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Report No: PAD1704

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT AND
INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A
PROPOSED GRANT FROM

THE STRATEGIC CLIMATE FUND – SCALING UP RENEWABLE ENERGY IN LOW INCOME COUNTRIES PROGRAM (SREP)

IN THE AMOUNT OF US$ 19.62 MILLION

TO THE

REPUBLIC OF HAITI

FOR A

RENEWABLE ENERGY FOR ALL PROJECT

October 3, 2017

Energy and Extractives Global Practice
Latin America and Caribbean Region

CURRENCY EQUIVALENTS
(Exchange Rate Effective June 3, 2017)

Currency Unit	=	Haitian Gourde (HTG)
HTG 67.65	=	US$ 1
US$ 0.014	-	HTG 1

FISCAL YEAR
October 1 – September 31

ABBREVIATIONS AND ACRONYMS

BOO	Build, Own, Operate
BRH	Bank of the Republic of Haiti *(Banque de la République d'Haïti), also Central Bank*
Capex	Consumption-based Accounting
CBA	Capital Expenditure
CEAC	*Cooperative Electrique de l'Arrondissement des Coteaux*
CFL	Compact Fluorescent Lamp
CPF	Country Partnership Framework
CSR	Corporate Social Responsibility
CTF	Clean Technology Fund
DA	Designated Account
DESCO	Distributed Energy Service Company
ECVMAS	Survey of Households for Living Conditions after the Earthquake *(Enquête sur les Conditions de Vie des Ménages après le Séisme)*
EDH	Electricity of Haiti *(Electricité d'Haïti)*
EIRR	Economic Internal Rate of Return
EPC	Engineering, Procurement and Construction
ESMAP	Energy Sector Management Assistance Program
ESMF	Environmental and Social Management Framework
FCS	Fragile and Conflict-Affected State
FDI	Industrial Development Fund *(Fonds de Développement Industriel)*
FIRR	Financial Internal Rate of Return
FM	Financial Management
FY	Fiscal Year
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GOGLA	Global Off-Grid Lighting Association
GOH	Government of Haiti
GP	Global Practice
GRS	Grievance Redress Service
GTF	Global Tracking Framework
GWh	Gigawatt hour

HH	Household
HTG	Haitian Gourde
ICT	Information and Communication Technology
IDA	International Development Association
IFC	International Finance Corporation
IFM	International Fund Manager
IFR	Interim Financial Report
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IP	Investment Plan
IPF	Investment Project Financing
IPP	Independent Power Producer
IPSAS	International Public Accounting Standards
IS	Implementation Support
KGGTF	Korean Green Growth Trust Fund
kW	Kilowatt
kWh	Kilowatt Hour
kWp	Kilowatt Peak
LCOE	Levelized Cost of Energy
LCR	Latin America and the Caribbean Region
LED	Light-Emitting Diode
Li-ion	Lithium Ion
M&E	Monitoring and Evaluation
MEF	Ministry of Economy and Finance (*Ministère de l'Economie et des Finances*)
MGSP	Municipal Grid Service Providers
MTF	Multi-Tier Framework
MTPTC	Ministry of Public Works, Transportation and Communication *(Ministère des Travaux Publics, Transports et Communications)*
MW	Megawatt
MWh	Megawatt Hour
MWp	Megawatt Peak
NGO	Non-Governmental Organization
NPV	Net Present Value
O&M	Operation and Maintenance
OGEF	Off-Grid Electricity Fund
OM	Operations Manual
Opex	Operating Expenditure
PAD	Project Appraisal Document
PAYG	Pay-as-you-go
PDO	Project Development Objective
PDNA	Post Disaster Needs Assessment
PIU	Project Implementation Unit
PPA	Power Purchase Agreement
PP	Procurement Plan
PPP	Public-Private Partnerships
PPSD	Project Procurement Strategy for Development

PRELEN	Rebuilding Energy Infrastructure and Access Project *(Projet de reconstruction de l'infrastructure électrique et d'expansion de l'accès à l'énergie)*
	Poverty Social Impact Assessment
PSIA	Photovoltaic
PV	Quality Assurance
QA	Resettlement Action Plans
RAP	Results Based Financing
RBF	Renewable Energy
RE	Regulatory Indicators for Sustainable Energy
RISE	Resettlement Policy Framework
RPF	Systematic Country Diagnostic
SCD	Strategic Climate Fund
SCF	Sustainable Energy for All
SEforALL	Solar Electric Light Fund
SELF	Solar Home Systems
SHS	Small and Medium Enterprises
SME	Statements of Expenditures
SOE	Strategic Plan for the Development of Haiti
SPDH	Scaling Up Renewable Energy in Low Income Countries Program
SREP	Technical Assistance
TA	Ton of Carbon Dioxide
tCO_2	Terms of Reference
TOR	United Nations Framework Convention on Climate Change
UNFCCC	United States Dollar
USD	United States Dollar
US$	U.S. Trade and Development Agency
USTDA	Value Added Tax
VAT	Variable renewable energy
vRE	Weighted Average Cost Of Capital
WACC	World Bank
WB	World Bank Group
WBG	Watt Peak
WTP	Willingness to Pay

Regional Vice President:	Jorge Familiar
Country Director:	Anabela Abreu
Senior Global Practice Director:	Riccardo Puliti
Practice Manager:	Antonio Barbalho
Task Team Leaders:	Dana Rysankova / Frederic Verdol

HAITI: Renewable Energy for All Project

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PAD DATA SHEET

Haiti

Haiti: Renewable Energy for All Project (P156719)

PROJECT APPRAISAL DOCUMENT

LATIN AMERICA AND CARIBBEAN

Energy and Extractives Global Practice

Report No.: PAD1704

Basic Information			
Project ID P156719	EA Category B - Partial Assessment		Team Leader(s) Dana Rysankova, Frederic Verdol
Financing Instrument Investment Project Financing	Fragile and/or Capacity Constraints [ ] Financial Intermediaries [ ] Series of Projects [ ]		
Project Implementation Start Date 1-Mar-2018	Project Implementation End Date 29-Jun-2024		
Expected Effectiveness Date 1-Mar-2018	Expected Closing Date 31-Dec-2024		
Joint IF No			
Practice Manager/Manager Antonio Alexandre Rodrigues Barbalho	Senior Global Practice Director Riccardo Puliti	Country Director Anabela Abreu	Regional Vice President Jorge Familiar

Approval Authority
Approval Authority
AOB Decision
please explain
The proposed Project is financed through a grant from the Strategic Climate Fund – Scaling Up Renewable Energy in Low Income Countries Program (SCF-SREP)

Responsible Agency: MTPTC Energy Cell			
Contact:	Nicolas Allien	Title:	Coordinator SREP
Telephone No.:	50928119587	Email:	cenergiemtptec@gmail.com

Project Financing Data(in USD Million)

[ ]	Loan	[ ]	IDA Grant	[ ]	Guarantee
[ ]	Credit	[X]	Grant	[ ]	Other

Total Project Cost:	19.62	Total Bank Financing:	0.00
Financing Gap:	0.00		

Financing Source	Amount
Strategic Climate Fund Grant	19.62
Total	19.62

Expected Disbursements (in USD Million)

Fiscal Year	2018	2019	2020	2021	2022	2023	2024	2025
Annual	0.50	2.50	3.00	4.00	5.00	3.00	1.00	0.62
Cumulative	0.50	3.00	6.00	10.00	15.00	18.00	19.00	19.62

Institutional Data

Practice Area (Lead)

Energy & Extractives

Contributing Practice Areas

Climate Change

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 households, businesses and community services.

Components

Component Name	Cost (USD Millions)
Grid-connected distributed Renewable Energy	11.00
Off-grid distributed Renewable Energy	8.62

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 [ ] 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

Name	Recurrent	Due Date	Frequency
MTPTC Energy Cell	**X**		CONTINUOUS

Description of Covenant

The Recipient shall operate and maintain, at all times during the implementation of the Project, the MTPTC Energy Cell under the administrative authority of MTPTC, with functions, staffing and resources satisfactory to the World Bank, as further detailed in the Operations Manual. (Schedule 2, Section I.A.2(a))

Name	Recurrent	Due Date	Frequency
MTPTC PIU	X		CONTINUOUS

Description of Covenant

The Recipient shall operate and maintain, at all times during the implementation of the Project, the PIU under the administrative authority of MTPTC, with functions, staffing and resources satisfactory to the World Bank, as further detailed in the Operations Manual. (Schedule 2, Section I.A.3(a))

Name	Recurrent	Due Date	Frequency
EDH Escrow Account	X		CONTINUOUS

Description of Covenant

The Recipient shall establish and thereafter operate and maintain at all times during the implementation of the Project, the Escrow Account under the administrative authority of EDH and on terms and conditions satisfactory to the World Bank, as further detailed in the Operations Manual, to facilitate payments under the O&M Contract, and ensure sustainability of Sub-component 1.a of the Project. (Schedule 2, Section I.A.5)

Conditions

Source Of Fund	Name	Type
CSCF	Authorization/Ratification of the Grant Agreement	Effectiveness

Description of Condition

The execution and delivery of the Grant Agreement on behalf of the Recipient have been duly authorized or ratified by all necessary corporate or governmental actions. (Article 5.01(a))

Source Of Fund	Name	Type
CSCF	Operations Manual	Effectiveness

Description of Condition

The Recipient prepared and adopted, in form and substance satisfactory to the World Bank, the Operations Manual. (Article 5.01(b))

Source Of Fund	Name	Type
CSCF	MTPTC Implementation Capacity	Effectiveness

Description of Condition

The MTPTC Energy Cell and the PIU are operational and duly staffed, all in form and substance satisfactory to the World Bank. (Article 5.01(c))

Source Of Fund	Name	Type
CSCF	Sub-component 1.a (i)	Disbursement

Description of Condition

No withdrawal shall be made under Category (1), until at least one contract for a solar PV battery plant under Sub-component 1.a. has been awarded by the Recipient in accordance with Section III of Schedule 2 to the Grant Agreement, in form and substance satisfactory to the World Bank. (Schedule 2, Section IV.B.1(b))

Source Of Fund	Name	Type
CSCF	Sub-component 1.a (ii)	Disbursement

Description of Condition

No withdrawal shall be made under Category (2) until the Recipient has established the Escrow Account; and the O&M Contract has been executed in form and substance satisfactory to the World Bank. (Schedule 2, Section IV.B.1(c))

Source Of Fund	Name	Type
CSCF	Sub-component 2.a	Disbursement

Description of Condition

No withdrawal shall be made under Category (4) until the Municipal Grid Service Agreement has been signed in form and substance satisfactory to the World Bank. (Schedule 2, Section IV.B.1(d))

Source Of Fund	Name	Type
CSCF	Sub-component 2.b	Disbursement

Description of Condition

No withdrawal shall be made under Category (5) until the first Productive Use Investment Agreement has been signed in form and substance satisfactory to the World Bank. (Schedule 2, Section IV.B.1(e))

Source Of Fund	Name	Type
CSCF	Sub-component 2.c	Disbursement

Description of Condition

No withdrawal shall be made under Category (6) until:
(i) The first Distributed System Investment Agreement has been signed in form and substance satisfactory to the World Bank;
(ii) The CTF Agreements have been executed and delivered and all conditions precedent to their effectiveness or to the right of the Recipient to make withdrawals under them have been fulfilled;
(iii) The OGEF has been established under the FDI on terms and conditions, and in a manner, acceptable to the World Bank;
(iv) The FDI Subsidiary Agreement has been executed by the parties thereto, in form and substance satisfactory to the World Bank; and
(v) a separate opinion satisfactory to the World Bank, of counsel acceptable to the World Bank, on behalf of the Recipient and FDI, has been issued, respectively, showing that the FDI Subsidiary Agreement has been duly authorized by the Recipient and the FDI and is legally binding upon the Recipient and the FDI in accordance with its terms. (Schedule 2, Section IV.B.1(f))

Team Composition

Bank Staff

Name	Role	Title	Specialization	Unit
Dana Rysankova	Team Leader (ADM Responsible)	Senior Energy Specialist	Energy	GEE04
Frederic Verdol	Team Leader	Sr. Power Engineer	Energy	GEEES
Monyl Nefer Toga Makang	Team Member	Energy Specialist	Energy	GEESO
Lucine Flor Lominy	Team Member	Energy Specialist	Energy	GEE04
Vincent Francois Jean Launay	Team Member	Infrastructure Finance Specialist	Financial Solutions	GEEFS
Nicolas Kotschoubey	Safeguards Specialist	Consultant	Environment	GEN04
Hana Salah	Safeguards Specialist	Consultant	Social	GSU04
Rose Caline Desruisseaux-Cadet	Procurement Specialist (ADM Responsible)	Procurement Specialist	Procurement	GGO04

Aboubacar Magassouba	Procurement Specialist	Consultant	Procurement	GGO04
Fabienne Mroczka	Financial Management Specialist	Sr Financial Management Specialist	Financial management	GGO22
Lydie Madjou	FM Specialist	Senior Financial Management Spec.	Financial Management	GGO22
Isabella Micali Drossos	Country Lawyer	Senior Counsel	Legal	LEGLE
Faly Diallo	Finance Officer	Finance Officer	Finance Officer	WFALA
Elisabeth Maier	Team Member	Operations Officer	Operations	GEE05
Elizabeth Sanchez	Team Member	Program Assistant	ACS	GEE04
Luisa F. Pacheco de Vincenzo	Team Member	Senior Program Assistant	ACS	GEE04
Juliette Suzanne Georgette Besnard	Team Member	Consultant	Energy	GEESO
Stephanie Nsom	Team Member	Consultant	Energy	GEE04

Extended Team

Name	Title	Office Phone	Location
Emmanuel Durand	Senior Economist	----	iiDevelopment, Germany
Jennifer Tracy	Senior Energy Specialist	----	iiDevelopment, Germany
Kilian Reiche	Senior Energy Specialist	----	iiDevelopment, Germany

Locations

Country	First Administrative Division	Location	Planned	Actual	Comments
Haiti			X		Nationwide

Consultants (Will be disclosed in the Monthly Operational Summary)	
Consultants Required ?	Consultants will be required

I. STRATEGIC CONTEXT

A. Country Context

1. **Haiti's geography, people, and history provide many opportunities.** Haiti is the third largest Caribbean nation by area and population. The Republic of Haiti and its 10.7 million people (as of 2015) are close to major markets (a two-hour flight to Miami, Florida) and benefit from a young labor force, a large and dynamic diaspora, and substantial geographic, historical, and cultural assets.

2. **However, Haiti has considerable development challenges**. Income inequality is the highest in the region and one of the highest in the world, with a 2012 Gini co-efficient of 0.61. Haiti ranks 163rd out of 188 countries on the 2015 Human Development Index. Nearly 60 percent of the population, or 6.3 million people, remain poor,[1] and 24 percent (2.5 million) are extremely poor, with poverty highest in rural areas. The poorest regions, which are also the furthest from the capital, show extreme poverty rates exceeding 40 percent and have very limited access to basic services. Gross domestic product (GDP) per capita was US$829 in 2015 - less than 10 percent of the regional average.[2]

3. **Gender inequality is also persistent.** Despite progress in education opportunities, adult women are still less educated, more likely to be illiterate, and disadvantaged in monetizing their economic assets. Gender-based violence remains widespread.

4. **Haiti's economic performance has been repeatedly compromised by political shocks and natural disasters.** The 2010 earthquake was one of the world's deadliest natural disasters ever, resulting in damages and losses of US$8 billion (120 percent of GDP).[3] While the post-earthquake period has seen generally positive economic growth, the last two years have been marked by political and economic uncertainties. Contested elections and the impact of natural hazards has slowed economic growth, accelerated inflation, and led to the depreciation of the national currency, the Haitian Gourde. This was exacerbated by deadly Hurricane Matthew, which hit Haiti in October 2016, causing an estimated US$1.89 billion (22 percent of GDP) in damages and US$2.2 billion (25 percent of GDP) in reconstruction needs.[4] The 2016 election of a new administration is expected to end this period of uncertainty and re-initiate economic growth.

5. **The World Bank's 2015 Systematic Country Diagnostic (SCD) for Haiti**[5] recommends a significant acceleration of growth rates to reduce poverty, but also notes that growth must 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.

