Implementation Support (IS) reflects the nature of the project and its risk profile (outlined in the project SORT) and aims to enhance the quality and impact of the proposed project interventions. The IS focuses on risk mitigation measures identified in the PAD and standard Bank supervision (including technical, institutional, environmental and social safeguards) and fiduciary aspects (financial management and procurement).

B. IMPLEMENTATION SUPPORT PLAN

2. Quarterly Implementation Support (IS) missions (including field visits to investments financed under Component 2) will concentrate on the following areas:

Strategic

3. The supervision mission will review the progress in the implementation of each component and assess whether the proposed design is still valid and/or whether course corrections are needed. This assessment will be based on discussions with all key stakeholders including MTPTC, MEF, FDI, EDH, private sector contractors and grantees and project beneficiaries, including those met on field visits.

Technical

4. The supervision mission will monitor whether the project follows provisions established in the Project Operations Manual. The field visits will assess whether the quality assurance provisions of the Project Operations Manual are being followed.

Safeguards

5. Overall responsibility for ensuring that the E&S Process is adequately implemented will be with the Energy Cell of the MTPTC. The Energy Cell will also be responsible for monitoring and reporting on a regular basis. EDH and OGEF Fund Manager will share the responsibility for monitoring compliance with E&S process and RPF, following instructions established in the Project Operations Manual. The Bank supervision mission will follow compliance with the safeguards requirements.

Fiduciary

6. The supervision missions will ascertain whether the procurement and FM provisions of the Project Operations Manual are being followed. In particular, regarding FM, based on a risk-based approach, FM supervisions will be conducted approximately every six months. These will pay particular attention to: (i) project accounting and internal control systems; (ii) budgeting and financial planning arrangements; (iii) review of IFRs; (iv) review of audit reports, including financial statements, and remedial actions recommended in the auditor’s Management Letter; and

(v) disbursement management and financial flows. FM supervision will pay particular attention to any incidences of corrupt practices involving project resources for project implementation. Supervision of procurement will be carried out primarily through prior review supplemented by supervision missions at least twice a year. The missions will also discuss progress in the implementation of the Procurement Plan.

Client relations

7. The mission will consult with all project stakeholders.

Table A4.1. Skills Mix Required

Skills Needed	# Staff Weeks per FY	# Trips per FY	Comments
Task Team Leader (Supervision)	12	6	HQ-based
Energy Specialist	20		Country based
RE Specialist (on-grid)	4	4	HQ-based or other region
RE Specialist (off-grid)	4	4	HQ-based or other region
RE Specialist (policy and regulation)	4	4	HQ-based or other region
Productive use specialist	4	3	HQ-based or other region
Economist /Financial Specialist	3	2	HQ-based or other region
Procurement Specialist	3	2	HQ-based or Country-based
Financial Management Specialist	3	2	HQ-based or Country-based
Environmental Specialist	3	2	Country-based
Social Specialist	3	2	Country-based
Gender Specialist	3	1	HQ-based
Legal Counsel	3	1	HQ-based

Table A4.2. Partners

Name	Institution/Country	Role
Client	MTPTC, MEF	Project Counterparts, overall responsible for Project implementation, in compliance with agreements spelled out in Financing Agreement coordinating the GOH's support for the Project.
Implementing entities	MTPTC, OGEF (FDI and International Fund Manager), EDH	Responsible for execution of project components.
Project Partner Institutions (Beneficiaries, inter alia off-grid energy enterprises)	Enterprises which have received project support	Provide on- and off-grid energy services to rural and peri-urban clients with support from the Project.
Local Institutions and Authorities	Municipal authorities	Local level representation of ministries: key actors in the coordination as well as participatory and decision-making mechanisms supported in the Project. Local municipal authorities: key role in the development of micro-grids. Sign tri-partite agreements

Other financial and technical partners	IDB, UNEP, UNDP, USAID, PanAmerican Foundation and other potential funders of on- and off-grid electricity projects	Ensure coordination so that financed programs complement one another in terms of sectors of intervention, geographical areas of intervention, timeline and sequencing, etc. to leverage development impacts.
NGOs	Local NGOs	Non-governmental partners to support awareness- and capacity-building activities.

HAITI: Renewable Energy for All

ANNEX 5. GENDER DIMENSION OF ENERGY ACCESS IN HAITI: LOCAL AND GLOBAL LESSONS

A. GENDER INEQUALITIES IN HAITI

1. According to the recent poverty assessment report,[93] many inequalities between men and women in Haiti persist. Women and girls in Haiti face significant obstacles when accumulating assets, including human capital, and they register lower education and health outcomes. Despite sizable progress in school enrollment among younger cohorts, adult women are still less well educated than adult men and are more likely to be illiterate. Underage marriage represents an additional threat for girls who are not in school: 17 percent of Haitian women are married in adolescence, compared with 2 percent of men, while this number drops among girls with higher education.

2. Women are significantly disadvantaged in using their assets and obtaining the relevant returns, particularly in the labor market. Apart from initial differences in endowments, women in Haiti seem to face additional obstacles in participating in the labor market. Holding constant several social and demographic characteristics, one finds that women are 20 percentage points more likely than men to be unemployed and, if working, 6 percentage points more likely to be in the informal sector. Wages among women are also 32 percent lower than wages among men. Statistical tests show that over two-thirds of this difference is unexplained by observable characteristics, suggesting that discrimination could play a role in accounting for the result.

3. Maternal mortality, at 380 deaths per 100,000 live births, is still five times higher than the regional average. Poor nutrition is also a threat for both children and mothers: 22 percent of children are stunted or too short for their age, while nearly half of women aged 15–49 have anemia. The prevalence of HIV/AIDS is higher among women (2.7 percent) than men (1.7 percent), reflecting both knowledge differentials (only 15 percent of young women have correct information on how to prevent sexual HIV transmission, versus 28 percent of young men), lack of agency, and physical differences. Furthermore, poor education and gender norms interact with health outcomes.

4. Gender-based violence and low participation in the public sphere are widespread in Haiti, reflecting weak agency. Gender-based violence is a chronic problem: 13 percent of Haitian women have experienced sexual violence, and 29 percent of women who have ever been married have experienced spousal violence, whether emotional, physical, or sexual.

B. OVERVIEW OF GENDER DIFFERENTIATED BENEFITS OF ENERGY ACCESS

5. Energy access interventions can affect women and men differently, as they have different roles and voices in the household and wider community. The literature on gender and energy suggests that providing household and community electricity access can promote gender equality, and women's empowerment can provide new employment opportunities for women, and can improve health and education for women and girls. Most of these gender benefits accrue, because

93 World Bank: Creating Opportunities for Poverty Reduction in Haiti, 2015.

women tend to spend more time at home, are responsible for household chores and home-based income-generating activities that can be carried out more productively with electricity.[94] Key benefits include:

- **Improved safety and reduced gender-based violence**. Community electrification, especially street lighting, increases safety for women and girls, and allows them to move more freely after dark – which also increases a possibility of socializing, education and income-generating activities in the evening hours.
- **Women empowerment through better access to information.** Greater access to mass media can influence knowledge about health, beliefs and attitudes about gender roles, and awareness of the rights of women. For example, gender assessment carried out for Bank's Bangladesh RERED Project has shown that access to media through solar home system ownership increased mobility and entrepreneurial ambitions for women.[95]
- **Increased productivity of time allocated to "domestic" and "reproductive" chores.** There is evidence that electricity increases productivity of women spent on domestic chores but there is less clarity on how the women spend the freed-up time. Some studies show increased income generating activities; others point to increased socialization and leisure and more time for child-care; while some actually show an increase in time spent on domestic chores due to the prolongation of the productive day.
- **Expanded income generating opportunities at home and outside home.** Access to electricity at home can result in income generating activities for women – particularly in those countries where there are not too many other obstacles for women to start a business. A study in Tanzania, Bolivia and Vietnam found that locating the enterprise in the household allowed women to combine income-generating tasks with household duties. In Bangladesh, access to electricity was found to be correlated with time women allocated to income generating activities and the probability of employment. In addition, men's and women's business and retail enterprises can continue operating and keeping their stores open during the evening.
- In Haiti, women demonstrate a similar pattern of engaging in income-generating activities in the household. For example, in the Artibonite region, activities range from producing fruit juice, ice cream, as well as raising chickens for commercial use in facilities next to their homes. Outside of homes, common activities include growing and selling agricultural products and selling bottled drinks in small shops. Women consider having electricity to support cooling systems as the priority for income-generating activities. Charging cell phones is also among the top priorities. The availability of electricity-use of solar lamps that last through the night will allow the chickens to be more frequently fed and grow at a faster speed. In places without electricity, women need

---

[94] This overview is based on a vast literature review summarized in two recent reports: Köhlin, Sills, Pattanayak, Wilfong: Energy, Gender and Development; What are the Linkages? Where is the Evidence? World Bank, 2011; and World Bank/Sustainable Energy for All: Global Tracking Framework, World Bank, 2015, as well as ESMAP/WBI e-learning module on gender and energy. In addition, the overview draws in particular on two recent studies from Bangladesh (Samad, Khandker, Asaduzzaman, and Yunus: The Benefits of Solar Home Systems: An Analysis from Bangladesh, Policy Research Working Paper 6724, World Bank, 2013); and Rwanda (Grimm, Munyehirwe, Peters, Sievert: A First Step Up the Energy Ladder? Low Cost Solar Kits and Household's Welfare in Rural Rwanda; RUHR Economic Papers #544, 2015) as they provide recent evidence on impacts of programs similar to the proposed Project.

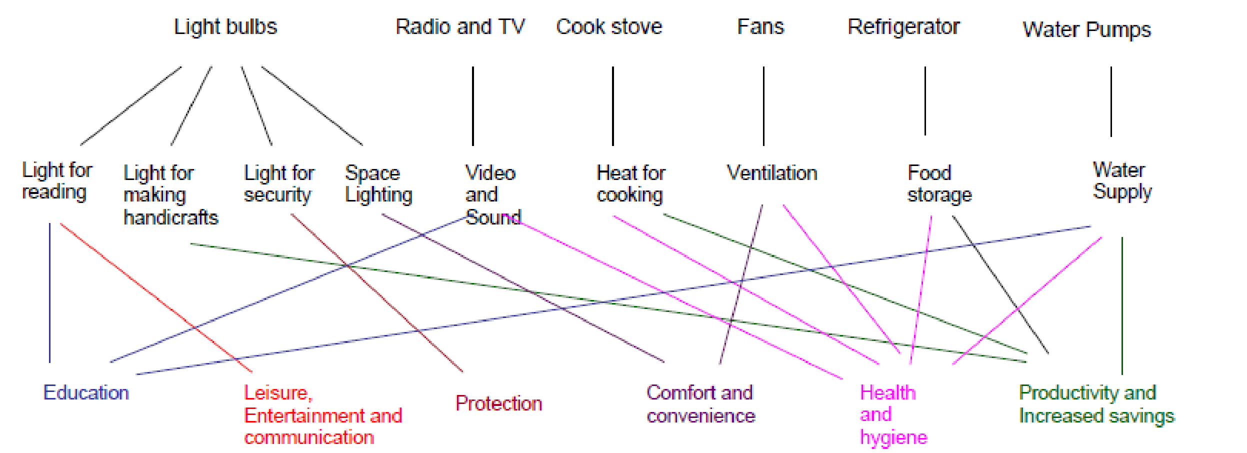
[95] Sadeque, Rysankova, Elahi, Soni: Scaling up Access to Electricity: the Case of Bangladesh, World Bank Livewire, 2014

to travel long distances by foot to cell-phone charging booths, which also charge a fee. Having electricity to charge cell phones in their own vicinities will significantly save them time. The battery duration was reported to be the most important quality for female-headed businesses and households.

- Some studies also show positive correlation between rural electrification and employment, especially for younger women. For example, electrification of rural communities in South Africa and Guatemala resulted in a 9 percent increase in female employment, but no comparable increase in male employment. In addition, studies show that there are win-win opportunities for integrating women in energy supply chain. Encouraging women to become involved in the energy sector, for example as energy entrepreneurs, offers multiple development benefits, like expanding economic activities for women, diversifying productive options, and creating new sources of wealth and income to support family investments in education and health. (See Box A8.1. for emerging examples of these win-win models in Haiti). Women's economic empowerment in energy (as in other sectors) contributes to broader aspects of empowerment, such as political participation and consultation in interventions where women are the identified beneficiaries.

- **Health and education benefits.** The health benefits of electricity stem from cleaner air, reduced risk of burns, fires, and accidents, better nutrition and food safety from refrigeration, and improved health knowledge from access to mass media, as well as improved health services due to electrification of health clinics. There is some emerging (although still limited) evidence that women and children are those who benefit most from the switch from health-damaging kerosene lighting. A recent study reports that accidental ingestion of kerosene is the primary case of child poisoning in the developing world, and a frequent cause of infant burns (e.g. in Bangladesh, kerosene lamps are responsible for 23 percent of infant burns). In addition, women and children spend a larger proportion of their time indoors and thus experience a greater exposure to pollutants than males. A recent impact study of Bangladesh solar home system program showed that solar power had a positive health impact, especially for women. Adopting a solar home system reduced respiratory disease in women by aged 16 and above by 1.2 percent (while no comparable effect was found for men). Studies also report positive impact on education (primarily increased time to study) for both boys and girls.

Figure A5.1. Electrification benefits



Source: Köhlin, Sills, Pattanayak, Wilfong: Energy, Gender and Development; What are the Linkages? Where is the Evidence? World Bank, 2011

C. OVERVIEW OF BEST PRACTICES TO FACILITATE GENDER BENEFITS OF ELECTRICITY ACCESS

6. Available research shows that the above mentioned gender benefits are neither definite nor assured in all situations.[96] For example, electric light after dark may improve the quality of life for some, by allowing reading, entertainment, or education via radio and television, whereas for others it may simply extend the working day. Reaching equitable outcomes is challenging as women often have less influence over decisions and exercise less control over their own lives and resources. Available evidence and experience, therefore, points out to a need to complement the electricity interventions with specific actions to ensure that electricity benefits indeed do accrue to both men and women. This can be done through several avenues:

- **Making it easier for female-headed households to receive electricity connections.** For example, Bank-supported Lao PDR "Power to the Poor" program aimed at increasing the density of connections by subsidizing the connection costs. The program's effectiveness was increased by specifically targeting poor female-headed households, which had difficulty obtaining connections due to a combination of economic and socio-cultural factors. In addition, high up-front costs of access to modern energy services may more severely affect female-headed households, often overrepresented in poorer quintiles. Low-income groups, particularly women, rarely have access to finance from formal institutions. This circumstance calls for an introduction of a range of financing schemes.
- **Making sure that women are well educated about the benefits and opportunities of electricity access**. Often, projects finance consumer education campaigns, but it is important to ensure that these campaigns are carried out in such a way that they

[96] Or in fact, that in some cases, electricity can have a negative impact on women – e.g. some studies have shown that electricity has resulted in longer work days with less leisure time for women, which may maximize overall household utility but may be detrimental to women in the household. Also, some studies have shown that electrification of communities, which led to greater mechanization, resulted in reduced employment opportunities for women.

effectively reach women. For example, Bangladesh RERED project has been providing training for all SHS users, but the gender-focused social assessment of the RERED project found out that the place and time of training was sometimes difficult to attend for women. As a result, a more gender-sensitive training approach was designed.

- **Creating opportunities for women to become integrated in the supply chain**. This is in particular relevant for off-grid electrification market development programs. These programs (like Haiti) aim at market transformation – from kerosene-based lighting to modern electricity/lighting, often supporting the creation of a new industry and supply chains. There is a growing evidence on how women's integration in these supply chains can be a win-win solution. A growing number of energy enterprises have begun to employ women as sales representatives to reach low-income consumers at the base of the pyramid with lighting and cooking solutions. Women help ensure that energy products reflect the priorities of women users, increasing the likelihood of adoption and continued use.[97] Such cases, in fact, are already emerging in Haiti.

Box A5.1. Women and off-grid electricity business opportunities – emerging evidence from Haiti

Integrating women in the off-grid electricity supply chain can be a win-win situation. For women, this represents new entrepreneurial and employment opportunities, while the businesses can strengthen their supply chains, improve the effectiveness of their marketing strategies, and ultimately increase their profitability and sustainability. For example, EarthSpark, a micro-grid operator, has demonstrated successfully that involving women in the development and operation of micro-grids promotes sustainability. For example, all micro-grid "ambassadors" (promoters of the micro-grid) are women, and half the energy vendors in the town are female. These vendors generate new income by selling energy credits similar to the way that mobile phone credits are sold. As the next step, EarthSpark is also planning to offer a loan product for women connected to the grid to start or expand agriculture-processing and food-preparation businesses. See Annex 2 for a more detailed description of this business model, built on an active participation of women in the off-grid energy supply.

- **Reducing time used on domestic chores.** Electricity is not the end by itself but an input for a variety of services. As discussed above, electricity can significantly reduce time needed for domestic chores, but the time-saving appliances are not always available and affordable to women. Electrification has been found to have greater positive impacts on women when accompanied by effective social marketing and financing schemes for appliances that reduce the time required for domestic chores.[98]

- **Providing additional support for women to use electricity for productive uses.** There is a mixed evidence overall to what extent the electrified households, and women in particular, use electricity for income-generating activities. Often, electricity is only one of many constraints for productive uses and if other constraints persist, impact on income generation may be limited.[99] Additional measures to reduce other barriers may therefore be needed. For example, Bank-supported Mali Household Energy and Universal Access project has successfully supported a partnership with microfinance

[97] See World Bank/SEforALL: Global Tracking Framework, 2015

[98] ESMAP: 2013. Integrating Gender Considerations into Energy Operations. World Bank, 2013

[99] Barriers related to low levels of ownership and control over resources, illiteracy, lack of exposure, and poor information and training may affect women more than men, as women are often excluded from decision-making. Informal nature of many women's enterprises is linked to problems of access to credit, equipment, and other support services

institutions to support women's micro-enterprises using newly provided electricity services.

7. The project integrates these lessons in the project design, focusing on measures consistent with the private sector-led nature of the project.

Table A5.1. Summary of Gender issues and corresponding actions

Issue addressed	Project action
Support female-headed households to get electricity access. **Female-headed households tend to be disproportionately represented in poorer quintiles. The high upfront costs of renewable energy products, combined with lack of access to credit, can serve as an important barrier for them to access off-grid electricity services.**	1. The project is supporting a range of renewable energy products and business models, including the basic products for the base of the pyramid, such as solar lanterns. 2. The project is in particular supporting a service-oriented approach, such as pay-as-you-go (PAYG) models, which minimize the need for upfront investment, and allow consumers to pay for services the same way they currently pay for kerosene (in small quantities, based on demand). 3. The project will carry out a consumer awareness campaign, which will also target female-headed households. Overall, the consumer awareness/education activities will be carried out in a gender-sensitive manner. 4. The project will have a beneficiary feedback mechanism through cell phone surveys, which will provide gender disaggregated data, and will provide feedback whether additional measures to support female-headed households are needed.
Reduce time women spend on domestic chores. **Electricity can significantly reduce time needed for domestic chores, but time-saving appliances are not always available and affordable to women.**	The project will not only provide access to electricity, but to the extent possible will also promote provision of energy efficient appliances, particularly in mini-grids. The project's service oriented approach provides an opportunity for bundling electricity service provision with leasing or other form of financing for these energy efficient appliances.
Support income-generating activities by women. **There is a growing evidence on how women's integration in these supply chains can be a win-win solution. Women can help ensure that energy products reflect the priorities of women users, increasing the likelihood of adoption and continued use.**	The project will take specific actions to integrate women in the emerging off-grid electricity supply chains, building already on positive examples emerging from the ongoing off-grid electricity activities in Haiti (see Box A5.1). The specific actions will include: 1 Gender-inclusiveness among the evaluation criteria for mini-grid and productive uses grants 2. Guidance on gender sensitive village grid operation in the tri-partite agreements. 3.Operating Guidelines tasking the Fund Manager to pay attention to gender impacts of the supported off-grid electrification investments. 4. The off-grid energy companies will be required to elaborate in their business plans the approaches to integrate women in their supply chains, which will be considered a bonus in evaluating these plans. 5. Knowledge exchange about the best practices within and outside Haiti. 6. Training, specifically targeting women entrepreneurs.

HAITI: Renewable Energy for All

ANNEX 6. ECONOMIC AND FINANCIAL ANALYSIS

1. EIRR is above country hurdle rate, and NPV at EIRR (2 percent) and typical FIRR (10 to 20 percent) is positive for all system types and components. All proposed project components and considered RE "system types" have EIRR well above Haiti's hurdle rate of 2 percent (according to the latest World Bank method), which are also sufficiently robust against the vast majority of scenarios, even in the no-carbon case. Therefore, the total project benefits will also be above threshold, even if the exact share of system types is still unknown. The same is true for the full SREP Program (which includes the CTF and IDA projects' co-financing costs and benefits that have been analyzed for the SREP IP and are also positive and sufficiently robust).