[1] Under the Haitian poverty line of US$1.98 per day based on consumption.
[2] IDA, IFC, MIGA: Country Partnership Framework for the Republic of Haiti for the Period FY16-FY19, 2015, and UNDP: Human Development Report, 2015.
[3] IDA, IFC, MIGA: Country Partnership Framework for the Republic of Haiti, FY16-19.
[4] Rapid Damage and Loss Assessment of Hurricane Matthew, the Government of the Republic of Haiti with joint support from the World Bank and the Inter-American Development Bank (October 24, 2016); Note: the subsequent PDNA published by Government in February 2017 raises the estimate of damages and losses to 32 percent of GDP equivalent.
[5] Haiti - Toward a New Narrative: Systematic Country Diagnostic, 2015 (report number 99448).

B. Sectoral and Institutional Context

6. The Ministry of Public Works, Transportation and Communication (MTPTC) oversees the energy sector in Haiti, including the national electricity utility *Electricité d'Haïti* (EDH), which until recently[6] had a monopoly over transmission and distribution of electricity.

7. **The Haitian electricity sector's reliance on petroleum products is increasing.** 81 percent of EDH's total generation is oil-based, mostly provided by Independent Power Producers (IPPs). The rest is EDH's own hydro generation. In addition, while EDH's available generation capacity has been stagnant over the past decade (today it is still at 176 MW), the aggregate capacity of stand-alone diesel engines, used for self-generation and back-up power, has been growing steadily, reaching currently an estimated 500MW.[7]

8. **Haiti's reliance on fossil fuels is costly.** EDH's average cost of thermal generation is around US$0.30/kWh, and even higher on its smaller isolated grids that run on diesel. The average cost of generation from individual diesel generators ranges from US$0.40 to almost US$2 per kWh. Such price conditions make renewable energy (RE), like solar PV, highly competitive, even without considering positive environmental externalities.

9. **Haiti has excellent renewable energy resources**. Significant economic potential exists for hydropower, solar PV, wind and biomass generation.[8] So far, however, only hydropower has been exploited, and only partially.

10. **Haiti is falling behind other countries, including its Caribbean neighbors**, which are all investing in energy supply diversification. The latest statistics from the SEforALL Knowledge Hub show that Haiti is an outlier insofar as it has yet to enact a supportive policy and regulatory framework for clean energy and access.[9]

11. **Only a third of the Haitian population has access to electricity,** and even that is sporadic and unreliable.[10] Fifty-three percent of urban households and 17 percent of rural households have electricity access. The access rate has remained virtually unchanged for 40 years. Electricity access is also highly skewed towards higher income quintiles, and is increasingly provided through informal and illegal connections. The typical daily electricity service of 13 hours or less and the relatively high tariff for commercial and industrial users (US$0.30/kWh) compels most industries to self-generate.

12. **EDH faces considerable technical, managerial, and financial challenges.** Technical and nontechnical losses are 65 percent, in part due to electricity fraud and theft. Further, the collection rate is only about two–thirds, hence EDH ultimately recovers less than a quarter of the value of the electricity purchased and generated.[11] In addition, fuel and power purchases are made in US dollars

[6] Presidential decrees dated February 03, 2016 ended EDH's monopoly on electricity transmission and distribution, and provided a framework for the creation of an energy regulatory body.
[7] EDH and MTPTC Energy Cell estimates.
[8] See Haiti SREP Investment Plan for summary of the available studies and resulting estimates of economic potential.
[9] See Regulatory Indicators for Sustainable Energy (RISE); rise.esmap.org. Haiti ranked second from bottom in RISE 2017 out of 111 countries.
[10] World Bank/SE4ALL: Global Tracking Framework, 2017, based on the latest national survey data and EDH data on average number of hours of service and outages.
[11] World Bank staff calculation based on EDH data.

while revenues are collected in Haitian Gourdes, which have depreciated significantly in 2016-17. Consequently, EDH has difficulties paying for operating costs and relies on government subsidies to bridge the gap, contributing - according to the International Monetary Fund (IMF) - 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. The Government of Haiti (GOH) is considering measures to reduce EDH losses,[12] including outsourcing EDH's commercialization functions (metering, billing and collection). Improving EDH's commercial performance is the GOH's greatest challenge for a viable electricity sector that can contribute to economic development.

13. **EDH-owned isolated grids**: EDH operates one main "interconnected grid" that serves the capital, Port-au-Prince, and surrounded areas, as well as nine smaller "isolated grids". EDH has a total of 273,000 "active" (i.e. legally connected, metered and billed) customers, and likely twice as many informal connections.[13] About 90,000 active customers are spread out through nine isolated grids across the country, serving secondary cities and larger rural towns. These grids typically serve around 500 to 20,000 customers, but the outdated and poorly maintained supply and distribution infrastructure, together with commercial weaknesses, are constraining service quality and expansion. Peak demand is significantly larger than local supply in all these systems.

14. **Municipal diesel grids**: Apart from EDH-owned grids, over 30 smaller diesel-powered municipal grids (mostly 100-500kW, serving 1,000 to 5,000 customers) are operated informally or under the Decentralization Law of 2006. Their diesel units are typically oversized, expensive to run, with sporadic service (if any at all), and with tariffs typically set below operating costs. However, they tend to have newer, relatively complete distribution networks and could therefore become operational with more efficient and sustainable generation (i.e. PV hybridization) and adequate commercialization (i.e. tariffs at cost-recovery level and energy efficiency measures).

15. **Municipal Renewable Energy (RE) grids** are emerging as a viable solution for rural towns with no electricity service. Currently, there are two private RE municipal (mini-) grid operators in Haiti with a nation-wide scale-up ambition. Both operate mini-grids in agreement with the municipalities, charging cost-reflective tariffs collected through smart pre-paid meters – demonstrating that municipal grids can be run sustainably as a commercial enterprise. A 2016 study[14] reconfirms the high potential for RE mini-grid development in Haiti (see Annex 2 for description of existing and potential RE mini-grids).

16. **Self-generation**, primarily through individual diesel engines, is currently the most widespread method to acquire electricity. 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 these are run by industries and businesses that require a reliable power supply that EDH is unable to provide. While diesel gensets are also used in rural areas (e.g. by larger enterprises and agribusinesses), their operation is expensive, and they are therefore rare compared to the urban setting. Most rural households and micro-enterprises have no electricity access, and pay US$10-20 a month for inferior and harmful alternatives, such as kerosene, dry cell batteries

[12] See MTPTC's 2017-2022 Roadmap for the Electricity sector, dated April 04, 2017.
[13] Haiti Poverty and Equity Note # 2: Electricity in Haiti: Who gets it and how?, 2017.
[14] USTDA, EarthSpark, Energy and Security Group: Feasibility study and ranking of mini-grid sites in Haiti, 2016.

and cell phone charging.[15] Significant opportunities exist for converting these expenditures to installment payments to purchase quality solar off-grid products.

17. **Private sector-driven, solar off-grid electrification solutions are spreading fast globally,** and innovative business models are emerging**,** such as the "pay-as-you-go" (PAYG) model, which allows households to pay for electricity in installments over time. As of 2017, three Haiti-based companies started to test PAYG solutions (see Annex 2), complementing an already active market for solar lanterns. However, Haiti's relative isolation from the main markets in Africa and Asia, as well as domestic barriers (high import duties and VAT, a high level of market spoilage due to low quality products, and difficulties in accessing financing) have limited and will continue to constrain market growth.

18. To unlock the market potential, the GOH (with support from the CTF-funded Modern Energy Services for All Project) is establishing the Off-Grid Electricity Fund (OGEF), which will invest equity and provide loans to Haitian off-grid electricity businesses with commercially viable and scalable business plans. OGEF will be managed by an OGEF Fund Manager, and will be a partnership between the *Fonds de Développement Industriel* (FDI) – a Haitian financial intermediary operating under the auspices of the Haitian Central Bank (BRH) - and a competitively selected International Fund Manager. See Box A2.1 in Annex 2 for more details.

C. Higher Level Objectives to which the Project Contributes.

19. **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. The Project would also have important climate change co-benefits, by displacing fossil fuels with RE generation.

20. **The Project is fully aligned with the World Bank Group's Country Partnership Framework (CPF)** for FY16-19 (Report No. 98132-HT), discussed by the World Bank Board of Executive Directors on September 29, 2015. The 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 RE development. It will support Haiti's competitiveness and productivity by promoting private-sector growth through energy investments.

21. **The Project also supports GOH's vision** for the energy sector, included in the Strategic Plan for the Development of Haiti (SPDH), which sets a path for Haiti to become an emerging economy by 2030, including the ambitious goal of universal electricity access. Furthermore, the Project supports GOH's National Roadmap (2017), which highlights the need for investing in RE and off-grid energy access.[16] The Project also supports Haiti's Intended Nationally Determined Contribution (INDC) commitment to expand RE generation to 47 percent of the generation mix by 2030.

[15] Data based 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.

[16] MTPTC's 2017-2022 Roadmap for the Electricity sector, dated April 04, 2017.The Road Map calls for: (i) improving EDH's performance and for coordinated efforts to build the national grid while supporting mini-grid and off-grid solutions for electrification; (ii) a diversification of Haiti's generation mix with indigenous renewable energy sources, and (iii) MTPTC to implement the present SREP-funded project, as well as the related CTF-funded Modern Energy Services for All Project.

22. **The Republic of Haiti has been selected as one of the recipients of the Scaling Up Renewable Energy Program (SREP)**. The Project is based on the SREP Investment Plan, endorsed by the SREP sub-committee in May 2015 (see Annex 7).

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

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

B. Project Beneficiaries

24. **The SREP Investment Plan defines a comprehensive SREP Program**, which is co-financed by: (i) the present SREP-funded Project; (ii) the parallel CTF-funded Modern Energy Services for All Project (CTF Project - P154351); and (iii) the ongoing IDA-funded Rebuilding Energy Infrastructure and Access Project (PRELEN - P127203). See Box 1 below for further details. For this reason, the PAD distinguishes between Program-level and Project-level indicators.

25. The Haiti SREP Program will result in new or improved electricity access for about one million people (including 500,000 women) and 10,000 enterprises/community services. Of these, about 410,000 people (including at least 205,000 women) and 4,500 enterprises/community services are attributable to the present Renewable Energy for All Project. The Program will have important climate change co-benefits (estimated at appraisal at 74 percent of project funding). It will displace fossil fuel generation with renewable energy, resulting in an estimated annual reduction of about 100,000 tCO_2 at the Program level (42,000 tCO_2 at Project level).

26. **The Project includes specific actions to ensure that gender-differentiated benefits materialize and are properly tracked**. The Project aims to reach a target of 50 percent of female beneficiaries, although sex-disaggregated electricity access rates are not yet available to quantify the gender gap. This target may be adjusted following results of the upcoming Multi-Tier Framework (MTF) baseline survey. Additional gender-related indicators are included in Annex 1, and a gender assessment and key actions are included in Annex 5.

C. PDO Level Results Indicators

27. The PDO will be measured against the following project-level indicators:

- Number of people provided with new or improved electricity service (a Bank core indicator), disaggregated by gender;
- Number of 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.

28. The Project will establish a baseline using the MTF methodology[17], and will measure Project progress and impacts against this baseline.

[17] World Bank, SEforAll: Beyond Connections: Energy Access Redefined; 2015.

III. PROJECT DESCRIPTION

29. **The Project supports a comprehensive investment and capacity building program to unlock the most promising RE investment opportunities in Haiti**. Considering the fragmented nature of Haiti's electricity system (nine isolated grids operated by EDH, over 30 municipal grids and an estimated 500MW in self-generation), the Project focuses on the distributed RE segment. Three user / off-taker segments with the strongest potential for near- and medium-term private sector investments have been identified: (i) small and medium-sized EDH grids; (ii) municipal grids; and (iii) individual (stand-alone) off-grid systems (Table 1). These have been grouped into two Components: Component 1 covers on-grid investments in EDH grids, while Component 2 covers off-grid investments in municipal grids and stand-alone off-grid systems ("distributed systems").

Table 1. Distributed RE access expansion options – electrification potential

Distributed RE segment	Max. population to be reached	Recommended SREP Program level target
RE retrofit, upgrade, and expansion of EDH grids	1,500,000	100,000
Municipal grids (retrofit and green-field)	300,000	100,000
Stand-alone distributed off-grid systems (households, social users, SMEs)	>5,000,000	700,000

Source: WB team calculations, based on *GOH: Haiti SREP Investment Plan*, 2015

30. **SREP Program**. SREP financing is a part of a broader SREP Program, identified in the SREP Investment Plan, consisting primarily of SREP, CTF and IDA PRELEN parallel financing, forming a comprehensive investment and technical assistance (TA) package described in Box 1.

Box 1: SREP Haiti Program

The SREP Haiti Program sets Haiti on a path to transform its energy sector from an underdeveloped, unreliable, and expensive fossil fuel-based power generation mix to a modern and sustainable energy system relying on diverse sources of power. The Program is financed primarily through three funding sources: SREP and the Clean Technology Fund (CTF) – both belonging under the Climate Investment Funds – and through the ongoing IDA-funded Rebuilding Energy Infrastructure and Access (PRELEN) operation.

CTF: Modern Energy Services for All Project, P154351 (US$15.65 million grant). This parallel Project will accelerate private sector-driven, RE-based off-grid electrification in rural and peri-urban areas of Haiti. The Project establishes the Off-Grid Electricity Fund (OGEF), which will invest equity and provide loans to commercially viable off-grid energy businesses.

SREP: Renewable Energy for All Project, P156719 (US$19.62 million grant): The Project will scale-up renewable energy investments in Haiti in order to expand and improve access to electricity for households, businesses and community services. This will include demonstrating the viability of integrating solar PV generation into the national utility grids, and complementing OGEF funding with grant funding for mini-grids and off-grid electrification to accelerate market development, increase affordability and support rural development.

The on-going IDA PRELEN P127203 (US$90 million) in line with its objectives and description, will: (i) provide additional technical assistance for scaling up renewable energy and energy access; (ii) support selected grid improvements to facilitate integration of solar energy to the national electricity grids; (iii) support off-grid access for community services, such as schools; and (iv) pilot innovative business models, such as those for

productive uses or mini-grids. (US$21 million of the grant proceeds in on-going or planned activities are for RE and energy access).

The three sources form a comprehensive package, each contributing to the SREP Program outcomes. In particular, CTF grant funding will be used to establish the Off-Grid Electricity Fund (OGEF), which will be professionally managed by an experienced Fund Manager to invest in commercially viable off-grid energy businesses, while SREP and IDA grants will be used to complement such investments in non-commercial areas to maximize the number of beneficiaries and to ensure that the off-grid electricity services are affordable for poorer population segments. All together the SREP Program financing package is designed to significantly leverage additional private sector investments (**US$64-72 million**).

	Component 1 (EDH grids)	Component 2 (municipal grids and off-grid)
IDA	TA/capacity building and minor investments in selected EDH isolated grids to facilitate vRE integration	TA/capacity building and piloting of new approaches
SREP	Investments in the solar PV plants and limited associated TA	Grants to the private off-grid energy service providers and associated TA/capacity building
CTF	-	Equity investments and loans to the private off-grid energy service providers

A. Project Components

31. **Component 1 Grid-Connected Distributed Renewable Energy (*SREP US$11 million).*** This Component 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 developing a supportive policy and regulatory environment for private sector-driven RE investments. The Component will finance investments and technical assistance. The Component will build 5-12 MW of RE capacity (solar PV + battery), which is expected to hybridize 2-3 EDH isolated grids currently running on diesel power, resulting in improved access for at least 100,000 people and 1,000 enterprises and community uses. The Component will engage the private sector in the construction and operation of the PV plants and chart a path towards attracting commercial investments in solar PV generation. It will demonstrate the potential of solar PV energy to simultaneously reduce the 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.

32. Sub-component 1.a: "*Demonstration Pilot Solar PV Investments*" will support the construction of pilot solar PV battery storage plants to feed at least one EDH isolated grid (although most likely the Sub-component will support 2-3 grids). Phase I will be publicly financed, focused on demonstrating the feasibility of connecting a mid-size solar PV plant with storage to one of the relatively small grids in Haiti. Annex 2 includes criteria for the selection of the Phase I EDH grid. The focus is primarily on the South of Haiti – the area most affected by Hurricane Matthew. Subsequently, Phase II will explore options to promote the development of solar PV battery storage plants by private investors. In such a case, the Project may be restructured, to allow a part of the funding under Component 1 to be used as a guarantee.

33. The Sub-component 1.b: "*Technical Assistance and Enabling Framework for RE Scale-up*" will provide technical assistance: (i) to the MTPTC Energy Cell, EDH, MEF, and other key

stakeholders for the design, implementation and monitoring of the Demonstration Pilot Solar PV Investments, including the environmental and social safeguards aspects, and private sector participation; and (ii) to develop a broader enabling policy and regulatory framework to support RE investments and private sector participation in the long term.

34. **Component 2: Off-grid Distributed Renewable Energy *(SREP US$8.62 million).*** This Component will extend access to clean and modern energy services to households, communities and enterprises that are not served by EDH by deploying a wide range of off-grid electrification options. The Component will finance grants and technical assistance. The Component will provide (mostly) first-time access to at least 310,000 people (contributing to a target of 900,000 people at the Program level) and 3,500 enterprises and community service institutions (as part of a targeted 9,000 enterprises/community services at the Program level). While the solar home 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 are also supported to ensure that the newly acquired electricity access is used to drive economic transformation in rural Haiti. The Component will therefore deploy a wide range of off-grid electrification options: municipal grids, larger stand-alone systems for productive and community uses, and smaller solar home and pico-PV systems for households and micro-enterprises. Solar energy will be the most likely RE source, but micro-hydro, biomass and wind will also be eligible.

35. The Sub-component 2.a: "*Renewable Energy Municipal Grids*" will provide grants to Municipal Grid Service Providers to partially cover municipal grid investment costs under Service Agreements with selected municipalities to build and operate RE grids on their territories, through: (i) hybridization of the existing municipal grids, and (ii) green-field investments. The municipal grids refer to pico-, micro- and mini-grid solutions, typically of 10-500kWp capacity, serving a few dozen to tens of thousands of customers on the territory of one or multiple municipalities. The approach will build on an emerging model applied in Haiti, in which mini-grid service providers sign concession agreements with the municipalities to build and operate municipal grids, following the provisions of the Decentralization Law of 2006. The Sub-component will further develop and regularize this model by creating a standard tri-partite Service Agreement among the MTPTC Energy Cell, Municipality and Municipal Grid Service Providers, which will define the length and other key terms of the concession. The grants will be used only to finance up-front costs, as public sector contribution to investments, covering mainly the costs of the distribution network. At the end of the concession, the municipal distribution network built under the Project will be transferred to the beneficiary municipality.

36. The Sub-component 2.b: "*Renewable Energy for Productive and Community use"* will provide grants to: (a) the Distributed Energy Service Companies (DESCOs) to develop and test viable and scalable business models to serve, inter alia, agribusinesses, rural enterprises, and public service institutions in rural areas (the Productive Use Beneficiaries); or (b) directly to these Productive Use Beneficiaries, in order to support rural economic development. To this end, the Sub-component will finance: (i) pilots of viable, scalable and innovative business models, and (ii) electrification of community and public service facilities. Given that this market segment is less developed than the mini-grid/household segments, the Project will establish a challenge grant facility, to competitively award grants to applicants with promising, scalable business models for productive uses (examples are provided in Annex 2). Special focus will also be placed on supporting female entrepreneurs. The facility will be developed in close collaboration with other

related sectors, including finance, agriculture and competitiveness to reflect the need for a multi-sectoral approach in order to drive intended final outcome – e.g. to ensure that improved energy access is used for increasing competitiveness of Haitian agri-businesses. In addition, the Project will collaborate with other Bank-financed projects in education, health and water sectors to support the sustainable provision of off-grid electricity for schools, health centers, water pumps and other community facilities financed under these projects. See Annex 2 for the list of the projects.

37. The Sub-component 2.c: *"Distributed Systems"* will provide grants to the DESCOs to supply solar home systems and pico-PV solutions[18] to Haitian households and small businesses through: (i) grants for quality-verified solar products to support the penetration of higher quality products into the Haitian market; (ii) grants for piloting viable, scalable and sustainable business models; and (iii) grants for growth of early stage off-grid businesses with viable business plans. 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 under the CTF-funded Modern Energy Services for All Project with limited, well-targeted grants provided by SREP to launch and support early growth of DESCOs. See Annex 2 for more details.

38. The Sub-component 2.d: *"Capacity building and Technical Assistance"* will provide technical assistance and capacity building needed: (i) to carry out feasibility studies, consumer awareness campaigns, and verification and monitoring and evaluation; (ii) to improve energy access policies and planning (e.g. least-cost geospatial electrification plans, regulatory framework for mini-grids); (iii) for broader capacity building to support RE and off-grid access scale-up in Haiti, including for public agencies, universities, vocational training centers, energy businesses (including for safeguards), and households (e.g. for efficient use of energy services); and (iv) to carry out communication and consensus-building activities to promote clean energy and access.

B. Project Financing

39. This is an Investment Project Financing (IPF) Project. The Project is financed from the Scaling Up Renewable Energy in Low Income Countries Program (SREP). The SREP funding is US$19.62 million, which will be extended on a grant basis. The SREP Project contributes to a broader SREP Program, as identified in the Haiti SREP Investment Plan (see Box 1), financed through public and private financing sources (see Annex 2 for more details on Program level financing).

C. Lessons Learned and Reflected in the Project Design

40. **For grid-connected distributed renewables**: Solar PV has been the fastest evolving energy technology of the past ten years, benefiting from dramatic cost reductions due to improving technology, increasing supply and competitive pressures. Parallel improvements in energy storage technologies allow for a more efficient integration of solar PV and batteries in on-grid solar PV projects, benefitting in particular smaller and weaker grids.

[18] DESCOs are understood here broadly as off-grid solar businesses providing both solar home systems and pico-PV products, through a variety of business models, including cash sales, pay-as-you-go and microfinance. Pico-PV solutions are understood as solar lanterns and small PV systems, typically under 10Wp. Solar home systems are larger systems serving households and small businesses, typically between 10 and 500Wp.

41. Experience from solar PV auctions of the past five years shows that the private sector can play an important role in scaling up solar PV technology and offer competitive prices. However, enabling conditions for private sector to participate must exist. Guarantees can help reduce country, regulatory and off-taker risks, but projects involving small investments in high risk countries may not attract private sector investment (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 the potential of grid-connected solar PV technology first with public sector investments, in order to remove technology/grid integration barrier and build conditions for attracting larger private sector funding in the future.

42. **For off-grid distributed renewables:** The last decade 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; (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) an expanded menu of options for national off-grid electrification:

- There is an opportunity to support a much wider range of technology options, system sizes and business models to satisfy the diverse needs of varied population segments. This, in turn, may allow leveraging transaction costs over larger volumes, and scaling up off-grid project ambitions.

- Given the continued stream of technology and business model innovations, national electrification programs need to be designed with enough flexibility to allow users to benefit from the best available options at any given time. 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" approach, maximizing user benefits and incentivizing further innovation.

- There is also an opportunity to leverage increasing volumes of private sector investments. Even though public support remains essential for now, project design should maximize this opportunity (as opposed to crowding out existing private sector efforts), and create conditions for gradually phasing out public support in favor of private investments, as the market gains more confidence in the new off-grid electricity solutions.

43. **For energy operations in Haiti:** The ongoing Haiti Rebuilding Energy Infrastructure and Access Project, P127203 (PRELEN) is currently unsatisfactory. PRELEN has allocated funds to support distributed renewable energy and energy access. Key lessons from the PRELEN include the following: (i) strong political commitment and broad-based consensus is needed to implement difficult reform measures that may affect existing stakeholders' interests; therefore communications and consensus-building activities should be built early on into the project design; (ii) the project should be flexible in order to allow for the re-orientation of activities towards areas that show satisfactory progress and results – in the case of PRELEN, the off-grid renewable energy activities have been progressing satisfactorily, while activities supporting EDH have suffered

delays; and (iii) parallel capacity building activities are needed to engage and educate key stakeholders involved in policy and investment decisions. These lessons are integrated into the Project design by: (i) including communications, consensus-building and capacity-building activities in Sub-component 2.d; (ii) supporting flexible design which will allow scaling up of those approaches and business models that show best results, and (iii) by focusing project activities on distributed renewable energy generation and access (areas that have shown the best progress under PRELEN).

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

44. **The Project will have two implementing agencies**: (i) MTPTC Energy Cell and (ii) *Fonds de Développement Industriel* (FDI). Implementation details will be included in the Operations Manual, adoption of which will be an Effectiveness condition for the grant.

45. **MTPTC, through its Energy Cell,** will be in charge of implementing both Project components with the exception of Sub-component 2.c. The Energy Cell will be responsible for day-to-day administration, overall planning, coordination, monitoring, evaluation, reporting and communication of Component 1 and Sub-components 2.a, 2.b and 2.d of the Project. MTPTC created the Energy Cell in 2012 to support energy sector development. The Energy Cell is composed of a coordinator and nine technical professionals. The Energy Cell will be strengthened further for the purposes of implementing the present SREP Project. The Energy Cell will also use services of the **Project Implementation Unit (PIU**), which is a separate unit within the MTPTC that has also been implementing the IDA-financed PRELEN Project. The PIU will be in charge of procurement and financial management, and will support the Energy Cell with safeguards expertise.

46. Having the Energy Cell and the PIU adequately staffed is a condition of grant's effectiveness and a legal covenant. The Operations Manual will describe in more details the requirements for the Energy Cell and the PIU staff, as well as the coordination mechanisms between the Energy Cell and the PIU (and other stakeholders) to ensure efficient implementation. The Project staff at the Energy Cell will, at a minimum, include an SREP/CTF coordinator with RE expertise, additional technical staff, a socio-environmental expert and an M&E expert. The PIU already has sufficient staff to support implementation of the SREP Project, but further strengthening of the PIU will be supported, if needed.

47. **FDI** will be in charge of implementing Sub-component 2.c (Distributed Systems), given that this Sub-component is closely related to the equity and debt financing under OGEF. FDI and MEF will sign a Subsidiary Agreement, which will define the rights and obligations of each party. FDI will establish OGEF as a separate financing window of FDI, with its own financing, management, and governance structure. OGEF operations will be supervised by an Advisory Committee, consisting of GOH (including the MTPTC Energy Cell and MEF) and non-government representatives. The MTPTC Energy Cell will act as a Secretariat for the Advisory Committee and will ensure coordination between CTF- and SREP-funded investments. To strengthen FDI capacity in the off-grid energy sector, FDI will enter into a partnership agreement to manage OGEF jointly with a competitively selected International Fund Manager with off-grid energy investment

expertise. The FDI Subsidiary Agreement, the establishment of OGEF and CTF Project effectiveness, are disbursement conditions for Sub-component 2.c.

48. **Other key stakeholders** involved in Project implementation are EDH, which will be a key partner for the implementation of Component 1, and MEF, which will provide overall support to the Project, facilitate coordination with key stakeholders, and through its public-private partnership (PPP) unit, provide support for the development of PPP approaches.

B. Results Monitoring and Evaluation

49. **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, including monitoring and ensuring compliance with environmental and social safeguards. The Energy Cell capacity will be strengthened by hiring an M&E specialist. The Energy Cell will provide bi-annual reports to the World Bank. The Operations Manual will include a description of M&E responsibilities, data collection requirements, frequency of reporting, and arrangements for independent verification of grant use. Impact evaluation will be carried out using the MTF survey.

50. **The Project will also seek citizen engagement and beneficiary feedback** in its implementation. The Project will carry out annual household surveys (by cell phone and follow up home visits where required). In addition, a free text messaging/hotline will be enabled to allow consumers to seek information, submit inquiries or file complaints about their service providers. The municipal grid tri-partite agreements will include provisions for capturing and resolving consumer grievances. Annex 1 includes citizen engagement indicators.

C. Sustainability

51. **The Project will promote sustainable solutions. For Component 1**, the EDH demonstration pilot grids will be administratively isolated from EDH financing to ensure that: (i) a part of the savings from reduced fuel spending can be used to finance operations and maintenance (O&M) of the solar PV + battery plants; and (ii) impacts in terms of reduced costs/improved EDH finances can be adequately monitored. In addition, EDH will establish and maintain an escrow account, into which a part of the revenues that are collected from the grid's users will be deposited to facilitate O&M payments. Establishment and maintenance of the escrow account will be a disbursement condition and a legal covenant. In a broader context, the GOH is currently exploring ways to improve the performance of EDH. The Project will contribute to this process by improving administrative and financial transparency on the demonstration pilot grid. Moving to Phase II of Component 1, additional measures will be required, including outsourced billing and collections in Component 1 grids, or their full concessioning.

52. **For Component 2**, the Project will finance only applicants with viable business plans. The Project design and the business plan evaluation procedures will address common sustainability issues of past projects, including poor technical quality of systems/components, inadequate tariffs, low capacity to operate off-grid systems, and lack of after-sales services and financing for spare parts. In addition, in order to ensure the sustainability of policies promoting RE and energy access, the Project will finance communication and consensus-building activities aimed at building long-term support for clean energy and energy access in Haiti.

V. KEY RISKS

A. Overall Risk Rating and Explanation of Key Risks

53. The overall risk of the Project is assessed as **High.** The key risks include:

54. Political and governance (High): The Project activities may experience disruptions due to political instability and civil unrest, which have occurred in the past in Haiti. To manage this risk, GOH has designed the project in close collaboration and consultations with private sector and civil society to build broad-based support for the Project and ensure its continuity over the long term. In addition, GOH will engage closely with municipal authorities and communities to enhance local support.

55. Sector governance (High): *Worsening EDH performance may prevent the Project from reaching its development objectives*. GOH, in the Roadmap for the Energy Sector, has prioritized actions to improve EDH performance. At the Project level, the focus is on hybridizing one to three smaller grids, which can be administratively isolated from larger EDH issues. GOH, through EDH, will administratively isolate the target grids and establish escrow accounts for O&M payments that will enhance administrative and financial transparency on these grids. The selection criteria for the target grids include the ability to demonstrate a revenue stream that would cover O&M costs.

56. Sector strategies and policies (High)**:** *Clean energy and energy access may not be a Government priority.* The mitigation measure is for GOH to build a broader consensus and support for energy access across all stakeholders: different government agencies, Parliament, municipalities, the private sector, civil society, etc., linked to its INDC commitments and energy access goals for 2030. The Energy Cell has started this process through extensive consultations during the preparation of the SREP Investment Plan. In addition, the Energy Cell will develop and implement a comprehensive communications strategy, show-case the Project's results and impact, support South-South exchanges for key stakeholders and engage in broader capacity building activities under Component 2.d.

57. Macroeconomic (Substantial): *Worsening macroeconomic condition may affect the performance of EDH and of private sector service providers*. For example, significant devaluation of the Haitian Gourde would likely have a negative impact on all service providers, which may source products/materials in US dollars but charge tariffs in local currency. GOH will monitor these potential impacts and if needed suggest modifications in the Operations Manual – e.g. adjusting grant amounts, to ensure that project-supported investments are sustainable.

58. Technical design: (i) Project complexity (Substantial): *The Project includes a range of RE investments, which may challenge the implementing units' capacity*. GOH is strengthening the MTPTC Energy Cell with additional staff and consultants to respond to the increased demand on its staff due to the inclusion of SREP and CTF Project, and to ensure that the staff has expertise in renewable energy and off-grid electrification. In addition, GOH will phase project activities and monitor emerging results. Project design is flexible – while different business models will be tested, the scale-up will focus on what works. Technical design: (ii) vRE integration (Moderate): *There may be technical problems with integrating larger volumes of variable RE to EDH's small and weak grids*. GOH will support gradual integration of vRE into the EDH grid. The first

demonstration pilot will test the proposed approach for vRE integration and fine-tune possible technical issues before scaling up.

59. Implementation capacity, including for fiduciary and safeguards aspects (Substantial): *Project implementation may be delayed due to implementation constraints at the Government, municipal and/or private sector level.* Building capacities for RE and access scale-up is at the core of the SREP Project. Having the Energy Cell and the PIU fully staffed will be a condition of effectiveness. FDI capacity to evaluate investments in off-grid businesses will be strengthened by partnering with an experienced International Fund Manager.

60. Stakeholders: (i) Private sector interest (Moderate): *Considering political, governance, regulatory, economic and financial risks for private investments in Haiti, the private sector may not be willing to invest*. Based on private sector consultations, the Project design takes into account the opportunities and constraints for private sector investments in Haiti, focusing on already existing private sector interest in off-grid electrification (Component 2), while being cautious about the ability to attract significant private sector investment in grid-connected RE (Component 1) at this time. Stakeholders: (ii) Opposition to the Project (Substantial**)**. *Some stakeholders, whose financial interest may be affected by the Project (e.g. those associated with fossil fuel supply chains) may oppose the Project.* The Project will develop and implement a communications strategy and build broader consensus for RE and access goals. Opportunities will be created to shift businesses and employment from fossil fuels to clean energy.