Box A6.1. New country threshold rate used for SREP economic analysis: Haiti Social Discount Rate = 2 percent

As per Fay et al (2016), World Bank Analysis now required a social discount rate to be determined based on GDP growth (social discount rate = 2 x average annual growth rate of per-capita consumption), as opposed to the typical 10 percent across the board values often used (in part, to reflect the recent period of low-interest rates and GDP across the globe, as well as de facto emerging market borrowing rates). Therefore, a set additional scenarios was prepared for the economic analysis, with a new EIRR of 2 percent instead of to 10 percent (see below). Per-capita consumption growth is usually approximated by growth of real GDP per capita. IMF 1980-2014 (per capita GDP PPP) cum regression analysis in Stata yields an average rate of growth of 1.02 percent, calculated as [Exp (.0101815) - 1] x 100. Thus, country hurdle rate for Haiti = social discount rate = 2.04 percent. We therefore used a Social Discount Rate of 2 percent for the PCN, in addition to the 10 percent case used for SREP IP. It should be noted that practitioners would profit from additional guidance on which time series to use for per capita consumption, as the results may differ. For instance, taking the WB dataset 2004–14 (stronger impact of earthquake), average growth rate of (real) per-capita GDP by least-squares regression gives 0.35 percent; so social discount rate would be 0.7 percent. By contrast, taking per capita growth of GNI PPP (at current US$), as opposed to GDP as above, the average growth rate for same period works out at 7.89 percent. so social discount rate would be 15.78 percent

Integrating women in the off-grid electricity supply chain can be a win-win situation. For women, this represents new entrepreneurial and employment opportunities, while the businesses can strengthen their supply chains, improve the effectiveness of their marketing strategies, and ultimately increase their profitability and sustainability. For example, EarthSpark, a micro-grid operator, has demonstrated successfully that involving women in the development and operation of micro-grids promotes sustainability. For example, all micro-grid "ambassadors" (promoters of the micro-grid) are women, and half the energy vendors in the town are female. These vendors generate new income by selling energy credits similar to the way that mobile phone credits are sold. As the next step, EarthSpark is also planning to offer a loan product for women connected to the grid to start or expand agriculture-processing and food-preparation businesses. See Annex 2 for a more detailed description of this business model, built on an active participation of women in the off-grid energy supply.

2. Naturally, the EIRRs including carbon benefits are even higher (from 11 to 54 percent) than the no carbon case (from 10 to 52 percent). Following World Bank standard procedure, we have calculated both.

3. The main benefit type under component 1 and 2 is the reduced spending on diesel fuel for electricity generation, thanks to the "with project" least cost "hybrid" RE-diesel generation, compared to the baseline fuel use in the existing village generators and co-generation gensets.

Given that the majority of component 1 and 2 sites already have existing distribution infrastructure and several diesel generators,[100] the net cost of adding PV (and storage) is much lower than in green-field cases, so that the economic Net Benefits would be positive even when discounted at much higher hurdle rates. For the (fewer and smaller) green-field sites expected under component 2, all-in Capex are obviously higher, but Net Benefits are still positive.

4. Depending on time span of analysis, average hub CRUDE OIL prices have varied between 50 and US$100/BBL in 2017 US$, while World Bank predictions for 2020 to 2030 from January 2017 are around US$60/BBL. This historic crude price corresponded to DIESEL SPOT market prices of roughly US$0.50 to US$1/liter. However, the relevant cost for Economic Analysis in case of components 1 and 2 is the in situ economic (CIF) cost of diesel fuel, which is higher by a factor of about 1.2 to 1.6, depending on the site. Based on local information received during appraisal for the pipeline sites, we have therefore assumed 0.70 (low) and 1.00 (high) US$/liter local economic "shadow cost" value for our fuel-based analysis of benefits. Depending on genset size, age and real-life part load characteristics, heat rates and thus fuel consumption for existing counterfactual "no project" gensets under component 1 and 2 may vary between 0.25 and 0.5 liter/kWh, so that the corresponding baseline minimum value of purely diesel generated power would be between US$0.18 and US$0.50/kWh. This estimate range for operational benefits confirms the WTP-based valuation of project benefits for the greenfield villages and OGEF systems (which is based on consumer surplus and present revealed spending), and to revealed WTP in target sites (which is also between 20 and 70 cents, based on real life tariffs and project preparation surveys). However, actual WTP reaches up to US$2/kWh in some cases found in Haiti (the price paid by some existing single users of small co-generation gensets), albeit for small quantities.

5. The benefits for the vast range of off-grid electrification systems that will be covered by the combined OGEF-SREP overall program umbrella (from 1 Wp PicoPV systems all the way to >10MWp component 1 EdH grids) can be approximated best - depending on their typical baseline situation in Haiti - by: (i) estimating the economic cost of saved diesel fuel, where a "no project case" generator exists (the minimum "with project" benefits are than the operational benefits based on in situ economic diesel cost, as described above for component 1+2), or (ii) estimating consumers' willingness to pay for the RE-generated kWh and the related consumer surplus (as described in the SREP IP). Users' present substitutable spending (as per project preparation surveys and tariffs in comparable isolated grids – both EDH and private operators) typically ranges from US$0.20 to US$0.40 per kWh and about US$10 to US$30 per month. Where the baseline situation includes both cases (say, green-field sites where some users may have small gensets and others do not), we have applied both methods. For overall readability of the analysis, we have then used a conservative estimate for each system type as BASE CASE, so that the calculated EIRR and NPV are also conservative. Given that (i) actual WTP is not only equal, but usually higher than present expenditures (as actual WTP includes today's consumer surplus and a whole set of difficult to quantify benefits such as health and education impacts), and (ii) revealed WTP in Haiti's many cogeneration diesel gensets can be as high as US$2/kWh, we have also run the

[100] The characteristics of the existing generators and the LV grid and nodal models of all 5 component 1 "short list" sites have been collected in site visits and from EDH during preparation and used for our analysis, so that heat rates and load curves are more exact than for the component 2 sites, where we have to work with data from Earth Spark, Sigora and others for a few typical village grids, from a much larger pool.

analysis for all sites with higher values for fuel and kWh WTP equivalents. Needless to say, the resulting EIRR for those runs are even higher than the ones quoted above.101 Finally, we have run optimizations of most village grid cases WITH already existing grids and diesel (and in some cases hydro) generators both (i) with and (ii) without taking the latter into account for NPV and LEC optimization, to make them comparable to literature values. Naturally, only the marginal cost and benefit of the "with project" retrofit (added PV and battery = cost; saved diesel fuel from this = benefits) are relevant for the least cost and hurdle rate tests.

6. Reflecting the high EIRR, Financial analysis also shows high internal rates of return for typical component 1 and 2 projects[102] (between 10 and 40 percent, but depending strongly on many assumptions - tariff, exact site, business model, etc. - which are unknown as of today because of the private sector-led selection), so that they can be potentially attractive for private investors. However, it is difficult to estimate the wacc (an thus hurdle rate for individual FIRR) of actual real-life investors, because the risk premium for offtaker and country risks is hard to estimate in a nascent market like Haiti. Yet it is crucial in light of the RE-typical long time span till breakeven - especially in combination with the fast falling capex of PV and batteries, which increase the risk of anchor client defection over time, and weaken the negotiation position of "captive solar suppliers", be it IPPs or ESCOs. In addition, the taxation of RE projects is presently in flux, thanks to energy cell TA under the parallel IDA project and SREP project preparation, so that after tax returns are hard to pin at this stage. However, the example of Earth Spark and Sigora prove that interested RE-hybrid grid investors do exist in Haiti (just not how many) - even at the higher capex prevalent in 2015-2016, so that 2017+ FIRR (which is significantly higher due to the fast falling capex) should attract some more. However, the risk of private sector uptake (of a Project Guarantee offer) remains and is thus raised in the risk section (it would be mitigated by the fallback option of structuring component 1+2 projects more like the initial Jeremie site described above, where the off-taker risk is taken out of the transaction).

7. **In terms of KPI, the SREP project outputs are unusually hard to predict** due to (i) the strong influence of final village grid selection (and final site data such as exact user number – presently we work with a conservative average of active and inactive users), and (ii) the extreme dependence of village grid unit cost on site and optimal RE penetration: For instance, the (very probable) **Jeremie** site calls for a high penetration scenario, with PV capacity and storage size roughly at par with peak demand (3 MW), at a comparably high total project capex for the new investment (because of the large battery and the added cost of automated system control), while the probable cases for most other Component 1 sites would be low penetration or medium penetration cases, with lower unit cost. Therefore, the cost efficiency in terms of (i) project investment per HH and (ii) per kWp and kWh generated as well as Carbon saved are hard to predict. For the BASE CASE KPI, we assume a mix of the 3 Component 1 cases shown in the

[101] Due to (i) the front-loaded nature of RE investments at relatively stable benefits (growing in the case of carbon), and (ii) the fast falling Capex for PV and batteries (which make replacement a minor issue to older RE CBA), we would like to point out that even higher rates of return would result from applying longer time horizons for the discounted cash flow (both for costs and benefits) than the standard duration of around 20 years! This is obviously a direct effect of the very low country hurdle rate of only 2 percent: While the residual value of benefits (and costs) after year 15 was insignificant at the typical EIRRs used in World Bank CBA over the last decades, this is no longer the case for today's low interest rate environment! We have therefore added 25-year cash flows to the standard 20 years for all village grid cases we have analyzed (but not for the over the small "over the counter" systems covered by CTF PAD and SREP IP which are repeated below for completeness sake).

[102] And also for the many types of single-user PV systems of the overall OGEF+SREP umbrella program, as discussed in the SREP IP.

table below: Jeremie high penetration (with 3-6k users) plus low to medium penetration for 2 sites around 15k users each (active + half of inactive). This results in a total capex of about 18M for hardware incentive under Components 1+2, about 120k beneficiaries from SREP only (and a little under 1M for CTF+SREP, depending on the share of PicoPV systems in CTF), about ¼ M tons of Carbon abated (similar to CTF), and about 12 MWp PV installed (plus about 3-4 MWh storage capacity in terms of Li-ion batteries), leading to more than 20 GWh annual RE generation added to the CTF-only case.

Table A6.1. Example for possible investment amounts Component 1, targeting sites 1-3 of our short list:

	Site 1 **Les Cayes** Peak demand 11 MW (incl existing hydro)	Site 2 **Petit Goave** Peak demand 10 MW	Site 3 **Jeremie** Peak Demand 3 MW (3-6k users)	**Thus, 3 typical Investment Cases Component 1 that fit a US$12 M budget** [Capex]:
HIGH PV SHARE	For example PV capacity ca. **11 MWp* + battery 11MWh** Unit Cost: 4$/Wp Capex ca 44M$ If Guarantee → ca 22M$	**PV 10 MWp + LiIon 10 MWh** 4 $/W Capex 44M$ Guarantee 22M$	**PV 3 MWp + battery 3 MWh** 4 $/W all-in conservative cost (PV + bat) **Capex 12M$** Guarantee 6M$	*Example A* 1. **Site #3 High PV Share and large storage** and no Guarantee possible (first project site) 2. No Other Sites can be funded in Component = 12M$ Component 1 Budget Need
MEDIUM PV SHARE	**PV 5 MWp + very small or no battery**** 3 $/W Capex 15M$ If Guarantee → ca 7.5M$	**4 MWp** 3 $/W Capex 12M$ Guarantee 6M$	**1.4 MWp** 3 $/W Capex 4M$ Guarantee 2M$	*Example B* 1. **Site 1 LOW** Share PV with Guarantee 2. **Site 2 MEDIUM** Share PV with Guarantee 3. **Site 3 MEDIUM** Share PV no Guarantee → 4+6+2 **= 12M$**
LOW PV SHARE	**PV 2 MWp + no battery** 2 $/W Capex 4 M$ If Guarantee → ca 2M$	**2 MWp** 2 $/W Capex 4M$ Guarantee 2M$	**0.7 MWp** 2 $/W Capex 1.4M$ Guarantee 0.7M$	*Example C* 1. **Site 1 LOW** SHARE + no Guarantee 2. **Site 2 LOW** SHARE + no Guarantee 3. **Site 3 MEDIUM** Share PV + no Guarantee → 4+4+4 **= 12M$**

8. Illustrative Component 1 Small Grid: "Jeremie" Site and typical Hybrid Small Grid System Layout Options

i. Due to the present price range of PV, fuel and (LiIon) batteries, off grid village grid CBA faces a "transition" period, during which:

a. a broad range of system configurations is "too close to call" at pre-feasibility stage (even if Homer and similar software may suggest otherwise) because data and simulation method uncertainties are larger than difference in financial and economic KPI, and

b. CBA and pre-feasibility system design face a fundamental trade-off between the standard economic indicators used in RE projects (as per WB guidance 2015).

ii. Said trade-off can be discussed best when simplifying the many possible system configurations (see colored table 4) into 3 main "classes" of RE Hybrids (see tables 1-3), according to their PV penetration (or RE share): High, Medium and Low, as shown in the tables below. The basic trade-off between those is Hybrid system classes is, that Higher Penetration leads to (A) Lower LEC, fuel usage and thus O&M cost (which is good) - but also to lower NPV and IRR (which is bad).

iii. At final system design stage (that is, during implementation), this trade-off is usually decided by the investor, in light of his financial situation (say, liquidity and debt access) over time and risk aversion, the detailed system data, national regulation (say, maximum tariff or minimum service quality), "subsidy rules" (say, maximum $/HH), experience with the 3 cases and EPCs for them (because the control standards for Medium and High case are not standardized), expectations about future Capex (because deferring part of the investment can make sense), and many more.

iv. If Capex trends hold, however, PV+battery high RE share systems will win out over the other too over the medium to long term. Presently, it is difficult because system control and LiIon quality issues can be handles only by few expert EPCs. Therefore, this is the most important case for demonstration effects.

v. For economic analysis, we therefore have assumed the most probable mix of cases, and used pragmatic criteria to predict the most probable case per site. Jeremie, for example, is small enough in terms of area and total system size to remain "manageable" for typical early stage EPCs (or even investors, if the guarantee issues could be solved) and thus allow a deep penetration even in rural Haiti. There is also no need for remote controlled dispersed generators. The idea is basically to "start small" with the more complex systems. A small amount of string inverters in situ allows for sufficient reaction time without increasing cost too much. Finally, the chance of interconnection is low. By the same token, for remoteness and small size, it is probably the best to have a ring-fenced early demo effect if NO private sector sponsor nor guarantee option can be achieved early on. For the larger systems such as Les Cayes (with 10-20k users instead of 3-6k as is the case for Jeremie), by contrast, barriers to private sector participation may have been removed. However, their sheer size and risk (in light of early stage knowhow on LiIon QA and DisGen control) might severely reduce the appetite for private sector participation, and increase project cluster risk if deep RE shares were targeted for those. Therefore, we think that the best case is to achieve maximum PV share and demo effect in Jeremie as first site, and the follow up with 1-2 larger EDH-operated grids (ideally as PPP) in the second cohort.

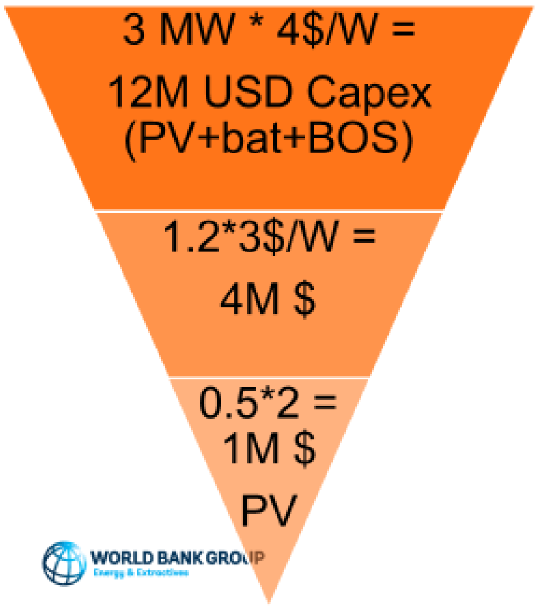
vi. By then, private sector will have learned that adding PV (and storage) decreases O&M cost and thus the risk that collected payments (say on an Escrow account) might not be enough to cover future recurrent cost, and thus price off-taker risk at lower premium. This effect is due to several aspects: (i) By definition, present 100 percent diesel fueled LEC is larger than resulting diesel+PV LEC (including replacement and additional PV O&M), as this is a precondition for positive EIRR (and shown by Economic Analysis across all cases). (ii)

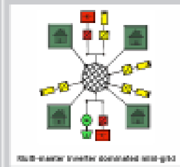
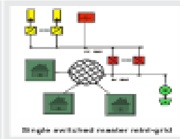
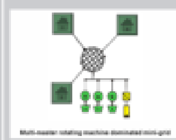
In addition, future replacements will be much less expensive than present Capex, both for PV and batteries. (iii) Finally, international expertise in professional PV design and efficient O&M has finally been internationalized over the last 2-3 years, so that the low O&M shares proven in the EU (<2 percent of Capex per year) can also be expected in emerging markets.

Table A6.2 and A6.3

component 1 big picture: 3 main options PV Share: High/Med/Low

Jeremie Case simplified:
- **3 MW** peak capacity,
- diesel+LV fully rehabilitated
- demand peak / noon ca 1.5; tender 2017, **invest 2018**



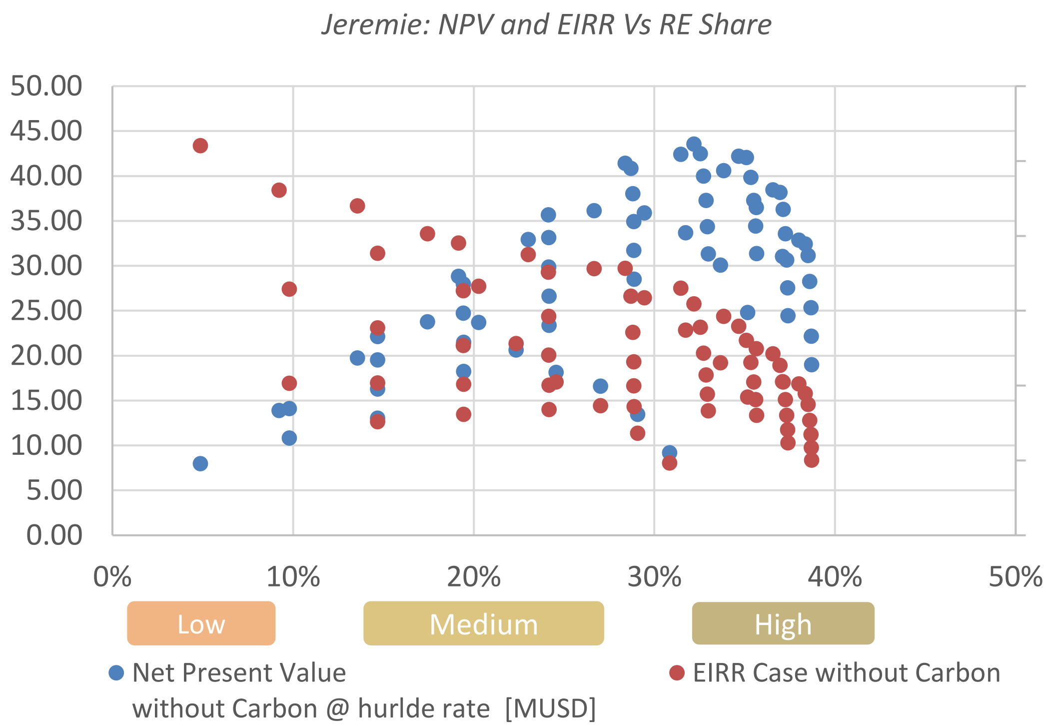
Solar Share „Type 1-3“	Typical Hybrid Minigrid topology	RE „Integration Requirements"
High P ≥100% of peak demand E ≥25%		1. Complex control ! 2. Large battery
Medium P ≈40% of peak demand E ≈10%		1. Basic control 2. Small battery
Low P ≈20% E ≈5%		1. Control can stay as is 2. No battery needed

Solar Share „Type“	Capex for „Jeremie“ Base Case (3 MW peak demand)	Unit cost explanation	1. fuel savings 2. LEC 3. IRR 4. VAN (green = good, red = bad)
High ≈100% P ≈ $\frac{1}{3}$ of E	**3 MWp** @ 4 $/W (incl storage) = USD 12 Mio Capex	Very complex automated System Controll including grid forming inverters + DisGen ICT+ LiIon battery with 10 MWp and 10 MWh for high fuel saving and low LEC	1. High 2. Low 3. **Lowest**, but will be best case >2020 (scale-up potential!) 4. High
Medium 40% of P ca 10% E	**1.2 MWp** @ 3 $/W (incl small storage) = USD 4 Mio Capex	More complex automated System Controll+ maybe small battery only for frequency stability, P>E	1. Medium 2. Medium 3. **Depends on system!** 4. **Depends on system!**
Low = „fuel saver“ case 20% of P ca 5% E	**0.6 MWp** @ 2 $/W = USD 1.2 Mio Capex	No changes needed: „no worries option“	1. Low, but highest per unit 2. High, but steepest improvement to no project case 3. **Highest** 4. Medium

Table 3: Simplified Table 4

			I. CBA ASSUMPTIONS FOR TYPICAL CT					II. RESULTING ECONOMIC INDICATORS WITHOUT CARBON							
	RE SHARE	P Share	PV size (MWp)	Li-Ion bat. (1MW)	CapEx [MUSD]	Present Value OpEx [MUSD]	excess generation (MWh)	Present Value COST [MUSD]	Present Value BENEFITS ex Carbon high WTP [MUSD]	Net Present Value without Carbon @ hurlde rate [MUSD]	EIRR Case without Carbon	Switching Value Capex in % of assumed cost	Annual Value BENEFITS cum Carbon Base Case [USD]	Net Present Value WITH Carbon BASE CASE @ hurlde rate [USD]	EIRR with Carbon Base Case [USD]
Low Share	9%	33%	1	0	1.8	1.3	103.3	3.1	17.0	13.9	0.5	4.1	17.8	14.7	0.5
Medium Share	19%	67%	2	1	4.6	3.5	51.2	8.1	37.0	28.8	0.4	3.3	38.8	30.8	0.4
High Share	29%	100%	3	3	8.5	6.7	31.0	15.1	56.0	40.8	0.3	2.6	58.8	43.8	0.3