VI. APPRAISAL SUMMARY

A. Economic and Financial Analysis

61. **The Project main benefits derive from reduced spending on energy**, resulting from partially substituted baseline fuel use in the existing EDH and municipal grids and co-generation diesel engines, and from substitutable non-electrical energy uses (e.g. kerosene, dry cell batteries, cell phone charging) of households and unserved enterprises. All project components and considered RE "system types" have an 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), resulting in EIRRs of 11-54 percent, inclusive of carbon benefits. Sensitivity analysis shows EIRRs to be sufficiently robust under many analyzed scenarios. Financial analysis also shows high internal rates of return for typical Component 1 and 2 projects (FIRR between 10 and 40 percent - but depending strongly on a whole array of assumptions which are yet unknown because of the private sector-led selection). See Annex 6 for more details.

B. Technical

62. **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 such as lithium ion batteries for hybrid uses with PV and diesel systems already exist. For Component 2, the Project will only support lanterns and solar kits that are Lighting Global[19] verified (or proven equivalent). Technical specifications

[19] Lighting Global is a WBG program supporting off-grid electricity sector. The program has established a quality assurance framework, including standards for pico-PV and solar home systems, which have now been also adopted as standards of the International Electromechanical Commission. See www.lightingglobal.org for more details.

ensuring quality for larger solar PV systems not covered by Lighting Global, and technical specifications for municipal grids, will be established and regularly updated.

C. Financial Management

63. The financial responsibilities of the Project will be managed by the PIU. A Financial Management Assessment was completed during appraisal and found current capacity at the PIU and implementation arrangements are acceptable and meeting the minimum fiduciary requirements under OP/BP10.00. The fiduciary aspects of Sub-component 2.c (Distributed Systems) 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 Operations Manual. The assessment of FDI and the International Fund Manager will be carried out after the International Fund Manager's selection during Project implementation.

D. Procurement

64. **Procurement for the Project will be carried out by:** (i) **the Energy Cell** and (ii) **the PIU.** The Project will be executed in accordance with the WB's Procurement Regulations for Borrowers under Investment Policy Financing (July 2016) ("Procurement Regulations"), and the provisions stipulated in the Procurement Plan and the Operations Manual. A procurement capacity assessment was carried out in March 2017 and both the Energy Cell and the PIU were found to have the necessary capacity. They will be responsible for all procurement and contracting related queries and processing, including management and compliance with fiduciary requirements.

65. **A Project Procurement Strategy for Development (PPSD) was developed,** and identified the appropriate selection methods, market approaches and types of review by the Bank. Most activities under the Project will be carried out through National or International Competition. Following the market analysis, identification of risks and the contract amounts, it was determined that the most important activities comprising services and works under the Project will be carried out through International Competition, representing 48.6 percent of the total amount. Competitively-awarded grants for hybridization of municipal grids, green-field grids and productive uses, as well as OGEF start-up grants will not finance procurable inputs and, as such, the Bank's Procurement Regulations for Borrowers will not apply to them. The MTPTC Energy Cell will lead the process of the competitive award for the grants for municipal and green-field mini-grids (Sub-component 2a) and productive uses (Sub-component 2b). The proposals will be evaluated by a multi-stakeholder committee, which will also include non-governmental representatives (e.g. Universities). The grants for distributed systems under OGEF (Sub-component 2c) will be awarded by the OGEF Fund Manager (FDI with the international fund manager), under an oversight of a multi-stakeholder Advisory Committee. Detailed evaluation criteria and processes for grant awards will be included in the Operations Manual.

E. Social (including Safeguards)

66. **The project is expected to have important socio-economic benefits from** increased access to electricity, including alleviating poverty through lower cost sources of power for households, job creation and new economic opportunities, particularly in rural areas and for women. Design of financial mechanisms under the project will take affordability and willingness to pay into account, supported by education, and communication campaigns.

67. **The Project will aim to close the gender gap** related to "female employment in the off-grid electricity sector". The Project will support specific actions aimed at promoting female employment in the off-grid electricity sector, including gender training offered to electricity companies, gender-targeted professional training offered to the local population, guidelines for gender-targeted job announcements and gender-sensitive job application processes, gender-related incentives for electricity companies, and a bidding process favoring candidates that have CSR and gender policies, and/or a significant percentage of female staff (e.g. as bonus in the selection criteria). Progress regarding the "female employment in the off-grid electricity sector" indicator will be tracked through company data, collected directly from off-grid businesses.

68. **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 unknown, a Resettlement Policy Framework (RPF) was prepared by the GOH, consulted with stakeholders in Haiti, and disclosed in French on June 2, 2017 on GOH's website and on June 5, 2017 on the World Bank's website. The RPF includes guidance on the application of OP 4.12 (see Annex 3). The social impact screening will cover also labor safety and standards, community health and safety issues, and potential violence and security risks in the proposed sites. The Operations Manual will include procedures for the Grievance Redress Mechanism (GRM).

F. Environment (including Safeguards)

69. **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 4.11 Physical Cultural Resources, and OP 4.37 Safety of Dams. The Project is rated category B. Because the exact nature and location of investments are unknown, the Project will use the Environmental and Social Management Framework (ESMF), which was prepared by the GOH, consulted with stakeholders in Haiti, and disclosed in French on GOH's website on June 2, 2017, and on the World Bank's website on June 5, 2017.

70. Potential impacts include health and safety, production of waste (especially batteries), and impacts to the land, water and biodiversity (from RE generation). Mitigation measures include appropriate siting of RE generation units, and appropriate disposal/recycling of batteries. The Project is not expected to have a negative impact on natural habitats, but the ESMF includes screening criteria for any potential impacts. The ESMF also outlines chance-findings procedures for physical cultural resources. The Project may support small hydro, which may trigger OP 4.37. The ESMF outlines the necessary steps to be taken if a sub-project triggers this policy, including a review by a qualified engineer if the dam is less than 15m high. Sub-projects with dams higher than 15m will not be eligible under the Project. The Project will not finance pesticides (herbicide, insecticide), nor activities involving the use or potential pollution of the Artibonite River or the Massacre or Artibonite aquifers, as determined by the World Bank in accordance with the World Bank's Safeguards Policies (OP/BP 7.50).

71. **The implementation of environmental and social safeguards** will be overseen and coordinated by the Energy Cell, with the support from the PIU. Within the Energy Cell, a socio-environmental specialist will be hired and trained before the project becomes effective. Entities implementing sub-projects will be trained on environmental and social impacts.

G. World Bank Grievance Redress

72. 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 Project

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 (where relevant – both Project and Program level is indicated)[20]

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	0	Program: 50,000 Project: 27,000	Program: 165,000 Project: 67,000	Program: 500,000 Project: 240,000	Program: 700,000 Project: 310,000	Program: 1,000,000 Project: 410,000	**Program: 1,000,000 Project: 410,000**	Bi-annual	Progress reports	Energy Cell, with OGEF inputs
Women provided with new or improved electricity service		Number			Program: 25,000 Project 13,500	Program: 82,500 Project: 33,500	Program: 250,000 Project: 120,000	Program: 350,000 Project: 155,000	Program: 500,000 Project: 205,000	**Program: 500,000 Project: 205,000**	Bi-annual	Progress reports	Energy Cell
Enterprises and community services with new or		Number		0	Program: 500 Project:	Program: 1,200 Project:	Program: 3,000 Project:	Program: 6,000 Project:	Program: 10,000 Project:	**Program: 10,000 Project:**	Bi-annual	Progress reports	Energy Cell, with OGEF inputs

20 Per Haiti SREP Investment Plan, off-grid activities under Component 2 are eligible for financing through three sources: SREP, the IDA-financed PRELEN project and CTF. These form a synergetic package (the "Investment Plan"), where each source of funding is used to maximize impact and leverage. It is therefore impossible to fully separate the impact of each co-financing source. However, to avoid double-counting in reporting, SREP results and CTF results will be reported separately 65% will be attributed to CTF and 35% to SREP, in line with their relative non-TA financial contribution to SREP program (US$14.22 million for CTF and US$7.62 million for SREP). The IDA-financed PRELEN project mainly contributes with technical assistance and small-scale piloting of innovative ideas and is therefore not a major source of investments. Annex 1 includes expected results for both the Program-level and the Project-level.

improved electricity service					320	590	1,800	3,000	4,500	**4,500**			
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		US$ million	0	0	2	10	30	52	64	**64**	Annual	Project Progress reports capturing data from investments	Energy Cell with OGEF inputs

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**	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	8	8	8	**8**	Annual	Progress report	Energy Cell with EDH inputs
Annual greenhouse gas emission reductions	SREP core	tCO_2	0	0	1,545	1,545	10,300	10,300	10,300	**10,300**	Annual	Progress report	Energy Cell
Number of people benefitting from improved access to electricity and fuels, as a result of SREP interventions	SREP core	Number	0	0	15,000	15,000	100,000	100,000	100,000	**100,000**	Annual	Progress report	Energy Cell with EDH inputs
Number of women benefitting from	SREP core	Number	0	0	7,500	7,500	50,000	50,000	50,000	**50,000**	Annual	Progress	Energy Cell

improved access to electricity and fuels, as a result of SREP interventions												report	
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	200	200	1,000	1,000	1,000	**1,000**	Annual	Progress report	Energy Cell with EDH inputs
Increased public and private investments in targeted subsectors as a result of SREP interventions	SREP core	US$ million		0	0	6	9	15	15	**15**	Annual	Progress report	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			
Generation capacity of energy constructed or rehabilitated	☒	MWp	0	0	Program: 1 Project: 0.3	Program: 4 Project: 1.4	Program: 10 Project: 3.6	Program: 15 Project: 5.4	Program: 23 Project: 8	**Program 23 Project: 8**	Bi-annual	Progress reports	Energy Cell with OGEF inputs

Annual electricity output from RE, as a result of SREP interventions	SREP core	GWh	0	0	Program: 1 Project: 0.5	Program: 6 Project: 2	Program: 15 Project: 5	Program: 23 Project: 8	Program: 34 Project: 12	**Program 34 Project: 12**	Annual	Progress report	Energy Cell
Annual greenhouse gas emission reductions	SREP core	tCO_2	0	0	Program: 3,548 Project: 1,242	Program: 15,205 Project: 5,322	Program: 40,546 Project: 14,191	Program: 60,819 Project: 21,287	Program: 91,228 Project: 31,930	**Program 91,228 Project: 31,930**	Annual	Progress report	Energy cell
Number of people, benefitting from improved access to electricity and fuels, as a result of SREP interventions	SREP core	Number	0	0	Program: 35,000 Project: 12,000	Program: 150,000 Project: 52,000	Program: 400,000 Project: 140,000	Program: 600,000 Project: 210,000	Program: 900,000 Project: 310,000	**Program 900,000 Project: 310,000**	Bi-annual	Progress reports	Energy Cell with OGEF inputs
Number of women with improved access to electricity and fuels, as a result of SREP interventions	SREP core	Number	0	0	Program: 17,500 Project: 6,000	Program: 75,000 Project: 26,000	Program: 200,000 Project: 70,000	Program: 300,000; Project: 105,000	Program: 450,000 Project: 155,000	**Program 450,000 Project: 155,000**	Bi-annual	Progress reports	Energy Cell with OGEF inputs
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	Program 300 Project: 120	Program: 1,000 Project: 390	Program: 2,000 Project: 800	Program: 5000 Project: 2,000	Program: 9,000 Project: 3,500	**Program 9,000 Project: 3,500**	Bi-annual	Progress reports	Energy Cell with OGEF inputs
Increased public and private investments in targeted subsectors as a result of SREP	SREP core	US$ million	0	0	10	20	40	70	94	**94**	Annual	Progress report	Energy Cell with OGEF inputs

interventions													
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 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			
Actions are taken in a timely manner in response to beneficiary feedback from phone surveys and household visits;		Yes/no	no	--	--	yes	yes	yes	yes	**yes**	Bi-annual	Progress reports	Energy Cell with EDH and OGEF inputs

and Feedback, Responses, and Action are monitored and reported on every 6 months.													
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 report	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 the number of household connections multiplied by the average household size.
Women provided with new or improved electricity service	The indicator measures the number of women that have received new or improved electricity service through the Project. This is measured by the number of household connections multiplied by the average household size and average ratio of women in a household.
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.
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 energy 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 every two years by the SEforAll Knowledge Hub of the World Bank (rise.esmap.org).
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.

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 beneficiaries)	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; and 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. Female beneficiaries of improved access are also tracked.
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.
Enabling framework for mini-grids, including Service Agreements in place	This indicator assesses whether an enabling framework to scale-up mini-grids, including the tri-partite Service Agreements to be developed under Component 2, is in place.

Number of people trained in renewable energy, of which number of female training participants	This indicator summarizes the number of people that have benefitted from renewable energy training (Government officials, university students, entrepreneurs, local technicians and other beneficiaries). The indicator also tracks the number of female beneficiaries of project's training.
Number of female jobs and female-headed (micro-) enterprises created	This indicator estimates the number of female jobs and female-headed (micro-) enterprises in the off-grid electricity sector that were created thanks to the Project support. This will be reported by the enterprises benefiting from OGEF support and will include female staff as well as female entrepreneurs involved in the off-grid energy service provision and supply chains.
Citizen engagement and beneficiary feedback	
Actions are taken in a timely manner in response to beneficiary feedback from phone surveys and household visits; and Feedback, Responses, and Action are monitored and reported on every 6 months	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. The issues found in the phone/household surveys are communicated to service providers and the Advisory Committee and FDI/the Fund Manager, which prepare and execute 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 mini-grids and off-grid systems are working according to the advertised performance.

HAITI: Renewable Energy for All Project

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 households, businesses and community services.

2. The 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).

3. The project will contribute to the broader Haiti SREP Program, which has been formulated in the Haiti SREP Investment Plan and is financed through several financing sources, mainly the present SREP-funded Renewable Energy for All Project, the parallel CTF-funded Modern Energy Services for All Project, and the ongoing IDA-funded Rebuilding Infrastructure and Access Project (PRELEN). See Annex 2 Box A2.1 for details on PRELEN and CTF Projects.

4. The Haiti SREP Program will result in 1,000,000 people (including at least 500,000 women) and 10,000 enterprises/community services with new or improved electricity access. Of these, 410,000 people (including at least 205,000 women) and 4,500 enterprises/community services are attributable to the present Renewable Energy for All Project.[21]

5. 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). The project aims to reach a target of 50 percent of female beneficiaries, although sex-disaggregated electricity access rates are not yet available to quantify the gender gap. This target may be adjusted following MTF survey results, expected by end of FY18.

6. The project will also have important climate change co-benefits by displacing fossil fuel generation with renewable energy, resulting in an estimated reduction of about 100,000 tCO_2 per year at the Program level, of which over 40,000 is attributable to SREP (see Annex 6).

[21] Per Haiti SREP Investment Plan, the off-grid component (Component 2) is co-financed by SREP, IDA PRELEN and CTF, forming a synergetic package, where different funding sources leverage each other, as well as additional private sector financing, in order to maximize impact. To avoid double-counting in reporting, SREP results and CTF results will be reported separately 65% will be attributed to CTF and 35% to SREP, in line with their relative non-TA contribution to funding off-grid energy investments (US$14.22 million for CTF and US$7.62 million for SREP). IDA PRELEN project mainly contributes with technical assistance and small-scale piloting of innovative ideas and is therefore not a major source of investments. Annex 1 includes expected results for both the Program-level and the Project-level.

B. Scope and financing sources

7. The SREP Program is split in two main components, each a SREP stand-alone 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).

8. As anticipated in the SREP Investment Plan, the Project is leveraging multiple financing, including: (i) the ongoing IDA-financed Rebuilding Energy Infrastructure and Access Project (PRELEN), which is strengthening its focus on clean energy and energy access; and (ii) the parallel CTF-funded Modern Energy Services for All Project, which is establishing the Off-Grid Electricity Fund (OGEF). In addition, the project leverages (iii) private capital, and additional financiers for technical assistance/training (ESMAP, Korean Green Growth Trust Fund, Schneider Foundation, French Ministry of Education). The Project also 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).