Table 4



9. Base Case EIRR and KPI for SREP and CTF total project

CBA Results of most probable SREP-targeted Systems at 2 percent EIRR and 10 percent high IRR (as in CTF): Jeremie

ECONOMIC ANALYSIS JEREMIE @2% — **Project lifetime: 25**

I. CBA ASSUMPTIONS FOR TYPICAL CTF SYSTEM SIZE					II. RESULTING ECONOMIC INDICATORS WITHOUT CARBON					III. RESULTING ECONOMIC INDICATORS WITH CARBON (HIGH WTP)										
PV size (MWp)	Li-Ion bat. (1MW)	CapEx [MUSD]	Present Value OpEx [MUSD]	excess generation (MWh)	Present Value COST [MUSD]	Present Value BENEFITS ex Carbon high WTP [MUSD]	**Net Present Value without Carbon @ hurlde rate [MUSD]**	**EIRR Case without Carbon**	Switching Value Capex in % of assumed cost	Carbon savings p.a. [t]	Carbon savings lifetime ['000 t]	Lveelized Annual Value of Carbon Low Case [MUSD]	Annual Value of Carbon Base Case [MUSD]	**Levelized Annual Value of Carbon High Case [MUSD]**	Annual Value BENEFITS cum Carbon Base Case [USD]	Net Present Value WITH Carbon BASE CASE @ hurlde rate [USD]	EIRR with Carbon Base Case [USD]	Switching Value Capex in % of assumed cost	RE SHARE	P Share
0.5	0	0.90	0.65	7.22	1.55	9.51	7.96	52%	466%	534	13.4	0.26	0.44	0.77	9.94	8.4	54%	515%	5%	17%
1.0	0	1.80	1.29	103.30	3.09	16.97	13.88	46%	408%	1021	25.5	0.49	0.84	1.48	17.80	14.7	48%	455%	9%	33%
1.0	1	2.82	2.22	0.00	5.04	19.13	14.09	33%	266%	1110	27.7	0.53	0.91	1.61	20.04	15.1	34%	298%	10%	33%
1.0	2	4.14	4.16	0.00	8.30	19.14	10.84	20%	133%	1110	27.8	0.53	0.91	1.61	20.05	11.8	21%	156%	10%	33%
1.5	0	2.70	1.94	202.37	4.64	24.36	19.73	44%	387%	1526	38.2	0.73	1.25	2.21	25.61	21.0	46%	434%	14%	50%
1.5	1	3.72	2.87	0.08	6.59	28.71	22.12	38%	315%	1691	42.3	0.81	1.39	2.45	30.10	23.6	39%	353%	15%	50%
1.5	2	4.89	4.31	0.00	9.20	28.73	19.53	28%	210%	1692	42.3	0.81	1.39	2.45	30.11	21.0	29%	239%	15%	50%
1.5	3	6.21	6.24	0.00	12.45	28.73	16.28	20%	133%	1692	42.3	0.81	1.39	2.45	30.12	17.8	21%	156%	15%	50%
1.5	4	7.53	8.18	0.00	15.71	28.74	13.03	15%	84%	1693	42.3	0.81	1.39	2.45	30.13	14.6	16%	103%	15%	50%
2.0	0	3.60	2.58	380.85	6.18	29.93	23.75	40%	351%	1982	49.5	0.95	1.62	2.87	31.56	25.4	42%	397%	17%	67%
2.0	1	4.62	3.52	51.20	8.14	36.96	28.83	39%	330%	2242	56.0	1.07	1.84	3.25	38.80	30.8	41%	371%	19%	67%
2.0	2	5.64	4.45	0.00	10.09	38.06	27.97	33%	264%	2277	56.9	1.09	1.87	3.30	39.92	29.9	34%	297%	19%	67%
2.0	3	6.96	6.39	0.00	13.35	38.07	24.72	25%	185%	2278	56.9	1.09	1.87	3.30	39.93	26.7	27%	213%	19%	67%
2.0	4	8.28	8.33	0.00	16.61	38.08	21.47	20%	132%	2278	57.0	1.09	1.87	3.30	39.94	23.5	21%	155%	19%	67%
2.0	5	9.60	10.26	0.00	19.86	38.09	18.22	16%	93%	2279	57.0	1.09	1.87	3.30	39.95	20.3	17%	113%	19%	67%
2.5	0	4.50	3.23	737.43	7.73	31.41	23.69	33%	283%	2317	57.9	1.11	1.90	3.35	33.31	25.7	35%	326%	20%	83%
2.5	1	5.52	4.16	220.20	9.68	42.61	32.93	38%	317%	2707	67.7	1.30	2.22	3.92	44.83	35.3	39%	358%	23%	83%
2.5	2	6.54	5.10	3.59	11.64	47.29	35.65	35%	289%	2853	71.3	1.37	2.34	4.13	49.63	38.1	37%	326%	24%	83%
2.5	3	7.71	6.53	0.05	14.24	47.36	33.12	29%	227%	2855	71.4	1.37	2.34	4.13	49.70	35.6	31%	258%	24%	83%
2.5	4	9.03	8.47	0.00	17.50	47.38	29.88	24%	172%	2856	71.4	1.37	2.34	4.13	49.72	32.4	25%	198%	24%	83%
2.5	5	10.35	10.41	0.00	20.76	47.39	26.63	20%	131%	2857	71.4	1.37	2.34	4.14	49.73	29.2	21%	154%	24%	83%
2.5	6	11.67	12.34	0.00	24.01	47.39	23.38	17%	99%	2857	71.4	1.37	2.34	4.14	49.74	25.9	18%	120%	24%	83%
3.0	0	5.40	3.87	1224.24	9.27	29.90	20.63	26%	209%	2562	64.0	1.23	2.10	3.71	32.00	22.8	27%	249%	22%	100%
3.0	1	6.42	4.81	432.60	11.23	47.35	36.13	36%	300%	3146	78.6	1.51	2.58	4.55	49.93	38.8	37%	341%	27%	100%
3.0	2	7.44	5.74	95.45	13.18	54.59	41.41	36%	295%	3371	84.3	1.62	2.76	4.88	57.35	44.3	37%	333%	28%	100%
3.0	3	8.46	6.67	31.03	15.13	55.96	40.83	32%	257%	3414	85.4	1.64	2.80	4.94	58.76	43.8	33%	291%	29%	100%
3.0	4	9.78	8.61	10.42	18.39	56.42	38.02	27%	204%	3428	85.7	1.64	2.81	4.96	59.23	41.0	28%	234%	29%	100%
3.0	5	11.10	10.55	3.82	21.65	56.57	34.92	23%	163%	3433	85.8	1.65	2.81	4.97	59.38	38.0	24%	189%	29%	100%
3.0	6	12.42	12.49	0.89	24.91	56.64	31.73	20%	130%	3436	85.9	1.65	2.82	4.97	59.45	34.8	21%	153%	29%	100%
3.0	7	13.74	14.43	0.69	28.17	56.65	28.49	17%	103%	3437	85.9	1.65	2.82	4.97	59.47	31.6	18%	124%	29%	100%
3.5	0	6.30	4.52	1686.56	10.82	28.95	18.14	20%	161%	2827	70.7	1.36	2.32	4.09	31.27	20.6	22%	199%	25%	117%
3.5	1	7.32	5.45	795.81	12.77	48.65	35.88	32%	263%	3477	86.9	1.67	2.85	5.03	51.50	38.9	33%	303%	29%	117%
3.5	2	8.34	6.39	399.89	14.73	57.15	42.42	33%	271%	3741	93.5	1.79	3.07	5.41	60.21	45.7	35%	309%	31%	117%
3.5	3	9.36	7.32	256.03	16.68	60.24	43.56	31%	248%	3838	95.9	1.84	3.14	5.55	63.38	46.9	32%	283%	32%	117%
3.5	4	10.53	8.76	185.90	19.29	61.75	42.46	28%	214%	3884	97.1	1.86	3.18	5.62	64.93	45.9	29%	245%	33%	117%
3.5	5	11.85	10.69	150.72	22.54	62.51	39.97	24%	177%	3909	97.7	1.87	3.20	5.66	65.72	43.4	26%	205%	33%	117%
3.5	6	13.17	12.63	125.56	25.80	63.06	37.26	21%	146%	3926	98.2	1.88	3.22	5.68	66.28	40.7	23%	171%	33%	117%
3.5	7	14.49	14.57	110.00	29.06	63.40	34.34	19%	121%	3937	98.4	1.89	3.23	5.70	66.62	37.8	20%	143%	33%	117%
3.5	8	15.81	16.51	98.30	32.32	63.64	31.32	17%	99%	3944	98.6	1.89	3.23	5.71	66.87	34.9	18%	120%	33%	117%
4.0	0	7.20	5.16	2106.83	12.36	28.97	16.61	17%	132%	3123	78.1	1.50	2.56	4.52	31.53	19.3	19%	168%	27%	133%
4.0	1	8.22	6.10	1245.54	14.32	47.98	33.67	27%	222%	3750	93.8	1.80	3.07	5.43	51.06	36.9	29%	260%	32%	133%
4.0	2	9.24	7.03	832.75	16.27	56.85	40.58	29%	236%	4025	100.6	1.93	3.30	5.83	60.15	44.1	31%	273%	34%	133%
4.0	3	10.26	7.97	666.49	18.23	60.41	42.19	28%	221%	4136	103.4	1.98	3.39	5.99	63.80	45.8	29%	255%	35%	133%
4.0	4	11.28	8.90	581.02	20.18	62.24	42.06	26%	201%	4191	104.8	2.01	3.43	6.07	65.68	45.7	27%	232%	35%	133%
4.0	5	12.60	10.84	532.29	23.44	63.28	39.85	23%	168%	4224	105.6	2.02	3.46	6.11	66.74	43.6	24%	196%	35%	133%
4.0	6	13.92	12.77	500.42	26.69	63.97	37.28	20%	141%	4246	106.1	2.04	3.48	6.15	67.45	41.0	22%	166%	36%	133%
4.0	7	15.24	14.71	481.75	29.95	64.38	34.42	18%	117%	4259	106.5	2.04	3.49	6.16	67.87	38.2	19%	140%	36%	133%
4.0	8	16.56	16.65	472.57	33.21	64.58	31.37	16%	96%	4266	106.6	2.04	3.50	6.17	68.08	35.2	17%	118%	36%	133%
4.5	0	8.10	5.81	2596.81	13.91	27.38	13.48	14%	99%	3370	84.3	1.62	2.76	4.88	30.15	16.4	15%	134%	29%	150%
4.5	1	9.12	6.74	1755.71	15.86	45.93	30.06	23%	181%	3982	99.6	1.91	3.26	5.76	49.19	33.5	25%	218%	34%	150%
4.5	2	10.14	7.68	1364.00	17.82	54.31	36.49	25%	196%	4242	106.1	2.03	3.48	6.14	57.78	40.2	26%	231%	36%	150%
4.5	3	11.16	8.61	1182.04	19.77	58.21	38.44	24%	187%	4362	109.1	2.09	3.57	6.31	61.78	42.2	26%	220%	37%	150%
4.5	4	12.18	9.54	1102.63	21.72	59.91	38.18	23%	171%	4414	110.3	2.12	3.62	6.39	63.52	42.0	24%	201%	37%	150%
4.5	5	13.35	10.98	1069.29	24.33	60.62	36.29	20%	148%	4436	110.9	2.13	3.64	6.42	64.25	40.2	22%	175%	37%	150%
4.5	6	14.67	12.92	1044.00	27.59	61.16	33.58	18%	123%	4453	111.3	2.13	3.65	6.45	64.81	37.5	19%	148%	37%	150%
4.5	7	15.99	14.86	1029.69	30.85	61.48	30.63	16%	101%	4463	111.6	2.14	3.66	6.46	65.13	34.6	17%	125%	37%	150%
4.5	8	17.31	16.79	1021.28	34.10	61.66	27.56	14%	83%	4469	111.7	2.14	3.66	6.47	65.32	31.6	15%	104%	37%	150%
4.5	9	18.63	18.73	1015.20	37.36	61.79	24.43	12%	67%	4473	111.8	2.14	3.67	6.47	65.46	28.5	13%	87%	37%	150%
5.0	0	9.00	6.45	3137.55	15.45	24.63	9.18	10%	66%	3582	89.6	1.72	2.94	5.19	27.57	12.3	11%	100%	31%	167%
5.0	1	10.02	7.39	2338.31	17.41	42.20	24.79	18%	140%	4162	104.1	2.00	3.41	6.02	45.61	28.4	20%	174%	35%	167%
5.0	2	11.04	8.32	1954.28	19.36	50.40	31.04	21%	156%	4417	110.4	2.12	3.62	6.39	54.02	34.9	22%	189%	37%	167%
5.0	3	12.06	9.26	1777.90	21.32	54.19	32.87	20%	151%	4533	113.3	2.17	3.71	6.56	57.90	36.8	22%	182%	38%	167%
5.0	4	13.08	10.19	1707.85	23.27	55.69	32.42	19%	138%	4579	114.5	2.19	3.75	6.63	59.44	36.4	20%	167%	38%	167%
5.0	5	14.10	11.12	1677.20	25.22	56.35	31.13	17%	123%	4600	115.0	2.20	3.77	6.66	60.12	35.2	19%	151%	39%	167%
5.0	6	15.42	13.06	1658.77	28.48	56.75	28.27	15%	101%	4612	115.3	2.21	3.78	6.68	60.53	32.3	17%	126%	39%	167%
5.0	7	16.74	15.00	1643.46	31.74	57.08	25.34	13%	83%	4621	115.5	2.22	3.79	6.69	60.87	29.5	15%	106%	39%	167%
5.0	8	18.06	16.94	1639.18	35.00	57.17	22.17	12%	66%	4624	115.6	2.22	3.79	6.69	60.96	26.3	13%	87%	39%	167%
5.0	9	19.38	18.88	1635.70	38.26	57.24	18.99	10%	51%	4626	115.7	2.22	3.79	6.70	61.03	23.2	11%	71%	39%	167%

C: CBA Results of CTF-targeted Systems

2% IRR = EIRR Haiti 2017

I. CBA ASSUMPTIONS FOR TYPICAL CTF SYSTEM SIZES							II. RESULTING ECONOMIC INDICATORS WITHOUT CARBON							III. RESULTING ECONOMIC INDICATORS WITH CARBON								
System Size [Wp]	CTF System Type	Hybrid Village Grid?	Li-Ion bat.	Life-time	CapEx [USD]	Present Value OpEx [USD]	Present Value COST Haiti [USD]	Annual Value BENEFITS ex Carbon [USD]	**Net Present Value without Carbon @ hurlde rate [USD]**	**EIRR without Carbon**	Switching Value Capex in % of assumed cost	System Size [Wp]	CTF System Type	Carbon savings p.a. [t]	Carbon savings lifetime [t]	Lveelized Annual Value of Carbon Low Case* [USD]	Annual Value of Carbon Base Start Price Only *** [USD]	**Levelized Annual Value of Carbon Base Case** [USD]**	Annual Value BENEFITS cum Carbon Base Case [USD]	Net Present Value WITH Carbon BASE CASE @ hurlde rate [USD]	EIRR with Carbon Base Case [USD]	Switching Value Capex in % of assumed cost
							2%		*2%*		*2%*					*2%*	*2%*	*2%*		*2%*		
2.5	1	No	yes	3	70	-	70	32	**23**	**41%**	132%	2.5	1	0.02	0.1	0.49	0.76	0.86	33	**25**	**46%**	136%
5	1	No	yes	4	150	-	150	48	**78**	**31%**	152%	5	1	0.05	0.2	1.0	1.5	1.7	50	**86**	**34%**	158%
10	**1**	No	yes	6	250	-	250	66	**184**	**28%**	174%	**10**	**1**	0.10	0.6	2.0	3.0	3.4	70	**206**	**31%**	183%
20	1	No	yes	8	400	-	400	100	**427**	**29%**	207%	20	1	0.20	1.6	3.9	6.1	6.9	107	**483**	**33%**	221%
20	2	No	No	20	250		480	88	**898**	**39%**	459%	20	2	0.22	4.4	5.9	6.7	9.1	97	**1,047**	**46%**	519%
50	**2**	No	No	20	500	250	750	180	**2,041**	**45%**	508%	**50**	**2**	0.41	8.1	10.9	12.6	17.0	197	**2,320**	**52%**	564%
100	2	No	No	20	900	450	1,350	325	**3,689**	**45%**	510%	100	2	0.51	10.2	13.7	15.8	21.4	346	**4,039**	**50%**	549%
100	3	yes	No	20	800	1,962	2,762	359	**3,122**	**43%**	490%	100	3	0.51	10.2	13.7	15.8	21.4	380	**3,472**	**48%**	534%
200	**3**	yes	No	20	1,600	3,924	5,524	665	**5,383**	**36%**	436%	**200**	**3**	0.70	14.0	18.8	21.6	29.2	694	**5,861**	**40%**	466%

10% IRR = Investor FIRR for typical WB project (moderate wacc) and also old WBG EIRR standard countyr hurdle rate

I. CBA ASSUMPTIONS FOR TYPICAL CTF SYSTEM SIZES							II. RESULTING ECONOMIC INDICATORS WITHOUT CARBON							III. RESULTING ECONOMIC INDICATORS WITH CARBON								
System Size [Wp]	CTF System Type	Hybrid Village Grid?	Li-Ion bat.	Life-time	CapEx [USD]	Present Value OpEx [USD]	Present Value COST [USD]	Annual Value BENEFITS ex Carbon [USD]	**Net Present Value without Carbon @ hurlde rate [USD]**	**EIRR without Carbon**	Switching Value Capex in % of assumed cost	System Size [Wp]	CTF System Type	Carbon savings p.a. [t]	Carbon savings lifetime [t]	Lveelized Annual Value of Carbon Low Case* [USD]	Annual Value of Carbon Base Start Price Only *** [USD]	**Levelized Annual Value of Carbon Base Case** [USD]**	Annual Value BENEFITS cum Carbon Base Case [USD]	Net Present Value WITH Carbon BASE CASE @ hurlde rate [USD]	EIRR with Carbon Base Case [USD]	Switching Value Capex in % of assumed cost
							10%	*10%*	*10%*		*10%*					*10%*	*10%*	*10%*	*10%*	*10%*		*10%*
2.5	1	No	yes	3	70	-	70	32	**15**	**41%**	122%	2.5	1	0.02	0.1	0.49	0.76	0.86	33	**17**	**46%**	125%
5	1	No	yes	4	150	-	150	48	**45**	**31%**	130%	5	1	0.05	0.2	1.0	1.5	1.7	50	**51**	**34%**	134%
10	**1**	No	yes	6	250	-	250	66	**96**	**28%**	138%	**10**	**1**	0.10	0.6	2.0	3.0	3.4	70	**112**	**31%**	145%
20	1	No	yes	8	400	-	400	100	**215**	**29%**	154%	20	1	0.20	1.6	3.9	6.1	6.9	107	**254**	**33%**	164%
20	2	No	No	20	250		450	87	**387**	**41%**	255%	20	2	0.22	4.4	5.9	6.7	9.1	96	**465**	**48%**	286%
50	**2**	No	No	20	500	200	700	179	**896**	**46%**	279%	**50**	**2**	0.41	8.1	10.9	12.6	17.0	196	**1,041**	**54%**	308%
100	2	No	No	20	900	360	1,260	322	**1,620**	**47%**	280%	100	2	0.51	10.2	13.7	15.8	21.4	344	**1,802**	**52%**	300%
100	3	yes	No	20	800	1,022	1,822	336	**1,112**	**37%**	239%	100	3	0.51	10.2	13.7	15.8	21.4	357	**1,294**	**42%**	262%
200	**3**	yes	No	20	1,600	2,043	3,643	619	**1,775**	**31%**	211%	**200**	**3**	0.70	14.0	18.8	21.6	29.2	649	**2,024**	**34%**	227%

10. Sensitivity of EIRR and FIRR on key assumptions have been analyzed for the full range of typical system types and sizes targeted by the project, to reflect (i) the diverse range of RE options close to "take-off" (as describe in SREP IP) and (ii) the uncertainty in final sub-project selection for components 1+2 (as described in this SREP PAD).

11. As the economics of PV-battery-diesel hybrid generation (i) are rapidly changing at the time of analysis (and expected to do so until projected project start and end), and (ii) depend significantly on a whole array of crucial project details (which vary with each village and provider model and will only be known at feasibility stage, when the exact target project sites will be selected from our long list, based on the criteria listed in the PAD), the exact EIRR and FIRR of each sub-project will vary and will only be known at implementation stage.

12. Therefore, we have analyzed (i) in depth the most certain sub-project (Jeremie) in more detail than usual, to illustrate all key effects of hybrid RE system IRR sensitivity around this sub-project's base case – such as PV and battery sizes relative to peak load (which also hold for the other systems in general, albeit to varying degree); and (ii) added a broad analysis of the costs and benefits of the other longlist projects, to show how the base cases for those vary - due to system load curve, user number, distribution losses, existing diesel generator(s) - and existing hydro generation (in 2 cases).

13. NPV(FIRR) varies strongly with WACC and exact provider model.

14. As said sub-project details notably include the exact ownership structure, risk sharing and business model, this affects NPV at FIRR even more strongly than at EIRR (because FIRR varies with sub-project sponsors' WACC). To illustrate this, we have added a very high FIRR (20 percent) and a moderate FIRR (10 percent) throughout the full set of sensitivity tables. Obviously, the potential project sponsors themselves will decide during implementation if project IRR is above their subjective FIRR (in which case they would invest). However, the NPV (FIRR) tables for our longlist of projects give an initial indication that a sufficient number of typical sponsors would be interested under the main scenarios we have described for risk allocation and project incentives.

15. The following key sensitivities are covered by our analysis:

a. PV Capex continue to fall rapidly, but local PV LEC in Haiti may be much higher than international benchmark, initially.

b. LiIon batteries will play a key role in post project Haiti, but capex and quality are in flux so that assumptions have a high uncertainty. This is typical for the strong "demo effect" on investment decision and wacc desired by SREP.

c. While PV has reached economic viability for many of the single-user and multi-user cases described in the Haiti SREP IP, the optimal PV share for each project investment vase depends strongly on the exact time of investment, the specific system, the project sponsor – and on the exact priority between financial and economic indicators (namely IRR, LEC, Capex, liquidity over time, and risk aversion). This is particularly obvious for village grids of all sizes (both greenfield and retrofits), which are the main chunk of SREP project investments. A similar trend holds for the optimal LiIon battery size (investment), though with a slight delay in Capex evolution (and thus optimal "battery share" of annual energy).

d. There are three main cases of "PV shares", with different general trends for the key indicators, as shown in the table below:
    i. Low PV Share (Village) Grids boast the highest IRR, but have high LEC and volatility (which increases offtaker risk (and thus wacc and hurdle FIRR) from potential private project sponsors' point of view) due to their relatively low fuel savings compared to case ii and iii.
    ii. Medium PV Share Grids have slightly lower IRR
    iii. High PV Share grids have the best LEC and savings but lower NPV.

e. At the present battery cost, "battery share" has a much less pronounced (and thus certain) impact on sub-system IRR than "PV share". Therefore, optimal battery sizing (and thus cost) is more uncertain.

Carbon Benefits

16. For the present SREP PAD and the parallel CTF PAD, recommendations from the latest World Bank Guidance (2014) were followed. The analysis includes: (i) a CBA scenario completely without Carbon Benefits; as well as (ii) a BASE CASE and (iii) a LOW CASE scenario for the CARBON PRICE ("Social Value") of abated Carbon (base case carbon price starting at US$30/t in 2015 and low case price scenario starting at US$15/t in 2015).[103]

17. We have calculated carbon savings in several steps:

(1) probable carbon savings per user were estimated separately (by applying the emission factors recommended in the latest World Bank and UNFCCC guidance documents for GHG accounting for electrification of rural communities) for a broad range of eligible OGEF system sizes and categories (CTF types 1-3).

(2) The expected total carbon savings for each project year were then estimated as the weighted average of the system-specific savings under realistic scenarios (obviously, actual shares and thus savings will only be known ex post).

(3) For total system lifetime savings, and their total "social value", we then used the same range of real-life life spans for each system type that was used for all elements of EIRR calculation - that is, (i) 3-10 years for CTF type 1 (solar lanterns and kits which are Li-Ion-based over-the-counter products) and (ii) 20-25 years (physical generator life) for types 2 including typical operations and maintenance replacements and balance-of-system components such as batteries (SHS and offgrid solar savers for SME) and 3+4 (low-end village grids, expected to average 200 Wp/User so that they are treated similar to SHS, and high-end village grids with 400 and 500 Wp/User).

(4) For calculating the value of these carbon savings, we applied the growing annual carbon values suggested in above-quoted World Bank guidance, separately for the low case, base case and high case carbon value trajectories given there.

120. Thus, for the abated CARBON QUANTITIES, the latest (2015) recommendations by WBG and UNFCCC for small off-grid access systems were applied to the main system classes targeted by SREP and the parallel CTF:

- pico lanterns and kits with Li-Ion batteries - the actual physical lifetimes (3-10 years) and no O&M costs are assumed, and no carbon benefits are counted after product life;

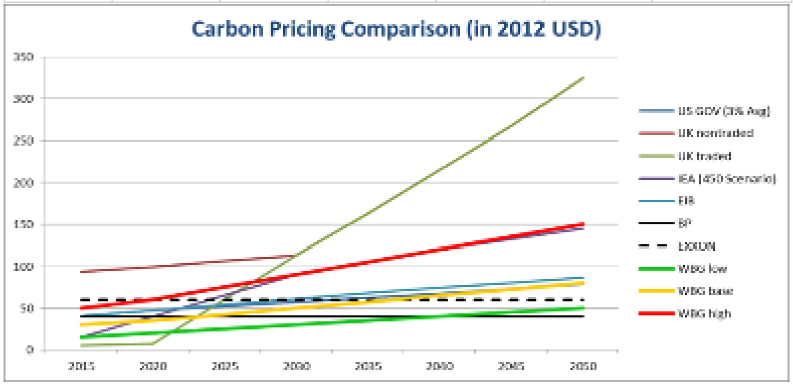
- "classic" solar home systems of 20-200 Wp with lead-acid batteries which are installed by a technician and have O&M costs and a lifetime of 20 years;

- solar hybrid Village Grids with 200 Wp/user and therefore can be treated as 200 Wp SHS for carbon benefit purposes (but not for Capex and Opex, which include the LV grid etc.)

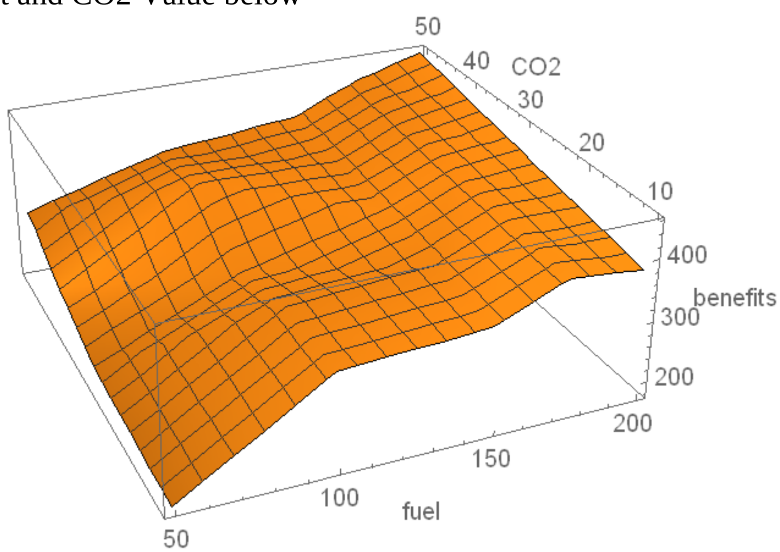
[103] World Bank: Investment Project Financing: Economic Analysis Guidance Note, 2014 / World Bank: Social Value of Carbon in project appraisal; Guidance note to the World Bank Group staff; 2014

- village grids as above but with 300 to 1000 Wp/user (not a probable option).

Carbon prices		from SREP IP and WBG GUidance on Carbon Values 2012+				
		2015	**2020**	**2030**	**2040**	**2050**
	Low	15	20	30	40	50
	Base	30	35	50	65	80
	High	50	60	90	120	150



Cum Carbon Benefits obviously increase with Carbon “Social” Value as per Table and Graph above, as confirmed by our example simulation of operational benefits as a function of fuel cost and CO2 Value below



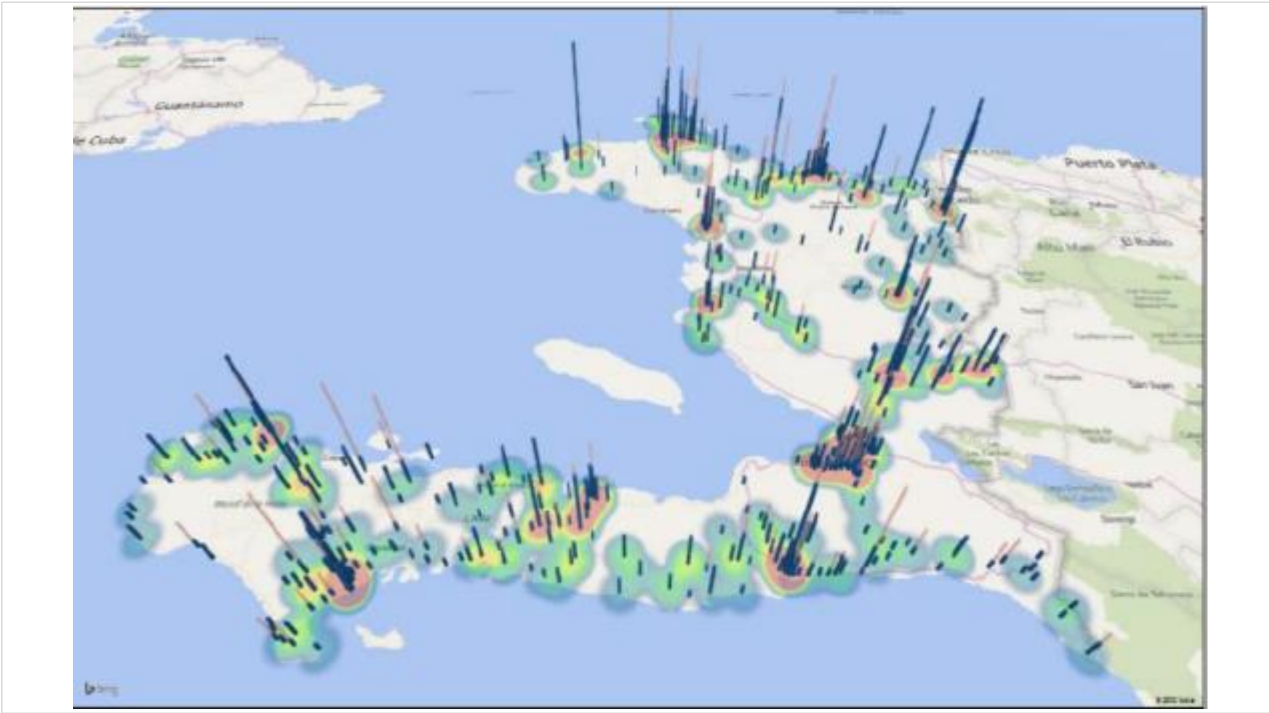
The main effects at play when updating SREP EIRR and FIRR from 2015 to 2017.

What has changed since SREP IP?	Effect on NPV?	Issues at play
UP: International Crude Oil Price	**DOWN**	Using heat rates, start-up costs and part load operation data for Haiti thermal gensets, lower diesel fuel costs can readily be used to calculate lower short-run marginal generation cost and LEC [$/MWh], as illustrated in the tables and graphs below. Yet, it should be noted that international Crude price reductions are not necessarily passed on 100 percent to captive clients on islands. While this can be neglected for the conservative "low thermal generation LEC" in economic analysis, winners and losers have to be analyzed in light of existing PPAs, both for EDH and smaller SME clients with genset power.
DOWN: Haiti HURDLE RATE used as IRR for NPV calculation (and for LEC)	**UP**	WB recommended new method for EIRR HURDLE RATE calculation. Thus Base case country threshold rate: 10 percent → 2 percent
DOWN: Base Case Capex PV 2017-2021 slightly down	**UP**	because 1 year later and additional LCR tenders reduce uncertainty → SEE ANNEX. For example, recent PV tenders in Brasil and PPAs signed in Chile suggest PV LEC well below US$0.10/kWh!
Case for small DisGen clearer	**UP**	Hard to quantify but >0
PCN recommends NPV-based RE tendering, not cost-based irrespective of system value	**UP**	Hard to quantify but >0
TOTAL EFFECT	Slightly Up	Base Case NPV(2016)-NPV (2015) =⍰NPV>0. However: ⍰NPV < sd(NPV). Thus, stick to SREP IP estimates for PCN, but may include finer scenarios for PAD.

Other Issues (including overall CTF Program)

18. The Economic and Financial Analysis of the overall SREP and CTF Project analyzed potential investments with an extremely broad range of RE electrification options to account for all possible off-grid business models and system types and sizes. These cases are based on the actual universe of existing users, villages and firms in Haiti. The cases cover various (i) off-grid RE technologies (mainly PV and PV hybrid, but covering a range of system sizes and types for the stand-alone as well as the village systems), (ii) firm sizes (small retailers to large DESCOs), and (iii) different business models (PAYG, Li-ion and/or iMeter-based "smart" off grid systems with higher upfront costs, as well as more traditional SHS and village grids with lead acid batteries and low-cost billing). This open, more comprehensive approach to off-grid electrification reflects (i) local conditions and the multitude of emerging business models serving different market segments in Haiti; and (ii) the current stage of international off-grid markets, where a growing diversity of solid and viable approaches has emerged. This unusually extensive analysis is made possible thanks to (i) the synergies with SREP IP preparation, (ii) the deeper information available from nascent IT-based off-grid businesses in situ, and (iii) the Digicel/iiDevelopment mobile-phone survey (N=1400) which allowed to construct income-corrected demand curves as well as WTP-distributions by department.

Geospatial spread of the Digicel/iiDevelopment 2014 energy survey

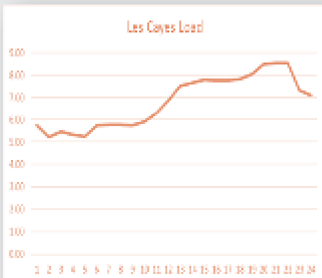
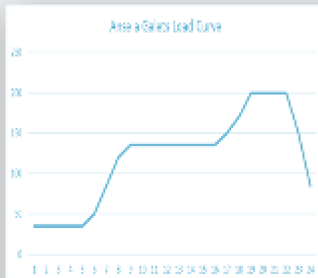
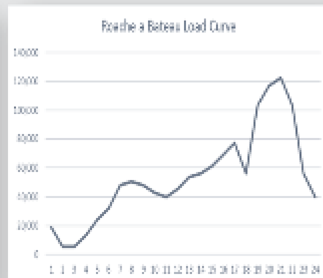


19. In total, the analysis covered four village “cases”, ten sizes of stand-alone PV users (from low-end PicoPV to large SHS and productive PV uses); as well as several supply company types and types of financial support. A comprehensive description of the demand- and supply side analysis, and the choice of cases, can be found in the related SREP IP and its background documents. This Annex focuses on the most representative cases, based on the most promising pipeline candidates (such as Revolt, EarthSpark, etc.) and probable market growth scenarios. The aggregate project-level analysis based on the probable scenario is presented below.[104]

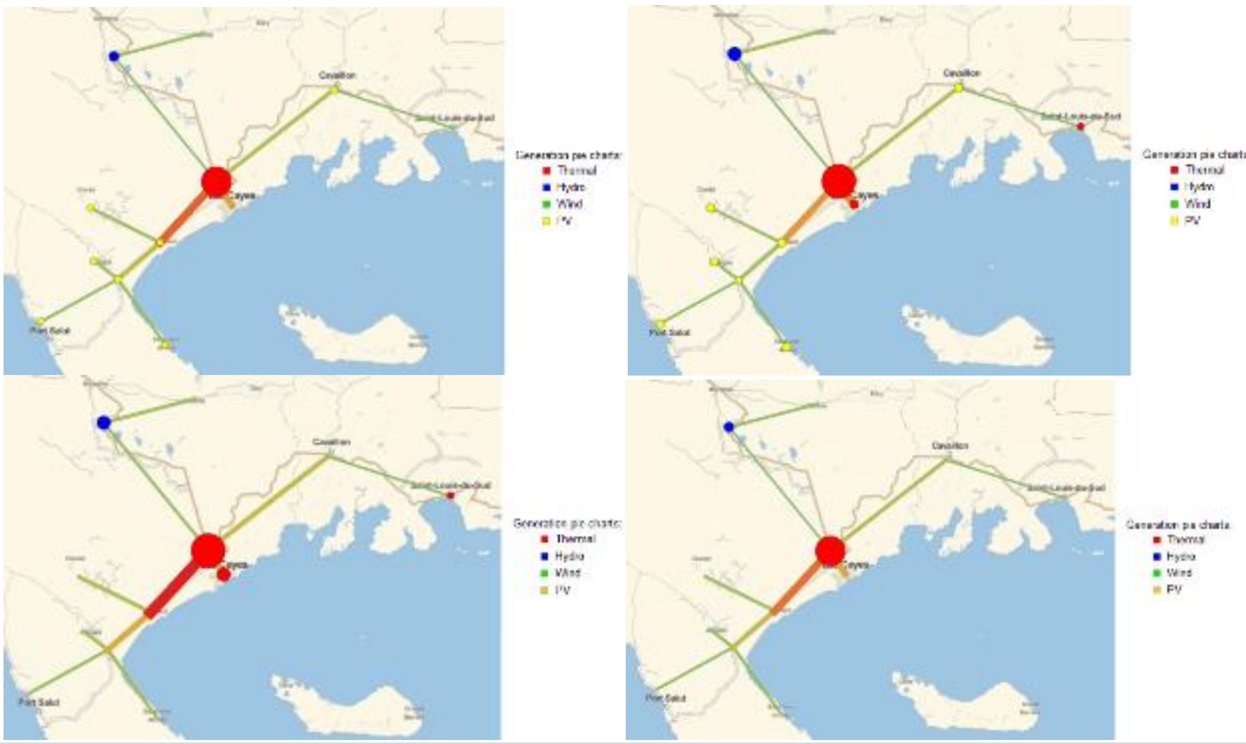
20. The final mix of cases may vary from the mix assumed in the Base Case Analysis and the sensitivity scenarios, as it will be determined by the actual private sector demand and implementation of the parallel CTF OGEF (retailer working capital, equity & RBF for nascent DESCOs and mini-grids, and medium term loans for mature DESCOs and mini-grids). In any case, the FI due diligence (for CTF), and the PCU (for SREP) will assure that the minimum requirements of economic least cost and financial robustness is met also by each individual “subproject” that is accepted for funding. Typical project funding cases are shown below.

[104] As per WB convention for rural energy projects, and for ease of clear comparison, all installations assumed in year 1 for the aggregate cash-flows are used in Economic Analysis, while they will be spread from year 1 to 6 in reality.

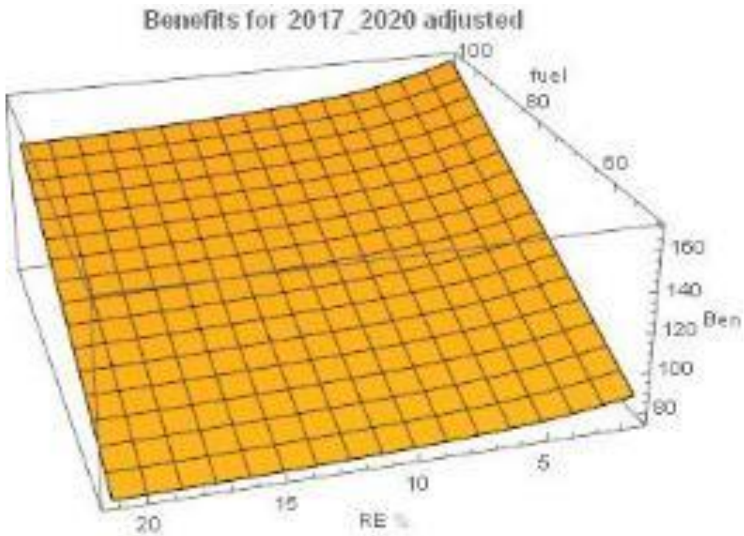
21. The tables and graphs on the next pages illustrate the Economic and Financial Analysis in more detail

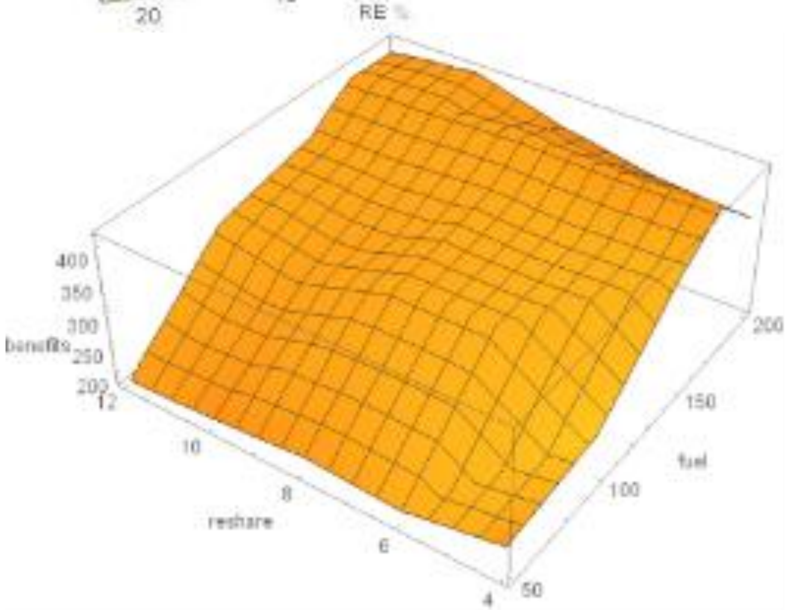
	Component 1 „EDH small isolated grids“	Component 2 „Retrofit Municipal Village Mini-Grids “	Component 2 „Greenfield Village Micro-Grids“
Main Difference:	1-10 MW generation EDH-operated Existing diesel and LV	100-1000 kWp demand Not EDH Existing diesel and LV	10-500 kWp demand Not EDH Greenfield: no LV in place
Load Curve Form:			
Probable PV share Total segment size Haiti	Can be anything from Low to High share (5-50% of energy, higher shares with storage) 9-11 EDH island grids excluding Port-au-Prience (depends on counting)	High + with battery >30 village grids with existing diesel and LV grid	High + with battery 40-80 high potential sites out of 350 possible sites according to Earth Spark and SREP IP market potential studies

Distributed PV generation in Les Cayes during 4 typical daytime hours (pie size = energy injected during 1 hour). Yellow = solar, Blue = existing hydro, red = existing thermal. The red lines indicate increased thermal losses. The possible gain from reducing LV losses was analyzed Versus the increased cost of distributed installation (and control!) of PV. Due to the short LV lines, there is no strong case for distributed generation based on line loss reduction alone. However, there may be an advantage in resilience of key clients against disasters, in case of smart inverters which allow island mode.