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

	IDA PRELEN	Other IDA[22]	SREP	CTF (OGEF)	Others	Private sector	Total
Component 1: Grid-connected distributed RE	4		11		0.5	0-8	15.5-23.5
- **PV and battery (investment+ potentially a guarantee)**			*10.5*			*0-8*	
- **On-grid investments supporting vRE integration**	*3*						
- **Technical Assistance**	*1*		*0.5*		*0.5*[23]		
Component 2: Off-grid distributed RE	17	3	8.62	15.65	2.5	64	112.77

[22] The list of World Bank-financed projects for which SREP will provide TA/financing for agri-businesses and community uses include: Relaunching Agriculture - Strengthening Agriculture Public Services II Project (GAFSP - IDA) (P126744); Haiti Business Development and Investment Project (P123974); Haiti - Education for All Project - Phase II (P124134); HT Sustainable Rural and Small Towns Water and Sanitation Project (P148970); Improving Maternal and Child Health Care (PASMISSI) (P123706)

[23] ESMAP TA support for vRE integration and Korea Green Growth Trust Fund

- **Mini-grids**	*2.4*		*3.62*	*3*		*9*	
- **Productive and community uses**	*10*	3	*1*	*2.0*	*1.5*[24]	*15*	
- **Households Systems**			*3*	*7*		*40*	
- **Technical Assistance and Capacity Building**	*4.6*		*1*	*1.43*	*1*[25]		
- **OGEF management and operation**				*2.22*			
Total SREP Program	**21**	**3**	**19.62**	**15.65**	**3**	**64-72**	**128.27-136.27**

9. Private sector leveraging under 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 under Component 2 will take the form of private equity and commercial loans, and will directly contribute to the Program-level result, as well as to further scaling up beyond the Program lifetime.

C. Approach

10. The 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 (the Port-au-Prince "interconnected grid" plus nine "isolated grids operated by EDH; over 30 municipal diesel grids; and 500MW estimated in diesel self-generation), investments in distributed renewables have been prioritized.[26] 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 (retrofit and green-field), and (iii) individual off-grid systems for productive and household uses (see Table A2.2).

11. 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

[24] Electricity Without Borders (NGO), and a solar PV in-kind contribution from EDF Energies Nouvelles for school solar PV electrification with ICT solutions (smart boards) – see Table A2.3.
[25] France (Ministry of Education) and Schneider Foundation RE training program and ESMAP TA support for mini-grids and Lighting Global.
[26] The SREP Investment Plan originally also contemplated a larger scale grid-connected RE investment serving the largest of the EDH grids (Port-au-Prince metropolitan area). This project, however, had to be abandoned due to the current transmission bottlenecks that for now do not allow an integration of a large scale RE investment into the grid. In addition, the demonstration impact would be diluted due to significant technical and commercial losses in the system, which would prevent users from experiencing any visible service improvements.

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 to attracting larger volumes of private sector investments. This is the rationale for Component 1.

- The Project has also identified those distributed RE segments, which can attract commercial sources of funding in the nearer term. This in particular includes municipal grid and off-grid energy enterprises, which already operate in Haiti and 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.

- In parallel, the SREP project will build an enabling policy and regulatory environment and capacities supporting further investments in clean energy and energy access in the long term. 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.

Table A2.2. Distributed RE access expansion options

Distributed RE access expansion option	Theoretical max. potential of segment (population)	Recommended SREP target (population)[27]
RE retrofit, upgrade, and expansion of EDH grids	1,500,000	100,000
Municipal grids (retrofit and green-field)	300,000	100,000
Stand-alone distributed off-grid systems (households, social users, SMEs)	>5,000,000	700,000

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

12. 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 Renewable Energy ***(SREP US$11 million)***

13. 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 developing supporting policy and regulatory environment for private sector-driven RE investments. The Component will finance investments and technical assistance.

14. The Component aims at building 5-12MW of RE capacity (solar PV + battery), which would hybridize 2-3 EDH isolated grids, currently running on diesel power, resulting in 8-20

[27] Haiti SREP Program level target.

GWh of additional annual renewable energy generation, and improved access for at least 100,000 people 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

15. EDH operates one main "interconnected" grid serving the capital, Port-au-Prince, and surrounded areas, as well as nine smaller isolated grids, with a total of 273,000 "active" (i.e. legal) customers, and likely twice as many informal connections. Of these, about 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 (between 1 and 10 MW peak demand, serving typically 1,000 and 20,000 "active" customers.[28] Peak demand typically outstrips the available supply. A few, however, are serving areas with a population well above 100,000 (see Table A2.3).

Table A2.3. EDH's grids[29]

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

16. 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

[28] A few, however, are serving areas with a population well above 100,000.
[29] The list summarized EDH data before Hurricane Mathew hit. It does not include a grid on La Gonâve Island which has about 0.5MW installed capacity and 1,000 customers.

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 refurbished grids.

17. The average tariff is relatively high, particularly for industrial and commercial consumers (US$0.30/kWh), but EDH's commercial performance is weak due to high losses and low rates of billing and collections. In addition, many industrial and commercial clients have left EDH as they prefer to self-generate in light of 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

18. 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. It is expected that the demonstration of visible service improvements for end users and cost reductions for EDH would trigger demand for replication throughout the remaining EDH grids.

19. **Technology:** The Component will support solar PV technology with battery storage. Solar PV was selected over other potentially viable RE technologies (hydro, wind, biomass) for this Component 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 current technology and price trends will likely result in "PV with storage" option becoming increasingly attractive over "PV only" in Haiti.[30] The least-cost proven battery technology, probably lithium ion, will be used for storage.

20. **Business model**: The Component design is aimed at enabling private sector investments in solar PV generation in Haiti. Originally, the team explored the use of guarantees 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 project 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 grids 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.

[30] See for example: IRENA: Rethinking Energy, 2017.

21. 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-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 Pilot Solar PV Investments

22. The Sub-component will support the construction of pilot solar PV battery storage plants to feed at least one EDH isolated grid (although most likely the Sub-component will support 2-3 grids).

23. The Sub-component aims at building 5-12MW of RE capacity (solar PV + battery). The final generation capacity and renewable energy generation depend on the final site selection, the completion of feasibility studies determining the final absorption capacity of the selected grid, the size of battery storage and the degree of private sector participation.

24. The Sub-component will follow a phased approach. Phase I will be publicly financed, focused on demonstrating the feasibility of connecting a mid-size solar PV plant with storage to one of the relatively small and weak grids in Haiti. Subsequently, Phase II will explore options to promote the development of solar PV battery storage plants by private investors. In such a case, the Project may be restructured, to allow a part of Component 1 funding to be used as a guarantee.[31] Leveraging private sector would be a priority for Phase II, 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.

25. 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), while IDA funds under the PRELEN project will be used to finance additional grid-related improvements needed to facilitate interconnection and to 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 an IPP approach is taken).

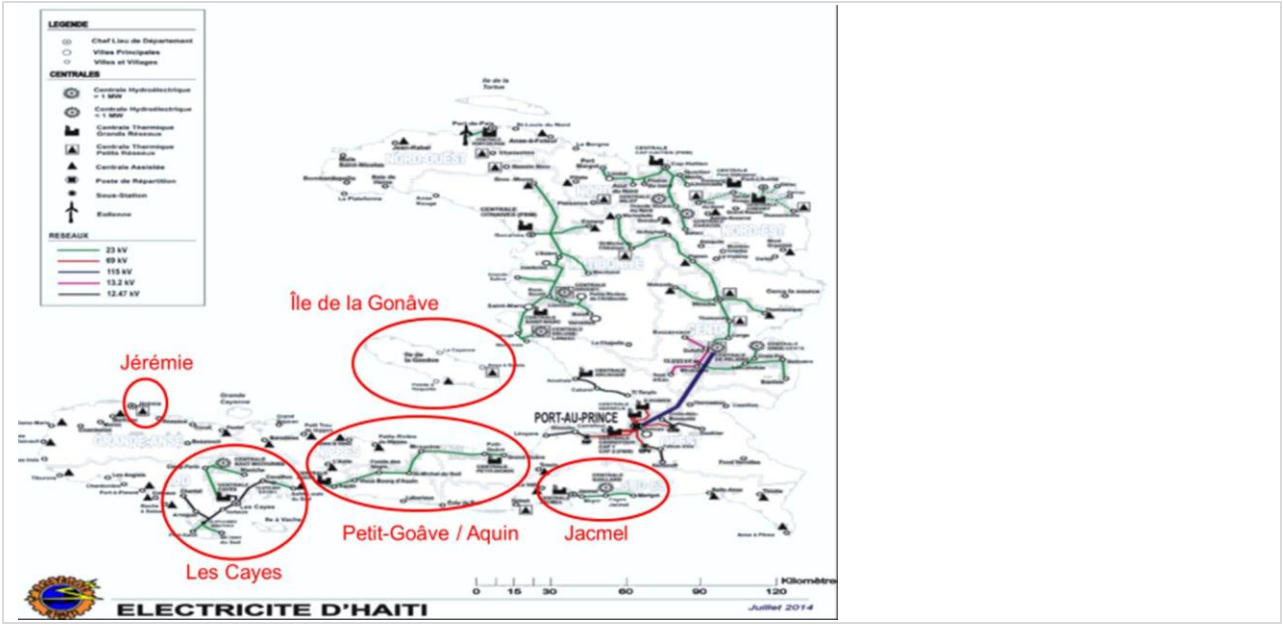
26. **Site selection**: Five small and medium-sized EDH grids (1-12MW) were prioritized out of a total of nine as suitable off-takers for the solar PV plants. These were Jeremie, Les Cayes, Petit Goâve, Jacmel and La Gonâve Island (see Figure A2.1 below and Table A2.3 above). A broad set of pre-feasibility modeling tools (Homer Pro, PVsyst, Mathematica-based mixed integer linear optimization, as well as Excel-based Sensitivity and Monte Carlo Analysis) were run to determine the viable options of system designs and sizes for these five sites, based on

[31] 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, the Project 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.

estimated pre-feasibility Capex and Opex for a broad range of capacities for the solar PV generator and battery storage. For discussion, and in light of data and modeling uncertainty inherent to pre-feasibility stage, the resulting array of economically viable system designs was then simplified into three main hybrid municipal grid categories, by "PV Share" of total energy generation: low, medium and high solar PV penetration (see Table A2.5 and Annex 6 for more details).

27. **Selection criteria for the EDH grids for solar PV investment** 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 is also given to areas devastated by Hurricane Matthew. Final sites will be selected by the 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. The resulted prioritized sites (short list) are depicted in Figure A2.1.[32]

Figure A2.1. Prioritized EDH grids



28. **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

[32] The list presented below is a result of an early stage prioritization and is not binding. To facilitate integration and promote maximum use of solar PV power, only EDH grids with EDH-owned diesel generators will be considered. This may exclude Les Cayes and Petit Gonâve 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 added as long as meeting the criteria identified above.

(see Table A2.5).[33] Example B is taken as the probable scenario for the Sub-component – assuming one publicly-financed project in Phase I and subsequent private sector investments in Phase II.

Table A2.5. Solar PV + battery capacity scenarios

	Site 1	Site 2	Site 3	
	Les Cayes Peak demand 11 MW (incl existing hydro)	**Petit Goave** Peak demand 10 MW	**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$**

**Caveat: As illustrated by the 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 higher 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 case.*

*** 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 generator number and type(s) in situ,*

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

and "dispatch strategy" cum PV.

29. **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.). These investments will be determined based on detailed feasibility studies and will be eligible for financing under the existing IDA PRELEN Project.

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

31. **Sustainability arrangements:** EDH will be required to isolate administratively the selected 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 impacts 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 can be paid from the value of saved fuel). See Annex 6 for more details. Establishing and maintaining the escrow account will be a disbursement condition and a legal covenant.

32. The Government is currently exploring ways to improve the performance of EDH, including its isolated grids. Options are to outsource collection and billing or to concession the grid operation to private sector. The project will contribute to this process by improving administrative and financial transparency as part of the demonstration project grid. The grid will be isolated administratively from the rest of EDH and its performance closely monitored. Moving to the second phase, which foresees greater private sector participation, additional measures will be required and facilitated by the project, including outsourcing billing and collections or concessioning the grid to the private sector.

Sub-component 1.b: Technical Assistance and Enabling Framework for RE Scale-up

33. This Sub-component will finance technical assistance to the Energy Cell,[34] EDH, MEF

[34] 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.

(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.

34. For the pilot demonstration project, the Sub-component will finance technical and transaction advisors for the Energy Cell for: (i) the more detailed assessment of potential site, design, procurement, contracting, supervision of works and commissioning of the demonstration project, and (ii) support for supervision of the O&M contractor, including 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.

35. The Sub-component will also 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[35], development of a realistic RE grid integration plan and targets, grid code, design of auctions and other competitive procurement processes and standard PPAs.

36. In addition to the TA provided under this Sub-component, 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 renewable energy capacity-building program under Sub-component 2.d.

Component 2: Off-grid Distributed Renewable Energy *(SREP US$8.62 million)*

37. Component 2 will extend access to clean and modern energy services to households, communities and enterprises that are not served by EDH by deploying a wide range of electrification options. The Component will finance grants and technical assistance.

38. The Component will provide (mostly) first-time access to at least 310,000 people (900,000 people at the program level), of whom at least 50 percent would be women, and 3,500 enterprises and community service institutions (9,000 at the Program level), such as schools, health centers and community water pumping services. The Component will deploy a wide range of off-grid electrification options: municipal 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, applying successful business models from more advanced off-grid energy markets, such as East Africa and South Asia. Significant private sector leveraging (US$64 million) is anticipated. The Component is expected to lay a foundation for sustained market growth that is anticipated to provide energy access to at least 2 million Haitians by the year 2025.

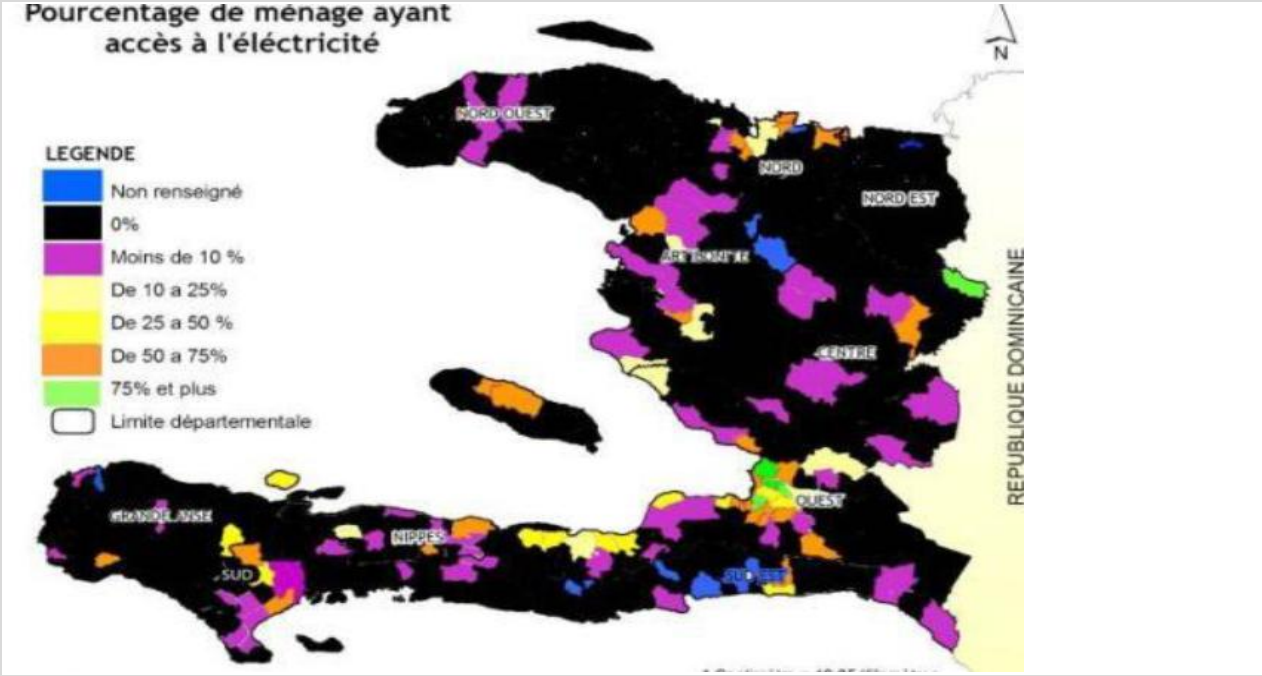
39. The Component will finance grants and technical assistance.

[35] The new budget approved by the Parliament envisages a tax exemption for renewable energy products and related applications, excluding batteries (currently taxed at 20 percent), from October 2017 onwards.

Background

40. 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. The electrification rate is only 17 percent in rural areas versus 53 percent in urban areas.[36] 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.

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



Key design features

41. 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) municipal grids[37] 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 beneficiaries (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] Per latest household survey data as of 2014 (World Bank/SEforALL: Global Tracking Framework, 2017).
[37] Municipal grids are understood as pico-, 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.