The Specific Minimum (sic) Operational Benefits of Injecting PV in the potential Project Site “Les Cayes” vary between with RE Share and assumed Economic Value of saved Fuel. Benefits based on consumer surplus and WTP are higher than the former.





Source: iiDevelopment

Conservative Base Case Analysis HOMER for typical Haiti Hybrid Grids Components 1+2

Jeremie Base Case

Results Summary

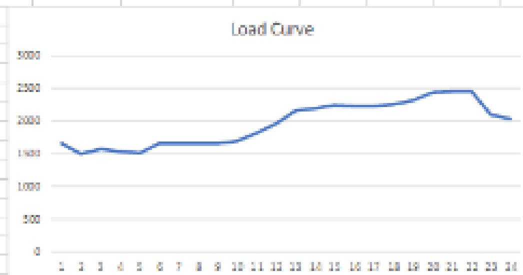
	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	RE Penet.	csv saved?
Base	0	0	0	1	4.91	0.288	n/a	-4,499,763	-11,799,405	161.0	64.9	31.7	0	S
Case 1	1000	0	0	2.21	4.53	0.268	25.1	389,466	1,011,268	149.0	61.5	30.8	9.2	S
Case 2	2000	1	750	4.97	4.08	0.247	19.6	854,943	2,241,854	137.0	58.3	30.5	19	S
Case 3	2650	2	1000	7.04	3.79	0.234	17.7	1,151,527	2,919,564	130.0	56.7	30.8	25	S
Case 4	4000	2	1150	9.11	3.39	0.214	16.1	1,534,629	4,024,148	119.0	53.5	30.3	34	S
Case 5	8051	2	1000	15.1	3.02	0.203	11.6	1,915,265	5,022,257	113.0	54.6	34.0	42	S

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	2%	Lifetime	25 years

Loads	Hour	Load
	0	1653
	1	1496
	2	1571
	3	1531
	4	1508
	5	1653
	6	1661
	7	1661
	8	1653
	9	1697
	10	1811
	11	1968
	12	2161
	13	2197
	14	2244
	15	2238
	16	2232
	17	2252
	18	2315
	19	2441
	20	2453
	21	2456
	22	2108
	23	2039

Homer Peak	3000.7	kW
Load Factor	65	%
Randon Variability		
Day to day	5	%
Timestep	5	%
Annual Energy	46,983	kWh/day



Le Cayes

Results Summary

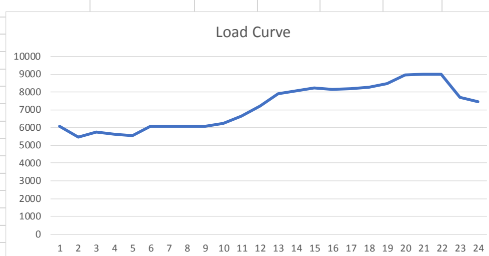
	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	RE Penet.	Unmet Load	csv saved?
Base	0	0	0	2	14.1	0.248	n/a	-12,737,891.00	-33,401,623.00	461.0	187.0	90.9	14%	9.12%	S
Case 1	5000	2	1303	11.6	12.7	0.22	n/a	1,511,000.00	3,962,183.00	425.0	178.0	91.8	27%	5.60%	S
Case 2	8333	2	5212	17.8	11.6	0.204	n/a	2,607,773.00	6,838,171.00	396.0	170.0	91.0	35%	4.89%	S
Case 3															
Case 4															
Case 5															

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	10%	Lifetime	25 years

Loads	Hour	Load
	0	6058
	1	5481
	2	5755
	3	5611
	4	5524
	5	6058
	6	6087
	7	6087
	8	6058
	9	6216
	10	6635
	11	7212
	12	7918
	13	8048
	14	8221
	15	8163
	16	8178
	17	8250
	18	8481
	19	8942
	20	8986
	21	9000
	22	7702
	23	7471

Homer Peak	10,992	kW
Load Factor	65	%
Randon Variability		
Day to day	5	%
Timestep	5	%
Annual Energy	172,142	kWh/day



Roche a Bateau

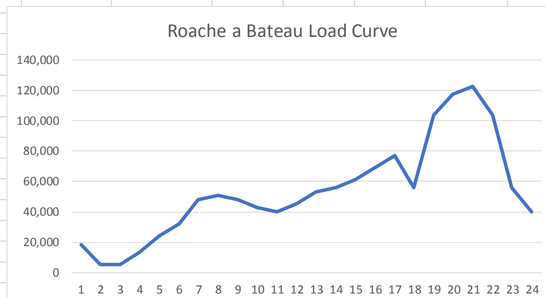
Results Summary

	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	RE Penet.	csv saved?
Base	0	0	0	27,800	176828	0.393	n/a	-161,158	-421,522	5.8	2.3	1.1	0	S
Case 1	0	3	50	402800	168746	0.389	n/a	20,394	53,342	5.9	2.6	1.5	0	S
Case 2	50	3	50	477800	144118	0.342	4.9	43,477	113,718	5.2	2.4	1.4	0.15	S
Case 3	100	3	50	552800	118158	0.289	10.3	67,297	176,022	4.4	2.1	1.3	0.32	S
Case 4	250	4	50	897800	90751	0.252	8.9	99,275	259,663	3.9	2.1	1.4	0.55	S
Case 5	650	14	150	2070000	74981	0.341	n/a	161,158	421,522	5.1	3.7	3.1	1	S

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	2%	Lifetime	25 years

Loads	Hour	Load			
	0	18,660	Homer Peak	150	kW
	1	5,320	Load Factor	36	%
	2	5,320			
	3	13,320	Randon Variability		
	4	23,980	Day to day	5	%
	5	31,980	Timestep	5	%
	6	47,970			
	7	50,630	Annual Energy	947	kWh/day
	8	47,970			
	9	42,630			
	10	39,970			
	11	45,300			
	12	53,300			
	13	55,970			
	14	61,290			
	15	69,290			
	16	77,280			
	17	55,970			
	18	103,930			
	19	117,260			
	20	122,590			
	21	103,930			
	22	55,970			
	23	39,970			



Anse à Galets

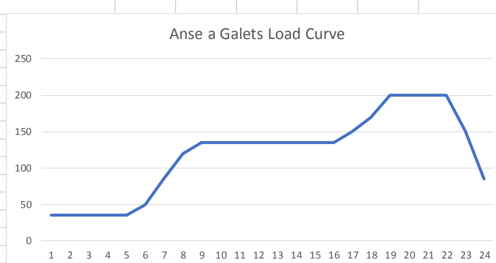
Results Summary

	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	Excess	RE Penet.	Homer saved	csv saved?
Base	0	0	0	0	578247	0.556	n/a	-518,702	-1,356,706	18.9	7.7	3.8	0.378	0%	S	S
Case 1	0	0	0	0.7367	435068	0.491	n/a	124,619	325,950	14.2	5.8	2.8	0.2	0%		S
Case 2	0	9	130	1.22	419629	0.437	n/a	180,357	471,739	14.9	6.7	3.8	0.003	0%	S	S
Case 3	130	10	100	1.53	359975	0.389	n/a	240,549	629,175	13.2	6.3	3.7	0.024	14%	S	S
Case 4	356	10	132	1.88	226183	0.272	n/a	360,435	942,747	9.2	4.9	3.2	0.032	51%	S	S
Case 5	1216	27	327	5.16	149750	0.3	n/a	518,702	1,356,706	10.0	7.2	5.9	0.445	100%	S	S

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	2%	Lifetime	25 years

Loads	Hour	Load			
	0	35	Homer Peak	250	kW
	1	35	Load Factor	49	%
	2	35			
	3	35	Randon Variability		
	4	35	Day to day	5	%
	5	50	Timestep	5	%
	6	85			
	7	120	Annual Energy	2856	kWh/day
	8	135			
	9	135			
	10	135			
	11	135			
	12	135			
	13	135			
	14	135			
	15	135			
	16	150			
	17	170			
	18	200			
	19	200			
	20	200			
	21	200			
	22	150			
	23	85			



Pointe à Raquette

Results Summary

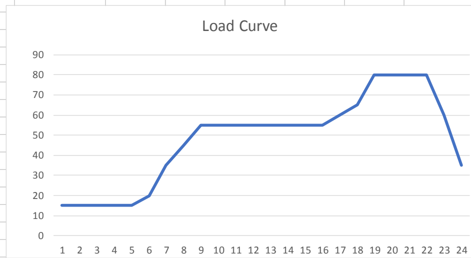
	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	Excess	RE Penet.	Homer saved	csv saved?
Base	0	0	0	27,800	169145	0.403	n/a	-153,475	-401,426	5.5	2.2	1.1	0.173	0%	S	S
Case 1	0	1	50	162800	152811	0.374	n/a	24,581	64,293	5.1	2.2	1.1	0	0%	S	S
Case 2	50	1	50	237800	140003	0.349	n/a	47,824	125,087	4.8	2.1	1.1	0	17%	S	S
Case 3	100	1	50	312800	111713	0.288	n/a	71,618	187,322	3.9	1.8	1.0	0	35%	S	S
Case 4	245	3	41.2	767660	73167	0.23	n/a	102,339	267,675	3.2	1.7	1.2	0.27	59%	S	S
Case 5	387	24	152	3510000	112526	0.523	n/a	153,475	401,426	7.2	5.1	4.1	0.279	100%	S	S

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	2%	Lifetime	25 years

Loads

Hour	Load			
0	15	Homer Peak	100	kW
1	15	Load Factor	49	%
2	15			
3	15	Randon Variability		
4	15	Day to day	5	%
5	20	Timestep	5	%
6	35			
7	45	Annual Energy	1155	kWh/day
8	55			
9	55			
10	55			
11	55			
12	55			
13	55			
14	55			
15	55			
16	60			
17	65			
18	80			
19	80			
20	80			
21	80			
22	60			



Anse à Galets and Pointe à Raquette interconected

Results Summary

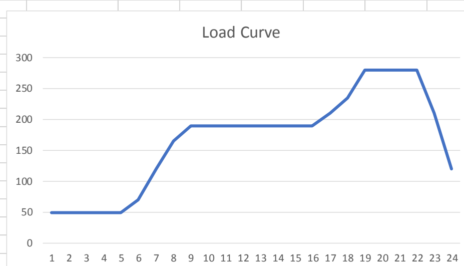
	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	Excess	RE Penet.	Homer sav	csv saved?
Base	0	0	0	113,440	513707	0.353	n/a	-467,076	-1,221,675	16.8	6.9	3.4	0.051	0%	S	S
Case 1	200	0	0	433440	479361	0.336	0.108	33,956	88,816	16.0	6.7	3.4	0.175	2.5%	S	S
Case 2	300	2	100	853440	328051	0.241	0.261	179,262	468,874	11.6	5.2	2.9	0.013	33.0%	S	S
Case 3	500	2	100	1.15	289032	0.221	0.22	217,543	569,002	10.5	5.0	3.0	0.14	42.0%	S	S
Case 4	750	5	200	1.92	284231	0.234	0.122	240,806	628,847	11.2	5.7	3.7	0.287	48.0%	S	S
Case 5																

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	2%	Lifetime	25 years

Loads

Hour	Load			
0	50	Homer Peak	350	kW
1	50	Load Factor	49	%
2	50			
3	50	Randon Variability		
4	50	Day to day	5	%
5	70	Timestep	5	%
6	120			
7	165	Annual Energy	4020	kWh/day
8	190			
9	190			
10	190			
11	190			
12	190			
13	190			
14	190			
15	190			
16	210			
17	235			
18	280			
19	280			
20	280			
21	280			
22	210			
23	120			



Jacmel

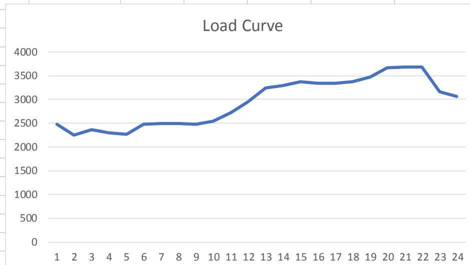
Results Summary

	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	RE Penet.	Homer svd?	csv saved?
Base	0	0	0	1	7.89	0.282	n/a	-7,343,053	-19,251,559	258.0	104.0	50.9	0	S	S
Case 1	3500	0	0	6.31N	6.47	0.236	27.1	1,406,143	3,686,542	217.0	90.9	47.1	0.2	S	S
Case 2	5000	0	0	8.56	6.03	0.223	24.6	1,829,797	4,797,364	205.0	87.4	46.6	0.26	S	S
Case 3	5000	2	3000	11.5	6.02	0.242	18.1	2,016,749	5,287,307	207.0	90.1	49.2	0.28	S	S
Case 4	7000	3	4500	16	5.63	0.214	14.9	2,481,880	6,506,641	199.0	89.7	51.2	0.35	S	S
Case 5															

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	2%	Lifetime	25 years

Loads	Hour	Load				
	0	2480	Homer Peak	5,000	kW	
	1	2244	Load Factor	65	%	
	2	2356				
	3	2297	Randon Variability			
	4	2262	Day to day	5	%	
	5	2480	Timestep	5	%	
	6	2492				
	7	2492	Annual Energy	78,300	kWh/day	(Scaled)
	8	2480				
	9	2545				
	10	2716				
	11	2952				
	12	3242				
	13	3295				
	14	3366				
	15	3342				
	16	3348				
	17	3378				
	18	3472				
	19	3661				
	20	3679				
	21	3685				
	22	3153				
	23	3059				



Cap Haitian

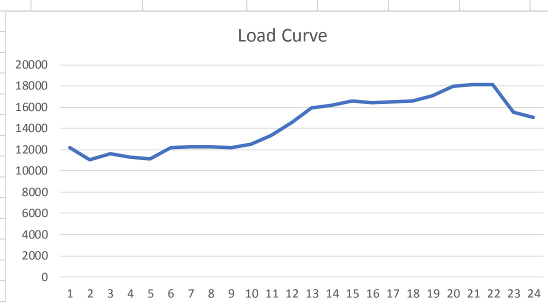
Results Summary

	PV Size	Battery	Converter	Capex	Opex	Lec	IRR	Fuel Saved	Carbon Saved	NPV 2%	NPV 10%	NPV 20%	RE Penet.	csv saved?
Base	0	0	0	4	28.3	0.28	n/a	-26,290,655	-68,940,024	922.0	373.0	182.0	0	S
Case 1	12000	0	0	21.8	23.2	0.234	n/a	4,962,226	13,012,074	775.0	325.0	168.0	20	S
Case 2	15000	20	16000	51.5	23.1	0.24	n/a	6,348,186	16,646,375	802.0	354.0	196.0	25	S
Case 3														
Case 4	50000	100	10000	184	16.1	0.216	n/a	16,721,024	43,846,294	706.0	394.0	278.0	65	S
Case 5	90000	300	36000	452	13.1	0.27	n/a	26,290,655	68,940,024	879.0	633.0	520.0	100	S

Inputs

Global	Discont Rate	2/10/20%	Inflation	4%	Annual Capacity Shortage	5%	Lifetime	25 years

Loads			Hour	Load			
			0	12200	Homer Peak		kW
			1	11038	Load Factor		%
			2	11590			
			3	11299	Randon Variability		
			4	11125	Day to day	5	%
			5	12200	Timestep	5	%
			6	12258			
			7	12258	Annual Energy		kWh/day
			8	12200			
			9	12519			
			10	13361			
Scaled avarage anual	283,853	kWhday	11	14523			
			12	15947			
			13	16208			
			14	16556			
			15	16440			
			16	16469			
			17	16615			
			18	17079			
			19	18009			
			20	18096			
			21	18125			
			22	15511			
			23	15046			

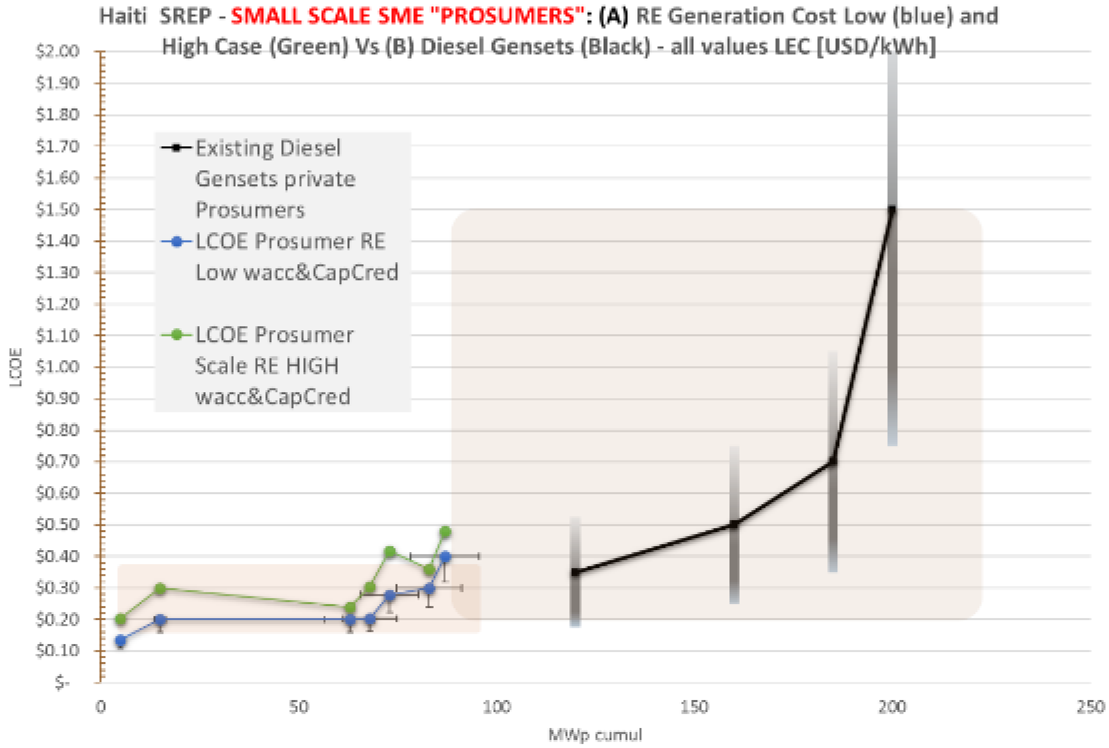


Key assumptions for the analysis

EDH Grids										
General			Grid specific							
cost of PV (M$/MW)	1.5			Jeremie	Cap Haïtien	Jacmel	Port de Paix	Petit Goave	Cayes	Gonaïves
cost of converter (M$/3000kW)	0.9		MWh per year per MWp PV installed	1684	1750	1679.217	1597.248	1639.73	1663.644	1763.51
converter lifetime	15		Diesel generation without PV (MWh)	17130	101364	28097.78	11874.75	42871.08	54681.18	74689.55
cost of battery high (M$/MWh pack)	1.02		Diesel used without PV (liters)	4499768	26290655	7343054	3131563	11209910	14226680	19496930
cost of battery low (M$/MWh pack)	0.50		yearly load (MWh)	17149	103606	28579.5	13165.19	42871.15	54985.89	91489.39
battery lifetime scenarios A (years)	15		CO2 emissions without PV (t/y)	11799.41		19255.13		29394.9	37305.56	51125.36
battery lifetime scenarios B (years)	10									
Min IRR for NPV 1	0.02	check sheets to modify actual % used								
WTP low ($/MWh)	300									
WTP high ($/MWh)	600									
diesel price low ($/L)	0.70									
diesel price high ($/L)	1.00									
CO2 emissions (kg/l)	2.56	used emissions reductions output by Homer								
PV O&M ($/y/MWh)	15000									
Converter O&M ($/y/3000kW)	123000									
Battery O&M ($/y/1MWh	10000									
Base IRR for discount	10%									

Small Village grids								
General			Village specific					
cost of PV (M$/MW)	1.5			Anse à Galets	PaR and AaG connected 25%	Anse à Galets 25%	Pointe à Raquette	Roche à Bateau
cost of converter (M$/3000kW)	0.9		MWh per year per MWp PV installed	1739.5	1734.308	1739.5		
converter lifetime	15		Diesel generation without PV (MWh)	1681.8	1467.30	1178.868		
cost of battery high (M$/MWh pack)	1.02		Diesel used without PV (liters)	518701.7	447263.8	391459.9		
cost of battery low (M$/MWh pack)	0.50		yearly load (MWh)	1059.548	1467.3	1059.548		
battery lifetime scenarios A (years)	15		CO2 emissions without PV (t/y)	1328.38312	1169.855	1023.895		
battery lifetime scenarios B (years)	10							
IRR for NPV	0.02							
WTP low ($/MWh)	300							
WTP high ($/MWh)	600							
diesel price low ($/L)	0.70							
diesel price high ($/L)	1.00							
CO2 emissions (kg/l)	2.56							
PV O&M ($/y/MWh)	15000							
Converter O&M ($/y/kW)	123000							
Battery O&M ($/y/1MWh	10000							