42. 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 technology. The recently released Government's Roadmap for Energy Sector also highlights the importance of expanding energy access through smart mini-grids and solar PV systems. The project aims at leveraging private sector participation through promoting public-private partnerships. The private sector is understood broadly to include enterprises, cooperatives and NGOs.

43. The Project's Component 2 is being complemented with additional parallel funding from: (i) the ongoing IDA PRELEN Project, which is now increasing its support to renewable energy and energy access (in line with its PDO), and (ii) the parallel CTF-funded Modern Energy Services for All Project, which is establishing the Off-Grid Electricity Fund (OGEF) to finance commercially viable off-grid electrification businesses through equity investments and loans. Both these projects will contribute to the broader SREP Program. See Box A2.1 for a description of these other two SREP Program sources.

Box A2.1. Project Co-financing Sources

Rebuilding Energy Infrastructure and Access Project (PRELEN)

Effective since February 2013, the 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 has 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. PRELEN is envisaged to rehabilitate the Drouet mini-hydropower plant, adding 3MW of baseload power to the Saint-Marc power system (equivalent to US$5.1 million per year of thermal energy).

Off-grid activities were also implemented under the PRELEN, including the 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, and support to the Government's Numerical Education program (500 rural schools have been electrified with solar PV and lithium-ion batteries). PRELEN has allocated available funding to implement more off grid activities, in coordination with SREP and CTF funded operations and in synergy with productive and social sectors.

PRELEN is critical for the institutional strengthening of Haiti's energy sector, as it finances the MTPTC Energy Cell staff and logistical costs, as well as the activities implemented under this entity on regulatory reform and capacity building.

The Off-Grid Electricity Fund (OGEF)

OGEF is designed to provide flexible financing in the form of equity, loans, and limited grant financing 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 through three business lines:

- Equity and grant financing for DESCOs. This business line will be used for financing equity, startup, and results-based grants for DESCOs to support setting up and early stage growth of off-grid businesses.
- 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.

OGEF is managed by an OGEF Fund Manager, composed of a partnership between the *Fonds de Développement Industriel* (FDI) – a Haitian financial intermediary operating under the auspices of the Haitian Central Bank - and a competitively selected International Fund Manager.

44. Table A2.6 summarizes how SREP grants and CTF commercial financing are expected to leverage and complement each other. The initial project pipeline will be based on businesses already operating in Haiti, but the OGEF Fund Manager will be also tasked to deepen the market and help launch new off-grid businesses in Haiti. While it is expected that the majority of investments will be solar, other RE sources, including micro-hydro, biomass and wind will also be eligible.

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

	SREP grants	CTF equity and loans
1. Municipal 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 Municipal Grids

45. The Sub-component will provide grants to the private micro- and mini-grid operators in Haiti (the Municipal Grid Service Providers - MGSPs). Grants will partially cover municipal grid investment costs under Service Agreements with selected municipalities to build and operate RE grids on their territories, through: (i) hybridization of the existing municipal diesel grids, and (ii) green-field RE investments.

46. The municipal grids will be developed under a public-private partnership arrangement involving the MTPTC Energy Cell, municipalities and the Municipal Grid Service Providers. The grants will be used to bring down the municipal grid investment costs so that the resulting tariff is in line with the affordability levels of rural Haitians.

47. The grants will be used as a public sector contribution to the investment costs, to cover approximately the distribution network costs, while private sector will be expected to invest in the generation equipment. The typical municipal grids are expected to be between 50kWp and 500kWp (serving between 500 and 5,000 households),[38] but the project may finance smaller or

[38] Typical lower range for green-field municipal grids, and upper end for the existing municipal grids.

larger municipal grids if economically viable.

48. **Business model**: The Sub-component will build on an already existing model applied in Haiti, in which Municipal Grid Service Providers sign concession/service agreements with the municipalities to build and operate municipal grids on their territories for a pre-determined period of time (the length currently varies case by case but typically exceeds 10 years). This modality is consistent with the Decentralization Law of 2006,[39] and therefore allows municipal 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) Municipal Grid Service Providers.

49. Currently, three mini-grid companies are operating under this framework. EarthSpark and Sigora are private mini-grids, operating with a concession from a municipality, both with nation-wide scale-up ambitions. Separately, NRECA International has successfully piloted a cooperative model. See Box A2.2 for the description of these three municipal 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.

50. **Contractual arrangements**: The Sub-component will further develop and regularize the existing municipal concession model by creating a standard tri-partite agreement among the MTPTC Energy Cell, Municipality and Municipal Grid Service Providers, which will define the length and terms of the concession,[40] 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 as compensation mechanism in case the municipal grid is absorbed by the EDH grid before the end of the concession period, and what technical assistance will be provided to municipal grids by the Energy Cell – e.g. support for energy efficiency measures, training of technicians, etc. The tri-partite agreement 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 complaints/grievance mechanisms.

51. 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 as 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 a use tariff, which will be collected through pre-paid smart meters.

52. In absence of the regulatory entity, the municipal grids will be regulated by the Energy Cell, with the local support from the municipality, following the provision of the tri-partite

[39] The law allows municipalities to build and operate municipal diesel grids.
[40] 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 municipal grid for a defined number of years under defined service quality and tariff terms.

service agreement. [41] The experience with the tri-partite agreement will be used to build more permanent regulatory structures under Sub-component 2.d.

Box A2.2 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 its 2nd grid (in Tiburon) complete but also two more 'starter grids' launched in 2017. Just recently, EarthSpark received funding from USAID to build out the 'investable plan' for their next 40 grids in Haiti. Although the Les Anglais mini-grid was severely damaged by Hurricane Matthew, EarthSpark's broader expansion plans have not changed.

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 micro grids, which are designed to scale quickly and cost-competitively. As a starting point, 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 European Union's 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 services in many 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'Arrondissement 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.

53. **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 municipal grids 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 the EDH grid after the end of the concession period. Technical and service quality standards will be included in the tri-partite service agreements.

[41] Such tri-partite service agreements are currently also being pursued 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.

54. Two types of municipal 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.

55. **PPP model to hybridize the existing municipal diesel grids**. There are over 30 diesel-powered municipal grids operated by municipalities under the Decentralization Law of 2006[42] (or informally). These municipal grids vary in terms of size and performance, but typically serve loads between 100kW and 500kW. They are supplied by diesel generators, which, however, in most cases are not correctly sized, and as a result are costly to operate.

56. A recent study[43] of municipal diesel mini-grids found that all of them (36) operated for far fewer hours than their nominal operating schedules (which are already low. i.e. typically 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 costs, preventing municipal grids 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.

57. Most of these grids, however, have relatively complete distribution networks, and could therefore become operational if efficient and sustainable generation supply were available and power were adequately commercialized. The costs of operation could be significantly reduced by solar PV hybridization and the introduction of energy efficiency measures, such as the 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.[44]

58. 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 2.d. 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 service agreement. The Energy Cell will competitively award these contracts to the private sector. To the extent possible, the sites will be bundled into geographic lots to support economies of scale, based on pre-feasibility studies, which will be financed under

[42] The 2006 Decentralization Law gives rights to municipalities to provide energy services on their territories, which has 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.

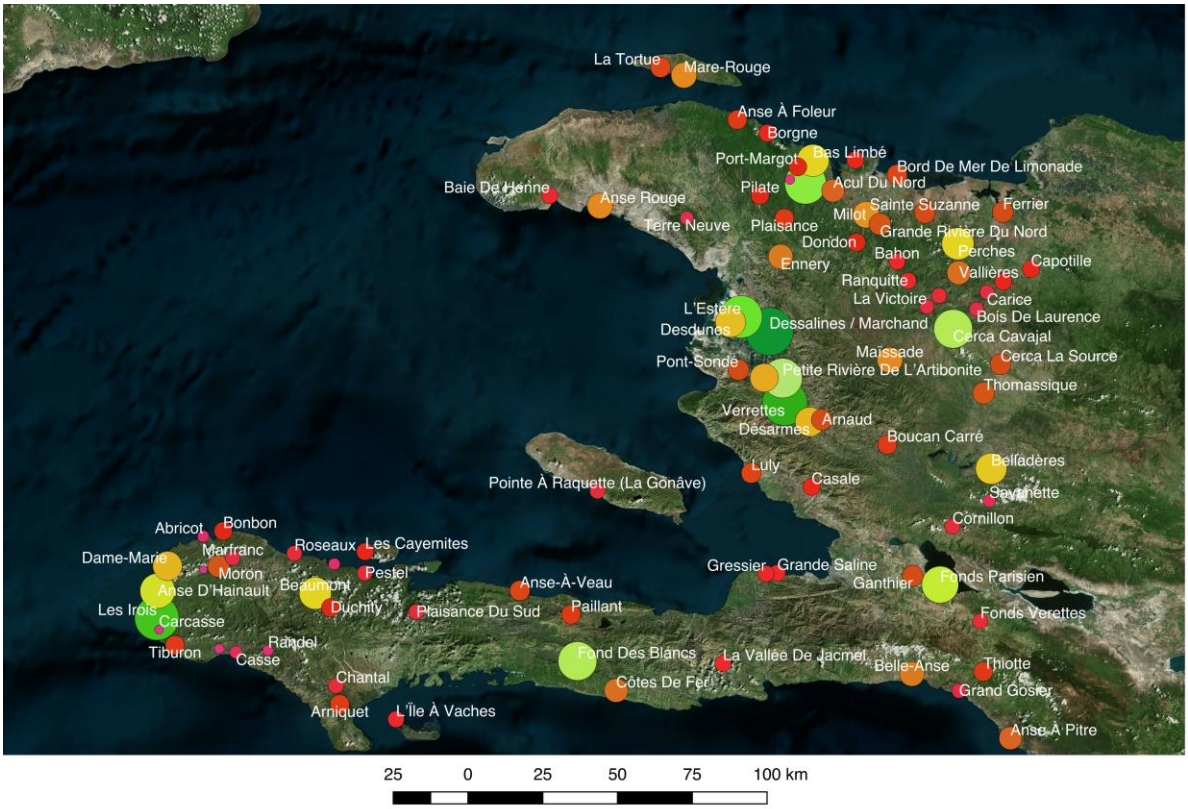
[43] Schnitzer D., Microgrids and High-Quality Central Grid Alternatives: Challenges and Imperatives: Elucidated by Case Studies and Simulation.

[44] 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.

Sub-component 2d.

59. **PPP model for green-field RE municipal grids.** Most rural towns in Haiti currently have neither EDH grids nor municipal grids. The development of these towns is constrained by the lack of access to reliable and affordable electricity. Significant potential therefore exists for scaling up municipal grids for rural towns and larger villages. A recent USTDA-financed study[45] reconfirms this potential. The study analyzed 80 rural towns for potential mini-grid 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 communities with the confirmed green-field RE mini-grid potential will be determined as a result of the geospatial least-cost electrification planning, which will be carried out under Sub-component 2.d.

Figure A2.3. The map of potential mini-grids in Haiti



60. Given that the private sector is best-suited to evaluate the financial viability of individual sites, the site selection will be left up to private operators of municipal grids. The Sub-component will competitively award per-connection grants, which will be partially results-based, disbursed against milestones,[46] including actual customer connections, which will be available to

[45] Carried out by EarthSpark and Energy and Security Group in 2015.

[46] A portion of the grant will be provided upfront to provide municipal 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.

Municipal Grid Service Providers. MGSP need to: (i) comply with pre-determined eligibility criteria, including demonstrated experience to operate municipal grids, (ii) present a sound business plan, including a credible financing plan for the non-grant investments, and (iii) be in agreement with the municipal governments - both parties willing to sign the tri-partite agreements with the Energy Cell. This per-connection grant will be awarded to the eligible Municipal Grid Service Providers through periodic calls for proposals. The municipal grid operators will be allowed to set differentiated, cost-reflective tariffs (including a return on capital but excluding the investment costs covered by the grant). The 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

61. The Sub-component will provide grants to a) the Distributed Energy Service Companies (DESCOs) to develop and test viable and scalable business models to serve, inter alia, agribusinesses, rural enterprises, and public service institutions in rural areas (the Productive Use Beneficiaries); or b) directly to these Productive Use Beneficiaries, with the final goal of supporting rural economic development. The Sub-component will finance (i) pilots of viable, scalable and innovative business models, and (ii) electrification of community and public service facilities.

62. Given that this market segment is less developed than the household segment, the Project will establish a challenge grant facility, to competitively award grants to applicants with promising, scalable business models for productive uses. The facility will be open to both the off-grid energy businesses or directly the final users (productive use beneficiaries), as long as in either case they can demonstrate sustainable and scalable business models, with eligibility and selection criteria included in the Operations Manual. The facility will be closely coordinated with related sectors, such as agriculture, water, competitiveness, and finance, to ensure that the improved energy access indeed supports the final outcomes, such as improved productivity, competitiveness, reduced costs etc. of the final business beneficiaries, including agri-businesses. 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), and that proposed solutions are financially, environmentally and socially sustainable.

63. The main focus of the challenge grant facility 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 2.d. 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). The Project 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.

64. 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

65. Agriculture is the source of livelihoods for more than 60 percent of Haitians.[47] It however only counts for 16 percent of the GDP in 2015.[48] Agriculture in Haiti today mostly involves smallholder farms, with a subsistence orientation.

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

Examples of electricity needs in agriculture and 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)

67. By increasing productivity and income, electricity allows for a more market-oriented approach to agriculture and makes possible the reduction of food spoilage. Key agricultural activities could therefore benefit from electrification in Haiti, such as:

68. *Solar-water pumping for irrigation:* In 2013, 4 percent of Haiti's total agricultural land was irrigated.[49] However, by allowing farmers to grow more crops a year, access to water improves livelihoods and increases social welfare. 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 worldwide is enabling customized solutions that match local needs and adjust to local constraints (e.g. site's topography, aquifer resources).

69. Different successful approaches have been implemented in developing countries (e.g. Bangladesh with the Bangladesh RERED II program, Morocco and Kenya). Private-sector players such as SunCulture offer innovative solutions that provide full solar-powered irrigation kits to farmers (including access to markets, information and training, inputs such as fertilizers, etc.), that have been shown to increase farm yields by as much as 300 percent. Pilot initiatives

[47] USAID: https://haitileveproject.org/activity-sectors/
[48] UNSTAT - Agriculture, hunting, forestry, fishing (ISIC A-B)
[49] World Development Indicators

could be launched in Haiti targeting smallholder farmers who produce vegetables.

70. *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 threshing, and to improve the quality of end products. Haiti imports 60 percent of the food that it consumes, while a significant amount of local production is spoiled due to inadequate processing.[50] The development of processing activities particularly makes sense in regions that are poorly connected to markets (e.g. Southern Haiti). Some initiatives have already been implemented and could be expanded to other areas. For example, the EarthSpark mini-grid in Les Anglais powers processing units that turn breadfruit into chips and flour, thereby extending shelf life from 3 days to at least 6 months. The development of solar-drying facilities to process fruits (e.g. mangoes, guavas, passion fruit, and pineapples), cassava,[51] maize 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. As the main food item imported by Haiti, rice is the most important staple of Haitians' diet. Producers who are currently in the rice business are supporting national food security. However, production is 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 for processing rice. An affordable and reliable power supply could be scaled up in quantity and quality and help rice farmers to become more competitive.

71. *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 4th largest valued export for Haiti[52] and these crops' quality and export volumes could be significantly improved if a drying process were available that eliminated delays and protected the produce against rains, re-wetting and other environmental contaminants, which is something that access to electricity could provide. Affordable materials[53] are now available on the market and equipment evolves very quickly to match local needs (e.g. mobile dryers, disassembled systems to be stored during off season). Successful use of solar-powered drying mill facilities has occurred in Central American countries (e.g. Guatemala, Honduras), where buyers pay a 15 percent premium to producers for coffee beans processed using solar dryers.

72. *Solar-powered storage / cooling for mangoes and avocados:* Smallholder farmers need proper cold storage to preserve the quality or extend the shelf-life of their products to target export markets, thereby increasing their revenues.[54] 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.[55] 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

[50] EarthSpark International, 2013
[51] 3rd crop produced in quantity in 2014, after sugar cane and mangoes (FAOSTAT).
[52] FAOSTAT, 2013.
[53] US$400 for materials.
[54] 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.
[55] FAO, 2011.

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 would be an adequate affordable supply solution, which could also avoid GHG emissions. Collection points providing solar-powered cold rooms to groups of farmers could facilitate cost reductions and logistical optimization via cooperative approaches. Innovative business models have been successfully tested in Sub-Saharan Africa (e.g. Uganda, Nigeria) and could feasibly 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).