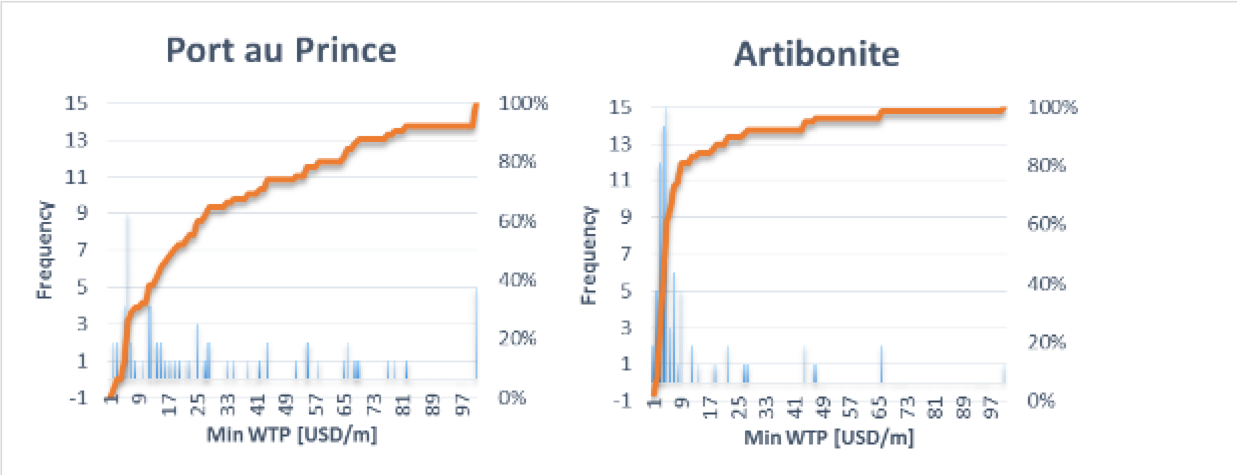
Selected Results of the Sensitivity Analysis



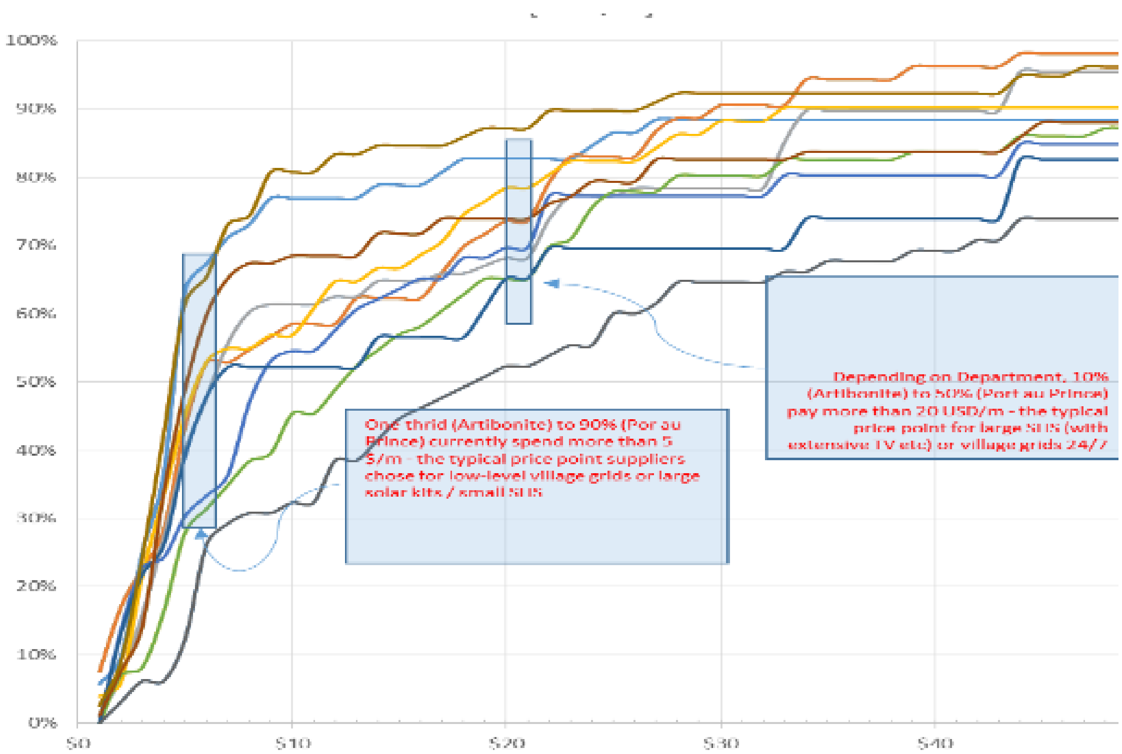
Average current substitutable energy expenses [$/m]	Rural	Urban	unweighted average
ARTIBONITE	$ 13.04	$ 23.65	$ 16.85
CENTRE	$ 22.84	$ 29.43	$ 25.06
GRAND ANSE	$ 20.78	$ 34.86	$ 27.51
NIPPES	$ 10.66	$ 26.72	$ 14.99
NORTH	$ 14.68	$ 36.66	$ 24.16
NORTH EAST	$ 17.95	$ 24.74	$ 22.37
NORTH WEST	$ 22.32	$ 37.14	$ 29.57
PORT AU PRINCE	$ 42.80	$ 44.76	$ 43.67
SOUTH	$ 11.37	$ 31.17	$ 18.47
SOUTH EAST	$ 13.22	$ 23.47	$ 16.72
(blank)			
		thus, aprox. weighted national average	$ 29.55

Source: Digicel/iiDevelopment Survey (2014).

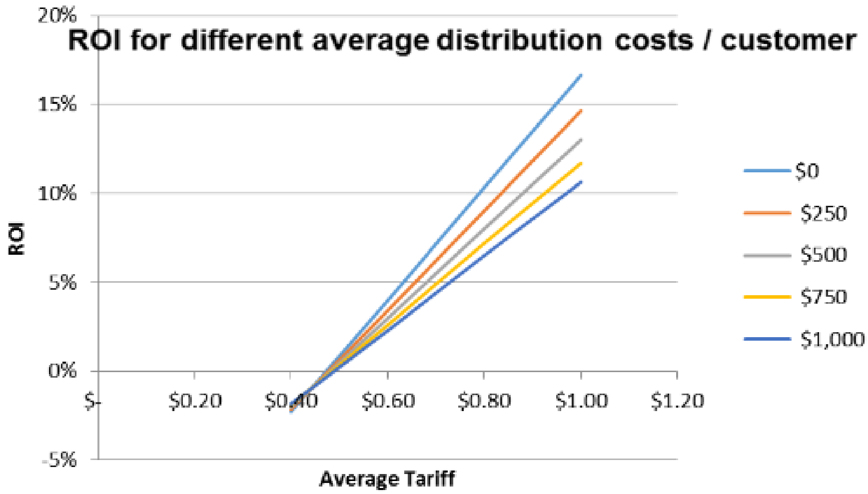
Current substitutable energy expenditures = minimum WTP (average monthly in Artibonite and Port-au-Prince)



Source: Digicel/iiDevelopment Survey (2014)



Financial Analysis, based on SREP IP dataSREP Market Segment 6:



Expenses		
	Capital	Ongoing
PV	$ 62,500	$ -
Battery	$ 18,000	$ -
Diesel	$ 12,500	$ -
Inverter & Controls	$ 1,500	$ -
Fuel	$ -	$ 12,152
Maintenance	$ -	$ 3,160
Sinking fund for replacements	$ -	$ 3,669
Administration	$ 100,000	$ 10,000
Distribution	$ 45,355	$ 454
TOTAL	$ 239,855	$ 29,434
Cost per watt (generation)	$ 4.73	for estimate verficatio
Gross Income		
Contribution to Capital cost recovery	$ 19,622	$/yr
ROI	8%	
Tariff required to cover ongoing costs	$ 0.48	
Tariff required to achieve required investor ROI (existing distribution)	$ 0.80	
Tariff required to achieve required investor ROI (new distribution required)	$ 0.87	Covers op costs + ROI% of capital costs annually

Business Case 6: Small anchor tenant microgrid (typical)		
Assumptions		
Parameter	*Value*	*Units*
Total number consumers	100	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	5	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 453.55	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 100,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	20	kW
Capacity factor	35%	
Average load	7	kW
Average daily energy	168	kWh/day
Annual energy	61320	kWh/yr
Real interest rate	4.00%	
Revenue		
Parameter	*Value*	*Units*
Average tariff	$ 0.80	$/kWh
Annual revenue	$ 49,056	$/yr

Business Case 6: Small microgrid LOW cost

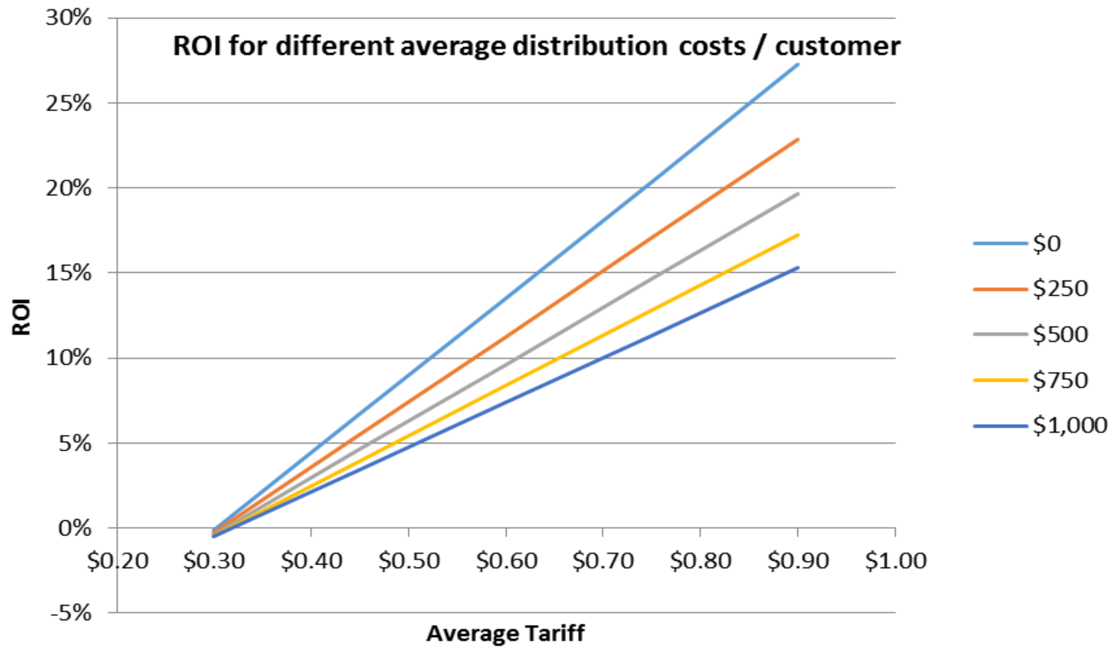
Assumptions		
Parameter	*Value*	*Units*
Total number consumers	100	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	5	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 453.55	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 100,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	20	kW
Capacity factor	35%	
Average load	7	kW
Average daily energy	168	kWh/day
EE measures?	Yes	
Peak load with EE	10.5	kW
Average daily energy with EE	88.3	kWh/day
Annual energy	32213	kWh/yr
Average energy consumption	322.1	kWh/connection/yr
Real interest rate	4.00%	

Business Case 6: Small microgrid HIGH cost		
Assumptions		
Parameter	*Value*	*Units*
Total number consumers	100	
Density (Pop / km^2)	250	
Pop/HH	5	
$/ meter for distribution system	5	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 807.11	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 150,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	20	kW
Capacity factor	35%	
Average load	7	kW
Average daily energy	168	kWh/day
EE measures?	Yes	
Peak load with EE	10.5	kW
Average daily energy with EE	88.3	kWh/day
Annual energy	32213	kWh/yr
Average energy consumption	322.1	kWh/connection/yr
Real interest rate	4.00%	

SREP Market Segment 7:

Business Case 7: Medium remote microgrid (typical)

	Assumptions	
Parameter	*Value*	*Units*
Total number consumers	1000	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	5	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 453.55	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 200,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	205	kW
Capacity factor	35%	
Average load	71.75	kW
Average daily energy	1705	kWh/day
Annual energy	622325	kWh/yr
Real interest rate	4.00%	
	Revenue	
Parameter	*Value*	*Units*
Average tariff	$ 0.65	$/kWh
Annual revenue	$ 404,511	$/yr



ROI for different average distribution costs / customer
30%
25%
20%
15%
10%
5%
0%
-5%
ROI
$0.20
$0.30
$0.40
$0.50
$0.60
$0.70
$0.80
$0.90
$1.00
Average Tariff
$0
$250
$500
$750
$1,000

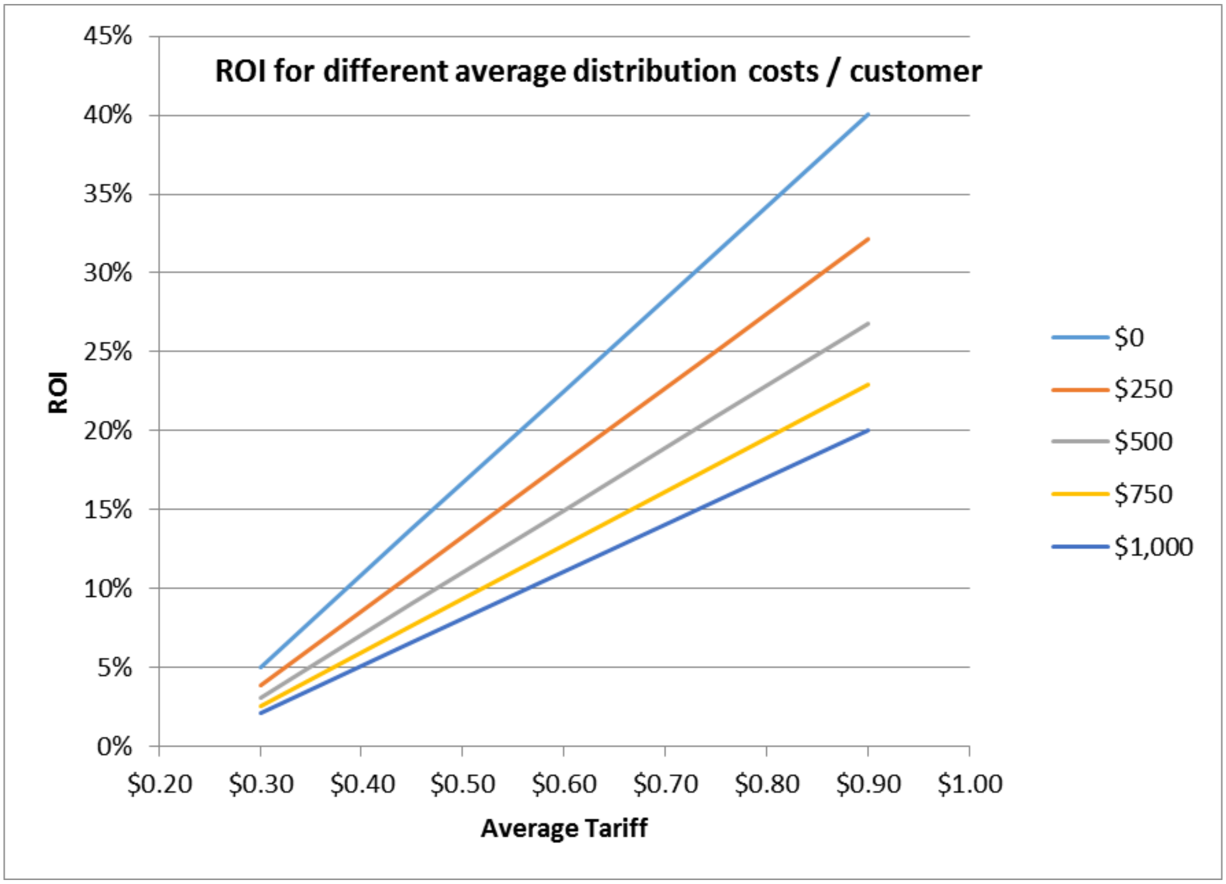
Market potential for Case 7: medium remote microgrids								
Town	**Schnitzer****	**EdH***	**Department**	**Installed capacity (kW)**	**Effective capacity (kW)**	**Grid (kV)**	**Manager**	**Status†**
Ennery	X	X	Artibonite	100	85	?	CA	working
Gros Morne	X	X	Artibonite	250	200	23	CA	working
Marmelade	X	X	Artibonite	300	250	23	CA	working; fed by Peligre
Dondon	X	X	Nord	150	100	4.16	CA	not working
Pilate	X	X	Nord	100	85	4.16	CA	not working
Plaisance	X	X	Nord	60	50	?	CA	working
Pignon		X	Nord	300	?	23	CA	working; fed by Peligre
Capotille	X	X	Nord-Est	100	85	23	CA	working
Mont Organisé	X	X	Nord-Est	175	150	23	CA	working
Ste Suzanne	X	X	Nord-Est	80	60	4.16	CA	working?
Anse à Foleur	X	X	Nord- Ouest	150	100	23	CA	not working
Bassin Bleu	X	X	Nord- Ouest	350	300	23	CA	not working
Bombardopolis	X	X	Nord- Ouest	200	?	23	CA	not working
Chansolme	X	X	Nord- Ouest	350	300	23	CA	not working
Jean Rabel	X	X	Nord- Ouest	500	400	23	CA	not working
Mole St Nicolas	X		Nord- Ouest	N/A	?	?	?	not working
Casale	X	X	Centrale-Ouest	175	?	?	CA	not working
Pointe à Raquettes	X	X	Centrale-Ouest	60	50	4.16	CA	not working
Anse d'Hainault	X	X	Grand'Anse	150	130	23	CA	not working
Dame Marie	X	X	Grand'Anse	225	185	23	CA	not working
Marfranc	X		Grand'Anse	300	?	?	?	?
Pestel	X		Grand'Anse	85	?	?	?	?
Anse à Veau	X	X	Nippes	100	85	4.16	CA	not working
Baradères	X	X	Nippes	100	85	12.47	CA	not working
Grand Boucan	X		Nippes	100	?	?	?	?
L'Asile	X	X	Nippes	240	200	23	CA	not working
Petit Trou de Nippes	X	X	Nippes	150	100	12.47	CA	not working
Pte Rivière de Nippes	X	X	Nippes	150	100	12.47	CA	not working
Coteaux	X	X	Sud	125	100	4.16	CA	not working; CEAC
Port à Piment	X	X	Sud	200	150	23	CA	not working; CEAC
Roche à Bateau	X	X	Sud	100	85	23	CA	not working; CEAC
Tiburon	X	X	Sud	150	100	23	CA	not working
St Louis du Sud		X	Sud	100	85	?	CA	working
Anse à Pitre	X	X	Sud-Est	150	100	12.47	CA	not working
Arnaud	X	X	Nippes	150	100	23	CA	not working
Belle Anse	X	X	Sud-Est	100	85	12.47	CA	not working
Côte de Fer	X		Sud-Est	200	?	?	?	?
Thiotte	X	X	Sud-Est	132	100	12.47	CA	not working
Borgne		X	Nord	?	?	?	EdH	not working
St Raphaël		X	Nord	?	?	23	EdH	working; fed by Peligre
St Michel de l'Attalaye		X	Artibonite	635	?	23	EdH	working; fed by Peligre
St Louis du Nord		X	Nord-Ouest	?	?	23	CA	?
Bainet		X	Sud-Est	150	130	23	EdH	not working
La Vallé de Jacmel		X	Sud-Est	?	?	?	EdH	not working
Onde-Verte (hydro)		X	Ouest	650	500	23	EdH	not working
Anse à Galets		X	Ouest	425	380	12.47	EdH	working

* Derived from spreadsheet provided by EDH
**Included in 36 EDH Centrale assistée MGs from the Schnitzer thesis
†from conversations with EDH

Business Case 7: Medium microgrid LOW cost		
Assumptions		
Parameter	*Value*	*Units*
Total number consumers	1000	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	1	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 170.71	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 150,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	205	kW
Capacity factor	35%	
Average load	71.75	kW
Average daily energy	1705	kWh/day
EE measures?	Yes	
Peak load with EE	109.1	kW
Average daily energy with EE	907.5	kWh/day
Annual energy	331254	kWh/yr
Average energy consumption	331.3	kWh/connection/yr
Real interest rate	4.00%	
Expenses		
	Capital	Ongoing
PV	$ 450,000	$ -
Battery	$ 165,000	$ -
Diesel	$ 62,500	$ -
Inverter & Controls	$ 25,000	$ -
Fuel	$ -	$ 42,633
Maintenance	$ -	$ 16,154
Sinking fund for replacements	$ -	$ 22,564
Energy efficiency	$ -	$ 5,520
Administration	$ 150,000	$ 15,000
Distribution	$ 170,711	$ 1,707
TOTAL	$ 1,023,211	$ 103,578
Cost per watt (generation)	$ 6.44	
Cost per watt (EE)	$ -	
Operating cost per watt (generation)		$ 0.80
Gross Income		
Tariff required to cover ongoing costs	$ 0.31	
Tariff required to achieve required investor ROI (existing distribution)	$ 0.57	
Tariff required to achieve required investor ROI (new distribution required)	$ 0.62	Covers op costs + ROI% of capital costs annually

Business Case 7: Medium microgrid HIGH cost		
Assumptions		
Parameter	*Value*	*Units*
Total number consumers	1000	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	5	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 453.55	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 200,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	205	kW
Capacity factor	35%	
Average load	71.75	kW
Average daily energy	1705	kWh/day
EE measures?	Yes	
Peak load with EE	109.1	kW
Average daily energy with EE	907.5	kWh/day
Annual energy	331254	kWh/yr
Average energy consumption	331.3	kWh/connection/yr
Real interest rate	4.00%	
Expenses		
	Capital	Ongoing
PV	$ 450,000	$ -
Battery	$ 165,000	$ -
Diesel	$ 62,500	$ -
Inverter & Controls	$ 25,000	$ -
Fuel	$ -	$ 42,633
Maintenance	$ -	$ 16,154
Sinking fund for replacements	$ -	$ 22,564
Energy efficiency	$ -	$ 5,520
Administration	$ 200,000	$ 20,000
Distribution	$ 453,553	$ 4,536
TOTAL	$ 1,356,053	$ 111,406
Cost per watt (generation)	$ 6.44	
Cost per watt (EE)	$ -	
Operating cost per watt (generation)		$ 0.80
Gross Income		
Tariff required to cover ongoing costs	$ 0.34	
Tariff required to achieve required investor ROI (existing distribution)	$ 0.61	
Tariff required to achieve required investor ROI (new distribution required)	$ 0.75	Covers op costs + ROI% of capital costs annually