73. Ice production for fishermen: In Haiti, traditional fish processing methods, such as sun drying and smoking, are widely used, but they result in considerable post-harvest losses. Forty 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.[56] As with many other foods, fish is imported to meet national demand. Therefore, the lack of adequate means of storage represents a major handicap in terms of economic development and food security. Given Haiti's long coastline (1,750km) and marine resources, there is demand to scale up ice and refrigeration capabilities. It would enable fisheries activities to grow from artisanal to medium and large-scale - supporting the activities and incomes of about 50,000 fishermen who operate from 400 fishing communities in Haiti.[57]

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

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

75. *Powering sewing workshops:* In 2013, the apparel sector employed 29,000 workers, accounted for nearly one-tenth of GDP,[58] 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 machines that require stable power supply. More reliable power would enable these small production facilities 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/fans.

76. *Powering small-scale commercial businesses*: Electrification is an important enabler for the development of small businesses and for generating economic growth locally, together with other key factors such as access to markets, finance and roads.[59] Businesses could use electricity

[56] Institute of Research and Application of Development Methods (IRAM), 2007.
[57] Institute of Research and Application of Development Methods (IRAM), 2007.
[58] CFI Haiti.
[59] https://www.usaid.gov/news-information/frontlines/march-april-2017/making-better-living-one-solar-sale-time

for:

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

c) Community uses

77. In addition, through technical assistance, the Sub-component will leverage synergies with other World Bank operations in Haiti that 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 O&M. An example of an innovative school electrification program, combining solar PV and information and communication technologies (ICT) investments, was piloted by IDA PRELEN, is described in Box A2.3.

Box A2.3. 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 the NGO Haiti Futur. The schools are equipped with a Smart Board, solar panels and a battery bank. 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 and 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 (85 percent) 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 among children; and a greater confidence among teachers as a result of better access to educational materials, which in effect leads to a greater variety of subjects covered.

Based on positive experiences from Haiti Futur, PRELEN will scale up this model to up to 500 schools.

Sub-component 2.c: Distributed Systems

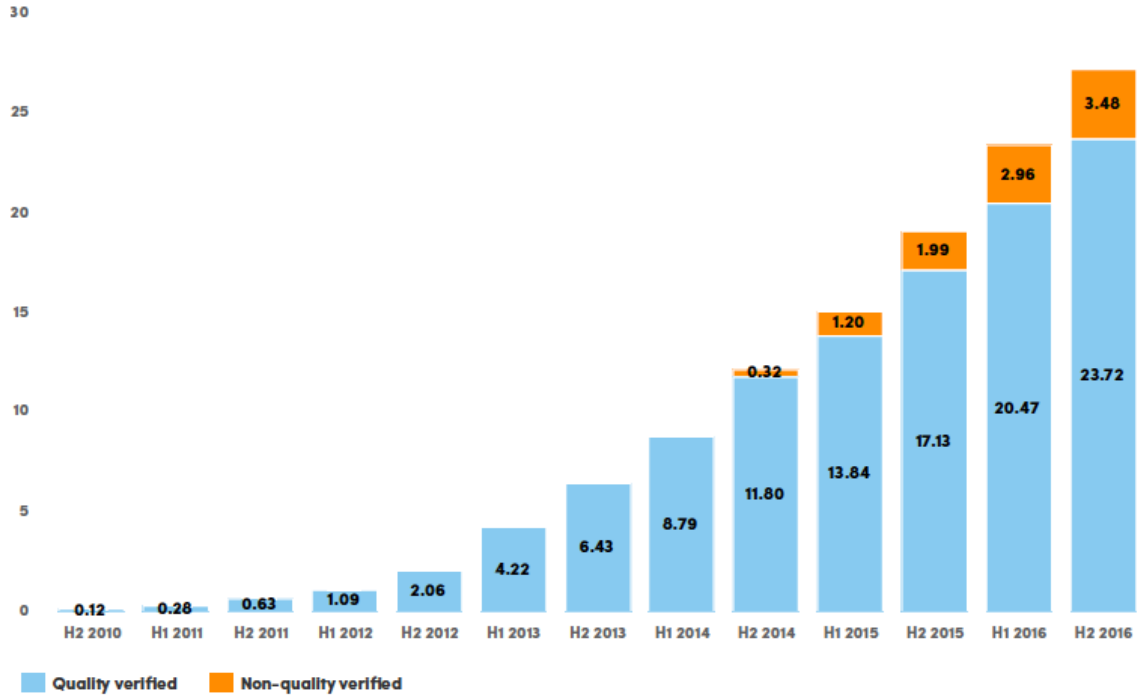
78. The Sub-component 2.c: *"Distributed Systems"* will provide grants to the DESCOs to

supply solar home systems and pico-PV solutions[60] to Haitian households and small businesses through: (i) grants for quality-verified solar products to support penetration of higher quality products on the Haitian market; (ii) grants for piloting viable, scalable and sustainable business models; and (iii) grants for growth of early stage off-grid businesses with viable business plans.

79. The majority of households in Haiti without electricity are relatively dispersed or live in small settlements where municipal 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 options. 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 to provide electricity access to 273,000 people at the Project level (700,000 people at the Program level).

80. Globally, the 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[61] - a solar lantern or a solar home system.

Figure A2.4. Cumulative global sales of pico-solar lighting products (millions of unit).
Source: Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data, May 2017



81. The pace of progress is remarkable, as indicated in Figure A2.4. Ten years ago, the global

[60] DESCOs are understood here broadly as off-grid solar businesses providing both solar home systems and pico-PV products, through a variety of business models, including cash sales, pay-as-you-go and microfinance. Pico-PV solutions are understood to include solar lanterns and small PV systems, typically under 10Wp. Solar home systems are larger systems serving households and small businesses, typically between 10 and 500Wp.
[61] Counting only "branded" products sold by GOGLA members, which are also in most cases Lighting Global-certified.

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.[62] Every year, the industry grows more diverse in terms of number and type of products, companies, as well as 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.

82. 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, have given rise to the new "pay-as-you-go" business models described in Box A2.4, which are now rapidly expanding across the globe, having overcome the key consumer affordability barrier.

Box A2.4. 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 model, 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 the customer 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 a certain scale is reached. 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 as customers do not need to commit themselves to significant purchase amounts until they are satisfied that the systems work properly and meet 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.

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

83. 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.

84. Two more Haitian off-grid energy companies (Ekotek and DigitalKap) 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 market spoilage by low quality products, difficulty to access financing, etc.) have slowed down the market development. Sub-component 2.c aims at unlocking the enormous market potential for DESCOs to provide solar home system and pico-PV solutions to households and micro-enterprises, using new technologies and business models, such as PAYG.

85. 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 and other off-grid businesses. Three types of grants will be eligible:

- Results-Based Financing (RBF) for Lighting Global (or equivalent) 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.
- Start-up grants for DESCOs with viable, scalable and sustainable business models to initiate their operations in Haiti and pilot new approaches.
- Grants for early stage growth of off-grid businesses. These 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.

86. Due to the close linkages between SREP grants and OGEF equity/debt funding (see Box A2.1), this component will be implemented by FDI, which manages OGEF under a partnership with a competitively selected International Fund Manager, with experience in investment in off-grid energy businesses globally. Sub-component 2.c will expand the volume of OGEF from US$12 million to US$15 million, allowing greater proportion of pure grant financing than available under CTF-funding alone.

87. A detailed description of the requirements, thresholds, eligibility, selection criteria and required competitive process are included in the OGEF Operating Guidelines, which will be annexed to the Project's Operations Manual.

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

88. RE scale-up requires comprehensive and systematic efforts to eliminate barriers for all types of RE investments. For that reason, the SREP Project would include a specific Sub-

component for these crosscutting issues, focusing both on (i) immediate TA activities needed to implement the SREP Component 2 and (ii) broader capacity-building efforts 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 an enabling regulatory framework for independent municipal grids
- Outreach and technical support for municipalities to support renewable energy municipal grid concessions
- Feasibility studies and technical/transaction advisors for mini-grid and productive use grant awards
- Development of a 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
- The design of appropriate fiscal incentives for off-grid renewables[63]
- Market intelligence gathering and dissemination
- Development of consumer awareness and the 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

89. 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 for 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

[63] The new budget approved by the Parliament envisages a tax exemption for renewable energy products and related applications, excluding batteries (currently taxed at 20 percent), from October 2017 onwards.

development partners, private and non-governmental entities already active in this space (e.g. the French Government, Schneider Electric Foundation, SELF and local universities). This will also include supporting gender mainstreaming, including the 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

- Communication and consensus-building activities to ensure long-term support to renewable energy and access

- South-South exchanges.

HAITI: Renewable Energy for All Project

ANNEX 3. IMPLEMENTATION ARRANGEMENTS

A. Project Institutional and Implementation Arrangements

1. **The Project will have two implementing agencies**: (i) MTPTC Energy Cell and (ii) Industrial Development Fund (*Fonds de Développement Industriel* – FDI)**.**

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 2.c (Distributed systems). The Energy Cell will also be in charge of the overall Project coordination and oversight, as well as monitoring and evaluation. 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 10 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.

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

4. The project effectiveness conditions include a requirement that the Energy Cell and the PIU are adequately staffed to ensure efficient project implementation. This should include at minimum an SREP/CTF coordinator with renewable energy expertise, additional technical staff, a socio-environmental expert and an M&E expert, and sufficient procurement and financial management staff. Having the Energy Cell and the PIU adequately staffed during project implementation is a legal covenant. The Operations Manual will describe the coordination mechanism between the Energy Cell and the PIU to ensure efficient implementation (see section C below).

5. **FDI,** working in partnership with an experienced, competitively selected International Fund Manager (IFM), will be in charge of implementing Sub-component 2.c (Distributed 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 in October, 2017). FDI and the IFM will jointly act as the OGEF Fund Manager. [64]

6. Other key stakeholders involved in Project implementation are EDH and MEF, including its PPP unit. EDH will be closely involved in the design and implementation of Component 1, and will be responsible for financing the O&M of the solar PV plants constructed under Component 1 (and in case of private sector investment, signing a PPA). MEF will provide overall support to the Project, facilitate coordination with key stakeholders, and through its public-private partnership (PPP) unit, it will provide support for the development of PPP approaches. The Energy Cell will set up a coordination mechanism involving MTPTC Energy

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

Cell, MEF, the OGEF Fund Manager and EDH (and other stakeholders as needed) to support implementation of the project. This coordination mechanism will be described in the Operations Manual.

B. Specific responsibilities

Component 1

7. 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, the selected contractor and MTPTC.

8. EDH will ensure administrative autonomy for the grid which the demonstration project will feed energy to, and it will establish an escrow account, to which it will mandatorily contribute a specific amount every month for O&M out of the collected revenues (as an automatic transfer). Establishing and maintaining the escrow account is a legal covenant under the Project.

9. In the event that private participation in investment is found to be feasible in Phase II, 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.

10. The technical assistance activities (Sub-component 2.b) will be implemented by the Energy Cell, in close coordination with EDH and MEF, and in consultation with potential private sector investors and civil society, to build broad-based support for the proposed policy and regulatory measures.

Component 2

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

12. For **Sub-component 2.a**, the Energy Cell will be in charge of promoting municipal grids in Haiti. **For existing municipal grids with diesel generation**, this will include carrying out a comprehensive assessment of the existing grids, promoting the municipal PPP scheme with potentially interested municipal grid operators and municipal authorities, designing the tri-partite service agreements, carrying out a competitive process to select municipal grid operators and to award grants, signing tri-partite agreements, assisting Municipal Grid Service Providers with community engagement, consumer awareness, gender-sensitive approaches and the promotion of productive uses and energy efficient measures, as well as, supervising and monitoring municipal grid performance and compliance with the provisions of the tri-partite service agreements, including safeguards provisions.

13. **For the green-field municipal grids**, the Energy Cell will carry out a market

assessment, using the geospatial planning tool developed under the Sub-component 2.d. It will map the potential mini-grid sites and provide this information to the interested Municipal Grid Service Providers. It will also design the grant scheme and publicize it among the Municipal Grid Service Providers, issue a call for proposals, evaluate the received proposals/business plans, award grants, sign tri-partite service agreements, and assist municipal grid operators with community engagement, consumer awareness, gender-sensitive approaches and promotion of productive uses and energy efficient measures. In coordination with municipalities, the Energy Cell will also supervise and monitor municipal grid performance and compliance with the provisions of the tri-partite service agreements, including safeguards provisions.

14. For **Sub-component 2.b**, the Energy Cell will carry out a comprehensive assessment of productive use needs and business opportunities, design the challenge grant facility, issue calls for proposals, evaluate proposals and business plans, award grants, and monitor compliance, including for safeguards. The evaluation committee should include experts from productive use sectors (e.g. agriculture, tourism etc.), as well as the OGEF Fund Manager, who is expected to finance scaling up of those business models that prove to be successful. Technical/transaction advisors will be engaged to support the grant award process. In-country experience with similar challenge grants will be leveraged.

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

Sub-component 2.c will be implemented by Industrial Development Fund (*Fonds de Développement Industriel* – FDI), in partnership with a competitively selected International Fund Manager (IFM). IFM will be competitively procured by MTPTC, following the World Bank's Procurement Regulations (July 2016). The process will be managed by the MTPTC PIU; the Energy Cell, FDI and MEF will be a part of the evaluation committee. FDI will establish OGEF as an FDI's separate financing window, with its own financing, management, and governance structure. It will be initially financed with CTF and SREP funds, but will in future allow the entry of additional financiers. OGEF will be set up for 11 years, but CTF and SREP funds would need to be disbursed within the first six years – before the Projects' closing dates. MEF will sign a Subsidiary Agreement with FDI to pass the SREP funds to FDI, which will define the rights and obligations of each party (it can be the same Subsidiary Agreement as the one that will be 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 the renewable energy sector, the financial sector, and the Global Off-Grid Lighting Association (GOGLA).

16. FDI and MTPTC will enter into an agreement with an International Fund Manager (IFM)

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 the local financial and SME landscape. The IFM, 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. FDI and the IFM will jointly evaluate investments. The IFM will also be tasked to build FDI capacity so that FDI could continue administering OGEF (or a similar successor fund) without the International Fund Manager in future.[65] Detailed arrangements will be included in OGEF Operating Guidelines, which will be annexed to the Project Operations Manual.

17. **Grant award process**. The MTPTC Energy Cell will be in charge of awarding the grants under Sub-components 2a and 2b. Two forms of competitive processes are envisaged. In the first case, the MTPTC will select the sites and finance pre-feasibility studies (under Sub-component 2.d). These studies will be made available to the private sector, which will submit proposals for grant funding. The evaluation will be based on the demonstration of technical competence and the lowest grant required. In the second case, the MTPTC Energy Cell will issue a call for proposals which will allow the private sector to present proposals for consideration. The evaluation criteria in this case will include primarily technical competence, viability and scalability of the business model and financial aspects (the amount of the grant required). The Operations Manual will describe in detail these modalities. In both cases, the MTPTC Energy Cell will establish an evaluation committee, which will also draw on end-user expertise (e.g. agriculture), and will include also non-governmental actors (e.g. universities). For Sub-component 2.c – distributed systems implemented under OGEF, the Fund Manager (FDI and the International Fund Manager) will be in charge of the selection of grantees. For results-based grants, all distributors of Lighting Global verified products will be eligible for the grant, upon the demonstration of the sale of the product (a sample will be independently verified). The start-up and expansion grants will be based on a call for proposals. The detailed process and evaluation criteria will be described in the Operating Guidelines, and grant award will be supervised by the OGEF Advisory Committee, which includes both governmental and non-governmental stakeholders. The signing of the first grant agreement, under terms and conditions satisfactory to the World Bank, will be conditions of disbursement for Sub-components 2.a, 2.b and 2.c.

18. The **Project Operations Manual** will set the rules, methods, guidelines, specific development plans, standard documents, and procedures for project implementation. Among others, it will provide a) the detailed description of all project activities, and the negative list; b) the human and other resources required for successful project implementation, and coordination among the different entities involved; c) the project administrative, financial, accounting, auditing, procurement, environmental and social safeguards, and disbursement procedures, including relevant standard documents; d) beneficiary and sub-project eligibility criteria, selection processes, model grant agreements or key characteristics of such agreements for all Sub-components 2.a, 2.b and 2.d; e) sustainability arrangements, including provisions for the opening and maintenance of the escrow account for Component 1 (see section C Sustainability

[65] 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 until year 11 under the partnership agreement between FDI and IFM.

below); f) monitoring indicators and arrangements, including arrangements for citizen engagements and beneficiary feedback; and g) the grievance mechanism and the code of ethics and conduct. The Operations Manual will also include guidance on gender-differentiated and gender-sensitive approaches. The Operations Manual will be a condition of effectiveness.