SREP Market Segment 8:



Business Case 8: Large remote microgrid (typical)

Assumptions		
Parameter	*Value*	*Units*
Total number consumers	5000	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	5	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 453.55	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 300,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	1000	kW
Capacity factor	35%	
Average load	350	kW
Average daily energy	8400	kWh/day
Annual energy	3066000	kWh/yr
Real interest rate	4.00%	
Revenue		
Parameter	*Value*	*Units*
Average tariff	$ 0.55	$/kWh
Annual revenue	$ 1,686,300	$/yr
Expenses		
	Capital	Ongoing
PV	$ 3,150,000	$ -
Battery	$ 930,000	$ -
Diesel	$ 625,000	$ -
Inverter & Controls	$ 250,000	$ -
Fuel	$ -	$ 400,758
Maintenance	$ -	$ 106,630
Sinking fund for replacements	$ -	$ 118,479
Administration	$ 300,000	$ 30,000
Distribution	$ 2,267,767	$ 22,678
TOTAL	$ 7,522,767	$ 678,545
Cost per watt (generation)	$ 4.96	for estimate verfication
Gross Income		
Contribution to Capital cost recovery	$ 1,007,755	$/yr
ROI	13%	
Tariff required to cover ongoing costs	$ 0.22	
Tariff required to achieve required investor ROI (existing distribution)	$ 0.39	
Tariff required to achieve required investor ROI (new distribution required)	$ 0.47	Covers op costs + ROI% of capital costs annually

Business Case 8: Large microgrid LOW cost

Assumptions		
Parameter	*Value*	*Units*
Total number consumers	5000	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	1	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 170.71	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 300,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	1000	kW
Capacity factor	35%	
Average load	350	kW
Average daily energy	8400	kWh/day
EE measures?	Yes	
Peak load with EE	525.3	kW
Average daily energy with EE	4412.7	kWh/day
Annual energy	1610647	kWh/yr
Average energy consumption	322.1	kWh/connection/yr
Real interest rate	4.00%	

Expenses		
	Capital	Ongoing
PV	$ 1,800,000	$ -
Battery	$ 525,000	$ -
Diesel	$ 375,000	$ -
Inverter & Controls	$ 125,000	$ -
Fuel	$ -	$ 201,174
Maintenance	$ -	$ 56,328
Sinking fund for replacements	$ -	$ 64,254
Energy efficiency	$ -	$ 27,599
Administration	$ 300,000	$ 30,000
Distribution	$ 853,553	$ 8,536
TOTAL	$ 3,978,553	$ 387,890
Cost per watt (generation)	$ 5.38	
Cost per watt (EE)	$ -	
Operating cost per watt (generation)		$ 0.67
Gross Income		
Tariff required to cover ongoing costs	$ 0.24	
Tariff required to achieve required investor ROI (existing distribution)	$ 0.43	
Tariff required to achieve required investor ROI (new distribution required)	$ 0.49	Covers op costs + ROI% of capital costs annually

Business Case 8: Large microgrid HIGH cost

Assumptions		
Parameter	*Value*	*Units*
Total number consumers	5000	
Density (Pop / km^2)	1000	
Pop/HH	5	
$/ meter for distribution system	1	
$/ customer for billing meter	100	
Average distribution cost / customer	$ 170.71	$/customer
Distribution maintenance per year	1%	%/$ distribution setup cost
MG administration setup costs	$ 300,000	$/microgrid
MG administration annual costs	10%	of setup costs
Required investor ROI	10%	
Peak load	1000	kW
Capacity factor	35%	
Average load	350	kW
Average daily energy	8400	kWh/day
EE measures?	No	
[redacted]		
Annual energy	3066000	kWh/yr
Average energy consumption	613.2	kWh/connection/yr
Real interest rate	4.00%	

Expenses		
	Capital	Ongoing
PV	$ 3,150,000	$ -
Battery	$ 930,000	$ -
Diesel	$ 625,000	$ -
Inverter & Controls	$ 250,000	$ -
Fuel	$ -	$ 400,758
Maintenance	$ -	$ 106,630
Sinking fund for replacements	$ -	$ 118,479
Energy efficiency	$ -	$ -
Administration	$ 300,000	$ 30,000
Distribution	$ 853,553	$ 8,536
TOTAL	$ 6,108,553	$ 664,403
Cost per watt (generation)	$ 4.96	
Cost per watt (EE)	$ -	
Operating cost per watt (generation)		$ 0.63
Gross Income		
Tariff required to cover ongoing costs	$ 0.22	
Tariff required to achieve required investor ROI (existing distribution)	$ 0.39	
Tariff required to achieve required investor ROI (new distribution required)	$ 0.42	Covers op costs + ROI% of capital costs annually

HAITI: Renewable Energy for All

ANNEX 7. SCALING UP RENEWABLE ENERGY PROGRAM (SREP)

A. Results framework

	Renewable Energy for the Metropolitan Area - SREP project XSREHT050A	
Indicator	**SREP-funded Project**	**Transformational Scale-Up**
Number of women and men, businesses and community services benefiting from improved access to electricity	100,000 people (of which 50,000 females) and 1,000 businesses and community services	1,500,000 people (of which 750,000 females)
Annual electricity output from RE as a result of SREP interventions (MWh/year)	9,000	135,000
Tons of GHG emissions reduced or avoided - Tons per year [tCO_{2eq}/yr] - Tons over lifetime [tCO_{2eq}]	 10,630 212,600	 159,000 3,180,000
Financing leveraged through SREP funding (US$ million, cumulative)	US$ 4.5 – 12.5 million of which: - IDA: $4 million - Private sector: $0 – 8 million - Other: $0.5 million	US$ 190 million
SREP leverage ratio	1 : 0.4 to 1:1	1 : 15
	Co-benefits • Enhanced energy security and reduced dependence on imported fossil fuels • Enhanced institutional capacity for integration of renewable energies on the grid • Fostered economic development through job creation and income generation, • Improved quality of health services, education, and public safety conditions in small towns, especially for women and children; • Improved gender equality and women's socioeconomic status; and • Promotion of low-carbon development pathway.	

	Renewable Energy and Access for All - SREP project XSREHT047A Per Haiti Investment Plan, the off-grid component is co-financed by SREP, IDA and CTF, forming a synergetic package (see below Investment Plan), where each source of funding is used to maximize leverage of private sector. It is therefore impossible to fully separate the impact of each co-financing source, and Annex 1 therefore includes expected results from all co-financing sources. However, to avoid double-counting in reporting to CIF, SREP results and CTF results will be reported separately.[105]		
Indicator	**SREP-funded Project** (excluding CTF co-financing)	**CTF/SREP-funded Project** (including CTF co-financing)	**Transformational Scale-Up** (By 2030, including impact of CTF-funded OGEF)
Number of women and men, businesses and community services benefiting from improved access to electricity	344,000 people (of which 172,000 females) and 4,300 businesses and community services	800,000 people (of which 400,000 females) and 10,000 businesses and community services	5,300,000 people (of which 2,650,000 females)
Annual electricity output from RE as a result of SREP interventions (MWh/year)	14,616	33,990	225,200
Tons of GHG emissions reduced or avoided - Tons per year [tCO_{2eq}/yr] - Tons over lifetime [tCO_{2eq}]	38,588 690,234	89,739 1,605,197	594,520 10,634,000
Financing leveraged through SREP funding (US$ million, cumulative)	US$ 60.5 million of which: • IDA: $20 million • CTF: $16 million • Private sector: $22 million • Other: $ 2.5 million	US$ 108.5 million of which: • IDA: $20 million • CTF: $16 million • Private sector: $70 million • Other: $2.5 million	US$ 300 million from private sources
SREP leverage ratio	1 : 6	1 : 11	1 : 30
	Co-benefits • Strengthened private sector role and participation in off-grid electrification; • Improved consumer awareness on the benefits of off-grid equipment and services; • Fostered economic development through job creation and income generation, • Improved quality of health services, education, and public safety conditions in rural areas, especially for women and children; • Improved gender equality and women’s socioeconomic status; and • Promotion of low-carbon development pathway.		

[105] 57% will be attributed to CTF and 43% to SREP, in line with their relative contribution to funding off-grid energy investments ($12 million for CTF and $9 million for SREP).

B. Introduction

Country and sectoral context

1. Haiti is an island nation in the Caribbean with approximately 10.7 million inhabitants in 2015 and a surface area of 27,750 km^2. The country gained its independence from France on January 1, 1804. It is a low-income country, with a GDP estimated at US$ 8.756 billion (2015). The economy is heavily reliant on the agricultural sector, which remains vulnerable to damage from frequent natural disasters, exacerbated by the country's widespread deforestation. Remittances from the diaspora are the primary source of foreign exchange, representing over 20 percent of the GDP and nearly double the combined value of Haitian exports and foreign direct investment in 2015[106].After an initial recovery from the damages resulting from the 2010 earthquake, the Haitian's GDP growth slowed to 1.2 percent in 2015, compared to 5.5 percent in 2011[107] as political uncertainty, drought conditions and depreciation of the national currency took a toll on investment. Investment in Haiti continues to be affected by the difficulty of doing business and weak infrastructure.

2. Haiti is highly dependent on imported fossil fuels for electric generation, which leaves the country vulnerable to global oil price fluctuations. High technical and commercial losses of the national utility, high costs of electricity generation and low electrification rates are among the key challenges faced by the sector. Haiti's economy is particularly hit by unreliable power and high electricity costs due to its dependence on imported fuel petroleum products. Approximately 81 percent of the power generated by EDH results from thermal generation; cost of service from thermal generation is about US$0.30 per kWh, while average electricity tariffs range from US$0.21 per kWh (for residential customers) to US$0.30 per kWh for industrial and commercial customers. Self-generation and back-up power represent about 500MW, three times the available generation capacity from EDH. Self-generation costs vary between US$0.40 and almost US$2 based on varied efficiencies of diesel gensets and costs of supplying diesel into more remote areas. Notwithstanding this, the country has a significant potential of renewable energy resources, which is largely under-developed. For more information, see Sections I-A and I-B of the Project Appraisal Document.

SREP Investment Plan

3. The path towards scaling up renewable energy and access in Haiti is embodied in the SREP investment plan, which provides for a $30 million for investment funding in EDH grids, village grids and individual off-grid systems for productive, community and household uses. The Investment Plan, which endorsed in May 2015, was prepared by a multi-entity governmental Task Force led by the Ministry of Public Works, Transportation, and Communications (MTPTC), with support from the World Bank Group. Consultations addressed government agencies, the private sector, academia, and civil society.

4. Haiti SREP program is conceived as a comprehensive program, with the objective to initiate a transformation from the underdeveloped, unreliable, and expensive fossil fuel–based

[106] Source: The World Factbook, Central Intelligence Agency, 2017
[107] Source: World Development Indicators, World Bank

electricity generation mix to a modern and sustainable energy system relying on diverse sources of power. In addition, the SREP program explicitly supports actions towards achieving universal access to electricity, responding to the Government's vision for Haiti becoming an emerging economy by 2030. The SREP IP balances allocation of resources between the need to improve provision of electricity services in urban areas and the need to expand access in rural areas – and it provides an overall blueprint for both SREP-funded and complementary interventions, such as CTF. The SREP Investment Plan was designed to be flexible in funding allocation to adapt to the evolution of the country's fragile political and socio-economic environment and further adjustment was required to account for the impact of Hurricane Matthew, which hit the country in October 2016 and created massive devastation in the southern part of the country and imposed a shift in the Government's strategic priorities. The following table provides the financing plan originally envisaged for the SREP program.

Table A7.1: SREP Indicative Financing Plan as per the Investment Plan

SREP component	SREP funding			Public co-financing			Private leveraging		Total
	WB	IFC	Total SREP	WB-IDA	WB-CTF	Other	IFC	Other	Public-private
1. RE for the metropolitan area[108]	8-10	0-2	10	6				16	22
2. RE for Port de Paix remote grid	2-4		2-4	10				2	12
3. Off-grid electricity	8-9	7-9	15-17	8	11.5		15	60	94.5
4. Small hydropower rehabilitation			-	4		14			18
5. Enabling framework, capacity and skills	1		1	2.5	0.5				3
Total	21-23	7-9	30	30.5	12	14	15	78	149.5

5. **On-grid RE electrification activities** originally also contemplated a larger scale grid-connected RE investment serving the largest of EDH grids (Port-au-Prince metropolitan area) and the hybridization of the Port-de-Paix remote mini-grid, in the north-west of the country. Project preparation activities led to the identification of transmission bottlenecks in the Port-au-Prince grid, which will prevent the integration of large scale renewable energy – the scale originally foreseen in the Investment Plan. In addition, demonstration impact would be diluted due to significant technical losses in the system, which will prevent users from experiencing any visible service improvement. Instead, therefore, the Government decided to focus the grid-connected investments on one or several smaller grids, where renewable energy can have a strong demonstration impact, in terms of both reduced costs and improved service.

6. In October 2016, Hurricane Matthew struck the southwestern part of Haiti, with winds over 119 km/h (74 mph)[109] or greater. Nationwide, the hurricane affected over 200,000 homes, leaving 1.4 million people in need of humanitarian aid. The storm surge, estimated at 9.6 ft (3m) flooded at least 11 municipalities along the southern coast of the country; while strong winds knocked power lines and cell towers, washing away the Petit Goave Bridge, the only terrestrial link between the nation's capital and the southwestern Haiti. Monetary damage was estimated at $1.89 billion. In the aftermath of Hurricane Matthews, the Government decided to focus its reconstruction efforts on the south, to revitalize economic activities through, *inter alia,* rebuilding infrastructure, expanding quality access and improving electricity services, in order to rebuild livelihoods and economic opportunities in the region. As a result, the focus has shifted from the Port-de-Paix isolated grid to small and medium-size EDH mini-grids in the south (Les Cayes, Jeremie, Petit Goave, La Gonave and Jacmel have been prioritized as potential sites). Apart from the geographic targeting, the selection criteria for prioritization included the technical compatibly with a solar plant and energy storage system, commercial viability (ability to generate revenues to sustain O&M), land availability and potential for demonstration impact and replication. Final sites will be selected during project implementation.

7. **Private sector participation.** While the on-grid electrification component (Component 1) envisaged the injection of private capital for the country's first RE project, the option of a publicly financed plant was retained in the Investment Plan as an alternative solution if PPP approach was not deemed feasible in the short term (e.g. EDH offtake risk, evolution of the country's macro-economic indicators, country risk premium, private sector interest, etc.). In the same vein, investment funding ranges were provided to reflect uncertainty regarding the evolution of specific drivers.

8. **Linkages with CTF-supported Haiti Modern Energy Services for All project.** The Project will leverage the Off-Grid Energy Fund (OGEF), which is being established by the Government under the CTF-funded Modern Energy Services for All Project to provide equity, loans and limited start-up grant financing to private enterprises providing off-grid renewable energy services in Haiti (both individual systems and village grids). The SREP project will complement OGEF investments by increasing the menu of investment options available to private companies, by blending grant funding with commercial financing. It is expected that OGEF will benefit from additional contributions from both public and private sector parties in future. The table below summarizes how SREP grants and CTF commercial financing is expected to leverage and complement each other.

Table A7.2: Synergies between SREP and CTF programs

	SREP	CTF	Synergies with CTF
Component 1: Grid-connected distributed RE			
1a. PV and battery on EDH isolated grid	Integration of renewables in EDH diesel grids	None	Complementary
1b. Technical assistance for on-grid investments		None	Complementary

[109] The hurricane was classified as category 4 (out of a maximum of 5) on the Saffir-Simpson scale when it struck Haiti, making it the strongest storm to hit the nation since 1964m and the third strongest Haitian landfall on record.

supporting vRE integration			
Component 2: Off-grid distributed RE			
2a. Mini-grids	Co-financing of private sector capital in the form of grants for distribution grid infrastructure (assets ultimately be transferred to municipalities)	Equity and loans to private sector companies	Expanding the universe of private sector-driven mini-grids – making investments in mini-grids commercially viable for private sector, while affordable for users. Accelerating pace of mini-grid development.
2b. Productive and community uses	Innovation grants as seed capital for potentially financially viable and scalable business models for productive and social applications (e.g. schools, health clinics)	Equity and debt for business clients for replication and scale up of successful business models through OGEF	Public sector financing/grants for rural productive and social uses could be integrated in the Pay-As-You-Go companies, while strengthening sustainability of public investment
2c. Households systems	Grants in the form of results-based financing to support early stage businesses and introduction of high quality products	Equity and loans for off-grid businesses to develop market for high quality solar lantern market and solar kits	Blending SREP grant funding with commercial funding provided through CTF will reduce capital cost for private businesses and improve affordability for households

9. IFC is in discussion with the Government to explore the most suitable mechanisms to provide advisory services to strengthen the institutional capacity of the municipalities and MTPTC to conclude robust contractual arrangements for private sector participation in renewable energy. The combined interventions of the World Bank and IFC will not only leverage synergies, but will also contribute to long term sustainability of the operations and durable impact on the socio-economic landscape.

10. The co-financing for the Renewable Energy and Access for All Project among SREP, CTF and IDA therefore provides a synergetic package, in which each source of funding is used to maximize impact and private sector leveraging. CTF funding (which is a loan to the government) is used for equity investments and lending to the private sector. This funding is complemented with SREP and IDA, which provide additional grants to the private sector to jump-start the market and to make access more affordable for the Haitian population. It is therefore impossible to exactly separate the impact of each financing, and Annex 1 of the PAD, in line with the IP targets, reports on the results achieved through the three sources of financing. However, in order to avoid double-counting to CIF, the results between SREP and CTF are split in 43:57 ratio, reflecting the ratio of funding amounts available in each source for off-grid investments (US$12 million for CTF and US$9 million for SREP).

C. Project description

11. The SREP Renewable Energy for All Project proposes a comprehensive investment and capacity building program to expand electricity access and improve the quality of electricity services through the deployment of renewable energy-based technologies, leveraging both public and private sector resources thereby, unlocking the most promising renewable energy investment opportunities in Haiti. Considering the fragmented nature of Haiti's electricity system (nine

isolated grids operated by EDH, over 30 municipal grids and 500MW estimated in self-generation), investments in distributed renewables have been prioritized. Three user / off-taker segments with the strongest potential for near- and medium-term private sector investments were identified: (i) small and medium-sized EDH grids, (ii) municipal village grids, and (iii) individual off-grid systems for productive and household uses.

12. **The Project Development Objective (PDO**) is to scale-up renewable energy investments in Haiti in order to expand and improve access to electricity for Haitian households, businesses and community services.

13. The Project is split in two components as described below, each one of them represent a standalone SREP project:

- Component 1 (or **SREP Renewable Energy for the Metropolitan Area project)** focuses on grid-connected distributed renewable energy. It aims to demonstrate the feasibility of using renewable energy to provide reliable and affordable electricity services in EDH grid connected areas, for future replication and scale-up. This component will support the construction of 6 – 12 MW of (solar PV plant + battery) which would hybridize 2 -3 EDH grids, currently running of diesel power.

- Component 2 (or SREP **Renewable Energy and Access for All** project) focuses on off-grid distributed renewable energy, with a view to support private sector solutions (e.g. village grids, standalone systems for productive and community uses and solar home systems for households) in areas not served by y EDH.

A detailed description of the project is presented in Annex 2 of the Project Appraisal Document.

Box A7.1: Availability of SREP grant funding and impact on project design

The Project provides for a total investment amount of $ 22.5 million from SREP. To that effect, $1.5 million grant out of $2 million originally programmed for December 2017 under the IFC's RE for Port-au-Prince Metropolitan Area project has been accounted for in the Project financing request. This is in line with the endorsed Investment Plan, which provided an investment financing of $20 – 23 million for WB- led interventions and $7-9 million for IFC-led projects.

The Government of Haiti was advised SREP does not have enough grant funding for all the projects expected to be submitted for approval in May 2017 and thus, the grant funding request of all projects may be reduced by a pre-specified amount[110]. This will impact the WB-led SREP Haiti's projects as follows:

- The additional $1.5 million (originally programmed for December 2017 under IFC-led activities) may be available in June 2017 at the earliest, provided there is available grant funding beyond May 2017;
- The balance of the WB-led project funding or $21 million, should be reduced by a further $1.38 million in May for consideration by the SREP sub-committee, to total to $19.62 million.

The World Bank will submit a funding request of $19.62 million for the Project in May 2017, with a view to seek a second approval of $2.88 million in June 2017, should grant funding be available from SREP. In the event grant funding is not available, Haiti's Renewable Energy for All Project will be downsized to $19.62

[110] Based on discussions with CIF-AU on the preparation on a sealed pipeline for SREP grant funding projects.

million, reducing both Projects. As a result, the Component's 1 on-grid solar capacity will need to be downsized from 6 to 5MWp, reducing further the attractiveness of a small investment in a risky sector for the private sector. In addition, productive and community uses Sub-component will be limited to a pilot initiative, likely to result in a reduced renewable energy capacity built under Component 2 (estimated reduction from 23 MW to 18MW). .

The adjustments in funding allocation resulting from the project downsizing are presented hereafter:

	SREP Project allocation ($ million)	SREP Downsized Project allocation ($ million)	Financing impact
Component 1: Grid-connected distributed RE	12.5	11	Reduction of $1.5 million
1a. PV and battery 1b. On-grid investments supporting vRE integration 1c. Technical Assistance	12 0.5	10.5 - 0.5	Reduction of $1.5 m
Component 2: Off-grid distributed RE	10	8.62	Reduction of $1.38 million
2.a. Mini-grids 2.b. Productive and community uses 2.c. Households systems 2.d. Technical Assistance and Capacity Building	4 2 3 1	4 0.62 3 1	Reduction of $1.38 m
Total SREP Project	**22.5**	**19.62**	**Reduction of $2.88 million**

14. **Problem Statement.** Haiti's economic performance has been repeatedly compromised by political instability and natural disasters. As a result, the country has struggled to develop institutional mechanisms, capacity and policy fundamentals essential for economic development which severely constraints access to basic infrastructure services, including electricity. Statistics provided by the International Energy Agency provide that Haiti is the worst performer in terms of electricity access in the Latin America region, with a national electrification rate of 29 percent (or 8 percent in rural areas), compared to a regional average of 95 percent (and 85 percent in rural areas).[111]

15. According to data collected by *Doing Business*[112], getting electricity in Haiti takes an average of 60 days and costs 3708.5 percent of income per capita. Globally, Haiti stands at 139 in the ranking of 190 economies on the ease of getting electricity.[113] As a result, electricity access is skewed towards urban centers and higher income households. With only 273,000 active customers, EDH has technical and commercial losses of approximately 62 percent, and a collection rate around 22 percent. It is estimated that over 66 percent of the population with electricity have informal/illegal connections. A fundamental transformation in service delivery mechanisms is required to improve quality and expand access electricity, foster poverty reduction and promote inclusive growth.

[111] Source: IEA, World Energy Outlook 2016

[112] Doing Business presents quantitative indicators on business regulations and the protection of property rights that can be compared across 190 economies over time. The data set covers 48 economies in Sub-Saharan Africa, 32 in Latin America and the Caribbean, 25 in East Asia and the Pacific, 25 in Eastern Europe and Central Asia, 20 in the Middle East and North Africa and 8 in South Asia, as well as 32 OECD high-income economies.

[113] Source: World Bank, Doing Business 2017 Equal Opportunities for All - Economy Profile 2017: Haiti

16. **Transformative impact.** The proposed project will contribute to the transformation of the Haiti electricity sector by demonstration the feasibility of integrating solar PV generation in the Haitian grid. The successful implementation of this project component (Component 1) will provide a roadmap to scale up the development of renewable energy projects, harnessing Haiti's significant RE resources, with an emphasis on solar. The proposed technical assistance and capacity building for grid integration will further support the transformation by contribution to the development of an enabling policy and regulatory framework for private sector participation in RE investments over the medium to long term.

17. At the time of preparing the investment plan a greater emphasis was put on providing lighting lanterns and pico PV as mechanism to provide access to electricity; based on a binary approach (e.g. "access" vs "no access"). Taking into account the fact that true transformation is achieved through the ability to support business and households' socio-economic needs, by providing electricity services of the desired quality, the proposed off-grid distributed RE component is more broadly aligned with the access agenda by focusing on mini-grids, productive uses and solar home systems to provide improved quality of electricity services to the target population. The higher cost of the underlying technologies compared to lower tier solutions (e.g. solar lanterns) will result in a lower number of beneficiaries that originally envisaged[114]. However, by supporting higher impact interventions (e.g. through productive and community uses and higher-tier household access) the project will contribute to the development of much needed economic opportunities in the rural parts of the country.

18. **Rationale for SREP financing.** Haiti has an immense and untapped RE potential, especially for solar and hydro. While hydro is at least partially exploited, experience with grid-connected solar power is absent. The use of SREP grant funding will be critical to enable Haiti to leap-frog into the adoption of renewable technologies for household consumption, productive uses and provision community services. The demonstration effect of the solar PV plus battery storage facilities will increase the attractiveness of similar investments to private sector investors and donors interested in on- and off-grid RE electrification. In synergy with the CTF-funded Off-Grid Rural Electrification Fund, SREP financing will be instrumental to increase access to low-cost capital to private developers, which will remove a key barrier to the deployment of reliable RE solutions, making end-user tariffs more affordable. These interventions will contribute to reduce the risk perception associated with distributed generation and attract new players such as commercial banks, which are currently reluctant to provide any capital to the sector, and impact investors/venture funds currently targeting off-grid markets in Africa only. Finally, capacity building, institutional strengthening and establishment of enabling policy, legal and regulatory frameworks will stimulate investment and promote the sustainability of RE technologies in Haiti. Given the early stage of the RE industry in Haiti, SREP financing is key to demonstrate viable approaches, reduce key regulatory, financial and capacity barriers in order to stimulate private sector investment, and jump-start the most promising market segments while creating the conditions for future replication and scale up.

D. Assessment of Haiti Renewable Energy for All project with SREP investment criteria

19. **Increase installed capacity from renewable energy sources.** The country's installed

[114] One million beneficiaries as per the Investment Plan, compared to 660,000 people, following project preparation.

capacity - managed by EDH - about 320 MW (with available capacity of approximately 176 MW and peak demand of 400 MW). The project will facilitate the construction of 6-12MW of grid-connected solar PV power and 8MW[115] of additional capacity from RE sources from off-grid systems (i.e. standalone solar home systems and mini-grids). This will be equivalent to an aggregate of 24 GWh[116] generated annually from renewable energy sources.

20. **Increased access to energy renewable energy sources. The proposed project will improve access to** electricity services to 444,000 people (including 222,000 females) and 5,300 businesses and community services[117] through EDH isolated grids, village grids and standalone solar home systems.[118]

21. **Low emission development.** EDH's energy mix consists of 19 percent hydro and 81 percent thermal power generation. The distributed renewable energy technologies deployed under the project will support Haiti's efforts for low-carbon development by contributing to the expansion of rural electrification using renewable energy resources. The project will help avoid 49,218 tCO_{2eq} every year and 902,834 tCO_{2eq} over the lifetime of investement.[119]

22. **Affordability and competitiveness of renewable sources.** Haiti is heavily reliant on imported fossil fuels for its power production. This translates into a large amount of subsidies from the Government to EDH and represents a significant portion of Haiti's external debt. For EDH grids, as well as village grids, preliminary pre-feasibility simulations (using modelling tools such as Homer, PVSyst, Mathematica-based mixed integer linear optimization, and Excel-based Sensitivity and Monte Carlo Analysis) were run to determine the most promising system designs and sites leading to least-cost generation, compared to the baseline fuel use in the existing EDH grids, village grids and co-generation gensets. At end-user level, willingness to pay (WTP) and market studies carried out during IP and project preparation revealed overall high expenditures on electricity substitutable items, with wide variety across regions and customer categories. Commercial customers and large users have a high WTP for stable and reliable electricity supply. But even, households in Haiti spend on average about US$30 a month on electricity or electricity substitutes with rural households spending $10-20 depending on a department (the poorest proportion of the population spending a much lower amount). SREP grant funding will enable the project to cater for different market segments with varying WTPs, through support to a wide range of technologies (from solar lanterns, through pay-as-you-go solar kits/home systems up to village mini- or micro-grids) and to reduce capital cost for private businesses which will in turn allow them to offer competitive and affordable electricity services.

23. **Productive uses of electricity.** Increased energy access from solar PV systems and mini-grids will harness rural infrastructure services for the promotion of productive uses, maximizing the economic benefits of energy-sector investments and stimulating economic growth. Solar PV systems and mini-grids will support and stimulate domestic, commercial, and light industrial income generating activities in rural areas – both on-grid (providing more reliable power to the customers on the EDH isolated grids), and off-grid (providing new access to off-grid households,

---

[115] 18MW including CTF financing
[116] 43GWh accounting also for CTF financing impact
[117] Assuming full US$22.5 million SREP funding is available
[118] 900,000 people and 11,000 enterprises accounting also for CTF financing impact
[119] 100,369 tCO2eq/year if CTF financing impact is accounted.

businesses and community services. The project will foster productive uses of off-grid renewable energy with a specific emphasis on supporting renewable energy solutions for agribusinesses and other rural enterprises. More specifically, component 2.b. of the project will support the provision of innovation grants to energy enterprises or other integrators presenting viable business plans for sustainable provision of renewable energy for agriculture and other rural enterprises (e.g. adaptation of PAYG business models for the enterprise sector). The focus will be on piloting and developing economically, financially and socially viable solutions which could then be included in OGEF financing. Special focus will also be on supporting female entrepreneurs.

24. Based on the initial analysis of rural productive value chains in Haiti and emerging successful worldwide experiences, the following promising applications have been identified:

(i) Electrification of agricultural activities to unlock rural economic development and improve food security in Haiti:

- Powering processing local production to secure the domestic market supply, such as processing of perishable food into a storable form, e.g. transforming breadfruit into chips and flour, solar-drying facilities to process fruits etc.;
- Powering processing cacao and coffee to boost exports in quantity and quality, e.g. solar-powered dry mill facilities;
- Solar-powered storage / cooling for mangoes and avocados for export, e.g. solar-powered cold storage at the fruit collection site can significantly improve quality of these export products;
- Ice production for fishermen: e.g. to avoid the significant loss (up to 40 percent) of harvested seafood that is lost due to insufficient facilities and handling on board fishing boats;
- Solar-water pumping for irrigation - the fast evolution of the solar-water pumping sector enables customized solutions that match local needs and adjust to local constraints (e.g. site's topography, aquifer resources).

(ii) Electrification of small-scale industrial activities and businesses to boost economic growth and employment, such as:

- Lighting, electricity and water heating for hotels and other tourism facilities;
- Oven cooking for bakeries and cooking and water heating for small restaurants and food kiosks;
- Beer brewing;
- Refrigeration, freezing and lighting for convenience stores;
- Use of computers and printers in cyber cafes;

- Use of electrical cosmetic appliances for barbers;
- Use of grinders, compressors and welding for vehicle repair;
- Use of power looms and sewing machines for clothing and outlets;
- Drilling, cutting, welding and use of lathes and mills for metal workshops.

25. **Economic, social, and environmental development impact.** The project will contribute to the expansion of electricity infrastructure for economic and social development using low carbon sources. More specifically, the project will facilitate (i) increased quality and quantity of electricity services in isolated grids and off-grid areas, (ii) accrue educational and health benefits owing from the improved level and quality of lighting and reduced indoor air pollution from reduced use of kerosene, (ii) reduce GHG emissions from using renewable energy sources, (iv) increase productivity from promoting productive uses of electricity, (v) generate employment opportunities, mainly related to the construction, operation and maintenance of hybrid mini-grid systems.

26. **Economic and financial viability.** All proposed project components and considered RE "system types" have EIRR well above Haiti's hurdle rate of 2 percent (according to the latest World Bank method), which are also sufficiently robust against the vast majority of scenarios, even in the no-carbon case. The EIRRs including carbon benefits are even higher (from 11 to 54 percent) than the no carbon case (from 10 to 52 percent). Financial analysis also shows high internal rates of return for typical component 1 and 2 projects120 (between 10 and 40 percent, but depending strongly on many assumptions - tariff, exact site, business model, etc. - which are unknown as of today because of the private sector-led selection), so that they can be potentially attractive for private investors. The economic and financial analyses, including methodology and assumptions are presented in Annex 7.

27. **Leveraging of additional resources.** The Project leverages financing resources from (i) IDA Rebuilding Energy Infrastructure and Access Project (PRELEN), which is being restructured to strengthen its focus on clean energy and energy access, (ii) CTF-funded Modern Energy Services for All Project, which has established the Off-Grid Energy Fund (OGEF), (iii) private capital, and additional financiers for technical assistance/training (ESMAP, Korean Green Growth Trust Fund, Schneider Foundation, French Ministry of Education).

28. ESMAP is financing technical assistance activities to help the Government take informed decisions on the key investment and design choices for the grid-connected solar PV plant that will be financed under the SREP program, and for the assessment of technical and regulatory options for mini-grids. In addition, the Korean Green Growth Trust Fund (KGGTF), is financing the Haiti Energy Integration and Trade Study, which aims to provide rigorous analysis of VRE integration by (a) undertaking ex-ante variable RE integration analysis for a fragile country/system (usually done empirically or through pilot projects), and (b) assessing the impact of cross-border energy

[120] And also for the many types of single-user PV systems of the overall OGEF+SREP umbrella program, as discussed in the SREP IP.

trade and smart grid solutions to ease VRE integration and enhance system reliability.

29. The Project also leverages synergies with other World Bank operations in Haiti in agriculture, private sector development, education, health and water sectors which are focusing on community uses of electricity. Total co-financing is equivalent to $117.5 to $125 million. There are on-going discussions with other potential financers, including the UAE, Government of Haiti, IDC and EIB. The total co-financing leverage is 1:0.4 to 1:1 for Component 1 and 1:10 for Component 2. In aggregate, the project achieves a financing leverage ratio of 1:4.

Table A7.3: SREP Program financing (US$million)

	IDA PRELEN	Other IDA[121]	SREP	CTF (OGEF)	Others	Private sector	Total	SREP Leverage ratio
Component 1: Grid-connected distributed RE	4		12.5		0.5	0-8	17-25	1:0.4 to 1:1
1.a. PV and battery (investment+ potentially a guarantee)			12			0-8		
1.b. On-grid investments supporting vRE integration	3							
1.c. Technical Assistance	1		0.5		0.5[122]			
Component 2: Off-grid distributed RE	17	3	10	16	2.5	70	118.5	1:11
2.a. Mini-grids	2		4	3		9		
2.b. Productive and community uses	10	3	2	2.5	1.5[123]	11		
2.c. Households systems			3	7		40		
2.d. Technical Assistance and Capacity Building	5		1	1.5	1[124]			
(OGEF fund manager and operating expenses)				2.5				
Total SREP Project	**21**	**3**	**22.5**	**16**	**3**	**70-78**	**125.5-133.5**	**1:4**
Additional: small hydro rehabilitation (IP Component 4)[125]	4						4	

[121] Agriculture, Private sector development, Education and Water projects
[122] ESMAP TA support for variable renewable energy integration and Korea Green Growth Trust Fund
[123] Electricity Without Borders (NGO) - thanks to a solar PV in-kind contribution from EDF Energies Nouvelles -, for school solar PV electrification with ICT solutions (smart boards)– see Annex2
[124]France (Ministry of Education) and Schneider Foundation RE training program and ESMAP TA support for mini-grids and Lighting Global.
[125] While not a part of the SREP project, the restructured IDA PRELEN project is also providing US$4 million for rehabilitation of a small hydro plant Drouet, which is a part of the broader SREP Investment Plan and one of the Government priorities for RE generation.

Total SREP IP	**25**	**3**	**22.5**	**16**	**3**	**70-78**	**139.5-147.5**

30. Private sector leveraging on Component 1 will only materialize if private investments into on-grid renewables are feasible in Phase II, e.g. through using SREP funds as a guarantee. Private sector leveraging on Component 2 will take the form of private equity and commercial loans. First, all private sector projects supported from OGEF and grant facilities managed by the Energy Cell will need to have private co-financing, which will mostly be in the form of private equity. It is estimated that to achieve the project targets, US$13 million will need to come directly from the private sector. In addition, the project expects that the seed funding provided through OGEF (grants, equity and loans) will support off-grid businesses growth, creating opportunities for further investments and commercial lending for these companies. For example, the distributed energy sector companies (DESCOs) in East Africa, initially supported by donors and impact investors are now (3-4 years later) attracting private investments and commercial loans. The same pattern is expected to be followed in Haiti, and it is estimated that at least additional $47 million will be invested in these companies during the lifetime of the project, allowing these companies to operate and grow beyond the life-time of the project and beyond the project's targets.

31. **Gender.** Rural electrification has the potential to improve equality and women's socioeconomic status. The project will address gender-issued support to various mechanisms including support to female-headed households and female-headed enterprises to get electricity access, consumer awareness campaigns targeting female-headed households, and training and other actions aimed at integrating more women into the off-grid energy supply chains. Beneficiary feedback mechanism through cell phone surveys, which will provide gender disaggregated data, and will provide feedback whether additional measures to support female-headed households are needed. Specific actions to ensure that the gender-differentiated benefits materialize and are properly tracked (see Annex 1 for gender-differentiated indicators and Annex 5 for gender assessment and actions).

32. **Co-benefits of renewable energy scale-up.** The proposed project is expected to have a number of environmental, economic and social co-benefits both at a local and global scale. These include:

33. Economic co-benefits: The main benefit type under component 1 and 2 is the reduced spending on diesel fuel for electricity generation compared to the baseline fuel use in the existing village generators and co-generation gensets as that the majority of component 1 and 2 sites already have existing distribution infrastructure and several diesel generators. Enhanced energy security through reduced dependence on imported fossil fuels and traditional sources of energy will be achieved. In addition, the project will generate employment opportunities, mainly from construction, operation and maintenance of RE based mini-grids and solar home systems. Increased access to electricity will support income generating activities through fostering productive uses. Finally, the project will address major constraints to engaging the private sector to provide off-grid electricity services on a large scale and clear the path for private sector participation in grid connected RE projects.

34. Environmental and health co-benefits: A total of 902,834 tons of carbon dioxide (CO2) emissions will be avoided over the lifetime of investment. This will lead to reduction in local pollution from diesel generators, kerosene lamps, candles and biomass (firewood) that are used as alternative sources of energy. This number underrates the actual fuel consumption of inefficient diesel generator sets and does not consider the substitution of kerosene. The project will also promote community health by avoiding the use of kerosene for lighting which produces indoor air pollution caused by particulate emissions that can increase the incidence of general ailment and respiratory disease, and by providing clean energy for rural clinics and health centers.

35. Social co-benefits: Education will be promoted more widely and effectively as the provision of electricity to schools and households a will lead to improved educational outcomes – e.g. by enabling children to study for additional hours in the evening, and by powering computers and other IT educational solutions (e.g. smart boards) in schools.

E. Monitoring and Evaluation

36. Overall monitoring and evaluation of the project activities will be the responsibility of MTPTC Energy Cell, including compliance with environmental and social safeguards. The Energy Cell will provide quarterly reports to the World Bank, including implementation progress and progress in meeting key project indicators. The Energy Cell will also have the overall responsibility for monitoring and evaluation of OGEF activities – both those financed by SREP and CTF. It will consolidate M&E reporting based on updates provided in the OGEF Fund Manager's quarterly reports. The project will use the indicators and mechanisms defined in Annex 1 for monitoring and evaluation (M&E) of results and intermediate outcomes. Additional details are provided in section IV. B of the Project Appraisal Document.

F. Implementation Readiness

37. **Country/sector strategies**. The proposed project is fully aligned with Haiti's vision for the energy sector as articulated in the Strategic Plan for the Development of Haiti (SPDH), SPDH envisages strengthening the private sector and providing basic services (including electricity) to the population. Reaching the SPDH goal of becoming an emerging economy by 2030 will require twin-track electrification efforts: improving EDH performance and supporting on-grid generation capacity to enable the utility to provide reliable and affordable services in urban areas and their surroundings; and supporting off-grid electrification in rural areas that will not be served by EDH

38. **Institutional arrangements**. The project will be implemented by both MTPTC Energy Cell, and **OGEF** Fund Manager. On the one hand, MTPTC Energy Cell will be in charge of implementing both Project Components 1 and 2 (with the exception of Sub-component 2c - Household systems), as well as overall project coordination and oversight. On the other hand, OGEF Fund Manager will be in charge of implementing Sub-component 2c (Household Systems), given that this Sub-component is closely interrelated with the equity and debt financing provided by OGEF under the parallel CTF-funded Modern Energy Services for All Project. OGEF Fund Manager will also provide advisory services to the Energy Cell for the implementation of other Component 2 activities, particularly for the review of business plans and award of grants for mini-grids and productive uses. Other key stakeholders involved in Project implementation are EDH and MEF, in particular its PPP unit. EDH will be closely involved in the design and

implementation of Component 1. MEF PPP unit will advise Energy Cell on transactions involving private sector participation and PPP arrangements for both Component 1 and 2. Annex 3 of the Project Appraisal Document provides a detailed description of the implementation arrangements.

39. **Sustainability.** The project will promote sustainable solutions. For the Renewable Energy for the Metropolitan Area project (Component 1), the project will engage private sector to build and operate the solar PV plant. As agreed with the Government and EDH, to mitigate the technical and commercial issues faced by EDH isolated grids, EDH will: (i) establish an escrow account, which will house contribution for O&M, including for the eventual replacement of the equipment, such as batteries; and (ii) receive long-term capacity building through the project that would allow it eventually to take over the plant operation.

40. In addition, the Government is currently exploring the way to improve performance of EDH, including the isolated grids, including a possibility to outsource collection and billing or to concession the grid operation to private sector. The project will contribute to this process by improving the administrative and financial transparency on the demonstration project grid. The grid will be isolated administratively from the rest of EDH and its performance closely monitored. Moving to the next phase, which foresees greater private sector participation, additional measures will be required, including outsourcing billing and collections on the grid or concessioning the grid to the private sector.

41. For Renewable Energy and Access for All - SREP project (Component 2), the project will finance only those businesses that present viable business plans, which will increase the likelihood of sustainable operations. The project design and the business plan evaluation procedures will address common sustainability issues in village grids and off-grid systems, including: poor technical quality of systems/components, inadequate tariffs in village grids, low capacity to operate village systems, lack of after-sales services and lack of financing for spare parts. Sustainability criteria will also include environmental and social sustainability, as defined in the environmental and social screening, assessment and mitigation measures, detailed in the ESMF and RPF (see section VI, E).