C. Capacity

19. **MTPTC Energy Cell and PIU.** The MTPTC is already an implementing agency for the IDA-financed PRELEN Project. The key MTPTC implementing units under IDA-financed PRELEN Project are the Energy Cell and the PIU and both will be used for the implementation of the SREP-funded project. The Operations 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-financed PRELEN.

20. The Energy Cell and the PIU are staffed with competent professionals, but as their responsibilities will increase with the addition of the SREP and CTF Projects, they will need to be strengthened with additional staff and/or consultants to support these increased duties. This will include hiring a socio-economic expert and an M&E specialist for the Energy Cell, as well as strengthening the Energy Cell's renewable energy and access expertise. GOH 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 providing it with adequate staff resources.

21. The Project will also benefit from the extensive procurement, financial management and safeguards experience of MTPTC's PIU. The PIU has managed safeguards for complex energy infrastructure investments in Haiti for the last ten years, whether Government- or donor-financed (including the IDA-financed PRELEN Project, and IDB's Peligre hydro project rehabilitation project). The scope of environmental and social safeguards successfully overseen by the PIU in the past also covered renewable energy projects, e.g. rooftop solar plant (100kW), large power storage, decentralized power storage, and large and small hydro projects.

22. Having the Energy Cell and the PIU adequately staffed is a condition of effectiveness and a legal covenant. The Operations Manual will describe in more detail the requirements for Energy Cell and PIU staffing. The Project staff at the Energy Cell, will at a minimum, include an SREP/CTF coordinator with RE expertise, additional technical staff, a socio-environmental expert and a M&E expert. The PIU already has sufficient procurement and financial management staff to support Project implementation.

23. **FDI** is a specialized institution of the Haitian Central Bank (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 the 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 that provides 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 the role of local partner in the management of OGEF. Its technical implementation capacity will be strengthened through entering into a partnership agreement with an International Fund Manager with a specific expertise in investing in off-grid businesses, a skill that FDI currently lacks.

24. The International Fund Manager (IFM) will be competitively procured. The minimum capability criteria will 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

25. The MTPTC Energy Cell has most of the key staff necessary to start implementation, but additional strengthening has been agreed (see above). PIU capacity has been found satisfactory, but given the added responsibilities under SREP, additional staff may be added during implementation.

26. FDI has also staff available to be assigned to OGEF, and additional dedicated staff will be provided once the IFM is hired. The IFM will be competitively procured once the CTF project is approved. In recent years, several funds have been set up (or existing funds have expanded) to invest in the emerging off-grid business markets, in particular in East Africa South Asia. Some of these fund managers have already expressed a tentative interest in OGEF.

27. Adoption of the Operations Manual, and having the Energy Cell and the PIU fully staffed will be conditions of Project effectiveness. Execution of the Subsidiary Agreement between MEF and FDI, the establishment of OGEF and CTF Project effectiveness are disbursement conditions for Sub-component 2.c.

E. Financial Management, Disbursement and Procurement

Financial Management (FM)

28. *FM Assessment*: A Financial Management Assessment was completed during appraisal and found the current capacity at the PIU and proposed FM arrangements acceptable, meeting the minimum fiduciary requirements under OP/BP10.00. 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.

29. *Staffing*: In the Energy Cell/PIU, 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.

30. *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 and the PIU, and with the help of the different actors of the project. They 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.

31. *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 Sector 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.

32. *Accounting System*. The PIU established for PRELEN has a computerized accounting software (ACCPAC), which is already in use for the PRELEN Project. 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.

33. *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.

34. *Financial Reporting arrangements*: IFRs are regularly prepared and transmitted to the World Bank for the PRELEN Project. Under the SREP 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 has been agreed during negotiations and will be reflected in the Operations Manual.

35. *Auditing Arrangements*: As for PRELEN, whose financial statements have been regularly audited, the 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.

36. *Fund Manager*: As mentioned, an International Fund Manager (IFM) will be competitively hired to assist FDI to manage Component 2.c. The capacity of FDI will therefore be evaluated jointly for FDI and the IFM. The IFM's financial management capacity will be included as a selection criteria during the hiring process and evaluated once the IFM is selected.

37. *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.

38. *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 2.a, b and d (managed by MTPTC), the Recipient, through the PIU, will open and operate a segregated Designated Account (DA) in US dollars 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. Thw ceiling of the DAs and the Minimum Application size for Direct Payment or Special Commitment are determined in the Disbursement Letter.

39. To facilitate timely disbursements for the project's eligible expenditures under Sub-component 2.c (managed by FDI/International Fund Manager), the Recipient will open and operate a segregated DA in US dollars at the Central Bank (*Banque de la République d'Haïti* /BRH). Subsequently, another account (the operating account) denominated in 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. The ceiling of the DAs and the Minimum Application size for Direct Payment or Special Commitment are determined in the Disbursement Letter. However, until the completion of the FM assessment of the FDI and the IFM and its satisfactory conclusion, the Advance method will not be available for these components.

40. 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.

41. SOE limits for expenditures against contracts for works, goods, consultant services for consulting firms, and individual consultant services are 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.

42. 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/PIU 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.

43. 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

44. **The project will have two implementing agencies**: (i) MTPTC and (ii) FDI. MTPTC, through its Energy Cell, and with the support of its PIU, will be in charge of implementing both Project components with the exception of Sub-component 2.c (Distributed systems). The Energy Cell will also be in charge of the overall project coordination and oversight, as well as monitoring and evaluation.

45. **Procurement for the Project will be carried out by**: (i) Energy Cell and (ii) PIU. The Project will be executed in accordance with the WB's Procurement Regulations for Borrowers under Investment Policy Financing (July 2016) ("Procurement Regulations"), and the provisions stipulated in the Procurement Plan and the Operations Manual. A procurement capacity assessment was carried out in March 2017 and both the Energy Cell and the PIU were found to have the necessary capacity. They will be responsible for all procurement and contracting related queries and processing, including management and compliance with fiduciary requirements.

46. **The Energy Cell will use the services of the Project Implementation Unit (PIU)** to carry out all project procurement and financial management. It will be in charge of: (i) Component 1 which is aimed to build isolated grid that will be administered by EDH; and (ii) Sub-components 2.a, 2.b, and 2.d that will finance off-grid distributed RE through grants, which will be awarded via a competitive process.

47. ***Fonds de Développement Industriel* (FDI),** along with the competitively selected International Fund Manager, will be in charge of implementing Sub-component 2.c aimed at providing grants for the provision of distributed PV systems, such as solar home systems and pico-PV systems, and associated services, to households and enterprises.

48. **A Project Procurement Strategy for Development (PPSD)** was prepared that identifies the appropriate selection methods, market approaches and types of review by the World Bank. Following the market analysis, risks identified, and contract amounts, it was determined that the most important activities under the Project will be carried out through International Competition. These activities represent 48.6 percent of the total amount, and they comprise: (i) Services (US$1.2 million) and (ii) Works (US$6 million). Services, comprising 4 contracts, will be procured through QCBS. Works, amounting to US$6 million will be procured through the build,

own, operate (BOO) selection method. Competitively-awarded grants for hybridization of municipal grids, green-field grids and productive uses, as well as OGEF start-up grants, as itemized below in Table A3.1, sections 2.a and 2.c, will not finance procurable inputs and, as such, the Bank's Procurement Regulations for Borrowers will not apply to them.

49. An acceptable Procurement Plan (dated May 31, 2017) was also prepared. For International Competition, in addition to World Bank Standard and Sample Bidding Documents, the Energy Cell and the PIU will use standard bidding documents agreed with the CNMP (*Commission Nationale des Marchés Public).*

Table A3.1. Activities carried out under the Project and associated risks and costs

Nº	Activities	Amount (US$ million)	%	Risk Rate	Comments
1.a	EPC + O&M contract for a 2-4 MW PV + Battery Plant	6.0	40.54%	4.5	Same contractor for both EPC and O&M
1.b	Technical/transaction advisors for PPP scheme for Phase II	0.5	3.38%	0.4	International consulting firm
2.a	Grant award competition for hybridization of municipal grids, green-field grids and productive uses	4.60	31.08%	4.5	
2.c	OGEF Start-up grants	3.0	20.27%	3	
2.d.1	Verification Agent	0.2	1.35%	0.2	
2.d.2	Regulatory framework for mini-grids	0.2	1.35%	0.2	
2.d.3	Consumer awareness campaign	0.3	2.03%	0.2	
	Total	**14.80**[66]	**100.00%**		

[66] Does not include funding allocated for Phase II of Component 1, given that as of project's appraisal, the modality of investment (public or private supported by guarantees) is not known, and only includes TA activities identified for the first two years of the project implementation.

Figure A3.1. Market positioning mapping risk rate and % of project total amount

50. A series of mitigation measures will be implemented to ensure the satisfactory performance of procurement functions within the Energy Cell, PIU and OGEF. These include: (a) assessment of procurement capability of the PIU; (b) supervision of procurement/selection transactions carried out by the PIU; and (c) inclusion of Special Procurement Provisions in the Procurement Plan. All procurement procedures will be described in the Operations Manual, which will be updated to reflect the above activities.

51. **To maintain sound procurement processes, the PIU will carry out procurement audits.** To this end, it will: (i) ensure all procurement records and documentation for each fiscal year of the Project are audited by independent auditors acceptable to the World Bank in accordance with appropriate procurement audit principles; (ii) furnish to the World Bank the procurement audit report; and (iii) furnish to the World Bank other information concerning the procurement records, documentation and reviews. The scope of this Audit will also include the procurement/selection transactions carried out by the PIU.

52. In view of the above, it can be concluded that the national environment is generally favorable for the procurement of the works and services identified for the implementation of the Project.Procurement of works and services, procurement of intellectual services and works will be carried out, as necessary, in accordance with the World Bank's Procurement Regulations. It should be noted that the intellectual services provided by the project for carrying out the engineering studies of the different works planned for this project will be fairly large. It is recognized that many local firms offer consulting services at prices not comparable to those on the international market.

53. As for the proposed works, there is no local company with financial and human resources to carry them out within a reasonable timeframe so the project will have recourse to overseas companies through a competitive procurement process. Local companies, however, may be able to associate themselves with international vendors. Finally, the project envisages taking appropriate measures to minimize the risks associated with the procurement process.

Table A3.2. Major contracts and selection methods from the PPSD

Contract Title, Description and Category	Bank Oversight	Procurement Approach	Selection Method	Evaluation Method
EPC + O&M contract for a 2-4 MW PV + Battery Plant	Yes	· International · Open · Open · Open	BOO	Lowest Evaluated Cost

54. 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.

G. Environmental and Social (including safeguards)

55. **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 4.11 Physical Cultural Resources, and OP 4.37 Safety of Dams. The project is rated category B.

56. Because the exact nature and location of investments is unknown, the project will apply a 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 with consultant support. The ESMF was consulted with stakeholders in-country, and was disclosed (in French) on the Government and World Bank's websites on June 2 and June 5, 2017, respectively.

57. Potential impacts include the 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 battery disposal/recycling procedures, appropriate training of operators in health and safety, appropriate consultation of local actors and NGOs regarding biodiversity, appropriate solutions for waste, etc.

58. The project will apply the ESMF, using the screening checklist in the ESMF to assess and mitigate any negative environmental impacts. 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 disposal (and ultimate recycling for those battery types that can be recycled). 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.

59. 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, OP 4.04 is triggered for screening purposes - any activities with impacts on natural habitats will be screened out using the ESMF. The OP 4.11 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 would trigger OP 4.37. The ESMF outlines the necessary steps to be taken if a subproject triggers this policy, including a review by a qualified engineer if the dam is less than 15m high. Projects with dams higher than 15m will not be eligible under the Project.

60. 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. The project will not finance dams higher than 15m. The Project will not finance activities involving the use or potential pollution of the Artibonite River or the Massacre or Artibonite aquifers (as determined by the World Bank in accordance with the World Bank's Safeguards Policies on International Waterways, OP/BP 7.50).

61. 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.

62. 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.

63. 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 sub-project proponent (by the Energy Cell in the case of the Component 1 public project, and by the private sector in the case of private investments – Component 1 Phase II and Component 2).

64. Overall responsibility for ensuring that the ESMF is adequately implemented will be with

MTPTC and the OGEF Fund Manager. The MTPTC 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 which will be annexed to the Project Operations Manual). The MTPTC Energy Cell will 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 financed by the IDB (See point C above on Capacity).

65. *Staffing:* A socio-environmental specialist will be hired by the Energy Cell before effectiveness. Additional staffing is not expected under the project; the Energy Cell and the 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), the Energy Cell and/or the 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 obtain 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).

66. **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. The 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.

67. The Project will aim to close the gender gap related to "female employment in the off-grid electricity sector". Although baseline data for "number of employees in the off-grid electricity sector disaggregated by sex" is not yet available, the Project will aim to create 1,000 female jobs in the off-grid electricity sector (including women employed by off-grid electricity providers, and female-owned retail businesses selling off-grid solutions, e.g. solar lanterns). This number corresponds to 50 percent of the estimated number of jobs that is expected to be created in the market. The team is in the process of collecting employment data directly from companies in the sector and may adjust this target based on results.

68. The Project will support specific actions aiming to promote female employment in the off-grid electricity sector, including gender training offered to electricity companies, gender-targeted professional training offered to the local population, guidelines for gender-targeted job announcements and gender-sensitive job application processes, gender-related incentives for electricity companies, and bidding process favoring candidates that have CSR and gender policies, and/or a significant percentage of female staff (as bonus in the selection criteria). Progress regarding "female employment in the off-grid electricity sector" indicator will be tracked through company data and collected directly from the electricity providers and off-grid solution retailers.

69. Some Project activities may lead to resettlement (particularly of squatters), land acquisition and loss of economic livelihood. As the exact locations of sub-projects is not known, a Resettlement Policy Framework (RPF) was prepared, consulted with stakeholders in Haiti and publicly disclosed on the Government and the World Bank websites on June 2 and June 5, 2017, respectively.

70. The RPF includes 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.

71. The MTPTC Energy Cell (for Sub-components 1.a & b, Sub-components 2.a & b) and the OGEF Fund Manager (FDI and the International Fund Manager) 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 a in the case of public investments and private companies (in the case of private investments) and Public Private Partnership (PPP) structure. 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 socio-environmental 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 throughout the project to ensure adequate environmental and social impact monitoring. The Energy Cell and OGEF will need to submit all sub-project safeguards for the Bank's no objection in the first two years of project implementation.

H. Monitoring & Evaluation

72. 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 by EDH and OGEF. The Project's Operations Manual will include a description of M&E responsibilities, data collection requirements and frequency, and the division of the roles between MTPTC, EDH and OGEF, each of which shall have an adequate budget to carry out its role diligently. The Energy Cell will hire an M&E specialist.

73. The project will also carry out a baseline survey, using the SEforALL Multi-Tier Framework (MTF) methodology,[67] and will use cell phone surveys (see below) to get regular updates on progress. The mid-term review will be conducted at the project's mid-term to assess the project's implementation progress. The regular M&E data, the survey data/beneficiary feedback and the MTF 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

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

receiving adequate services, whether desired gender impacts are being generated 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 Closing, MTF survey will be repeated to capture impacts.

74. The project will seek citizen engagement and beneficiary feedback in its implementation. Citizen engagement indicators are included in the Results Framework (Annex 1). 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.); and (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. Municipal grid tri-partite service agreement will include mechanisms for addressing user grievances, and a free text messaging service/hotline will be available to respond to customer queries. The success rate in resolving customer queries and complaints will be tracked throughout project implementation.

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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 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) 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 safeguards on a regular basis. EDH and the OGEF Fund Manager will share responsibility for monitoring compliance with E&S processes and the RPF, following instructions established in the Project Operations Manual. The Bank's supervision missions will monitor 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. 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, Pan-American Development 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.

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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,[68] 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, although 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

[68] World Bank: Creating Opportunities for Poverty Reduction in Haiti, 2015.

because women tend to spend more time at home, are responsible for household chores and engage in home-based income-generating activities that can be carried out more productively with electricity.[69] 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 the possibility for socializing, education and income-generating activities in the evening hours.
- **Women's 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, a 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.[70]
- **Increased productivity of time allocated to "domestic" and "reproductive" chores.** There is evidence that electricity increases the 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 the 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 or ice cream to raising chickens for commercial use in facilities next to their homes. Outside of their 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 for solar lamps that last through the night will allow the chickens to be

[69] 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 Project.

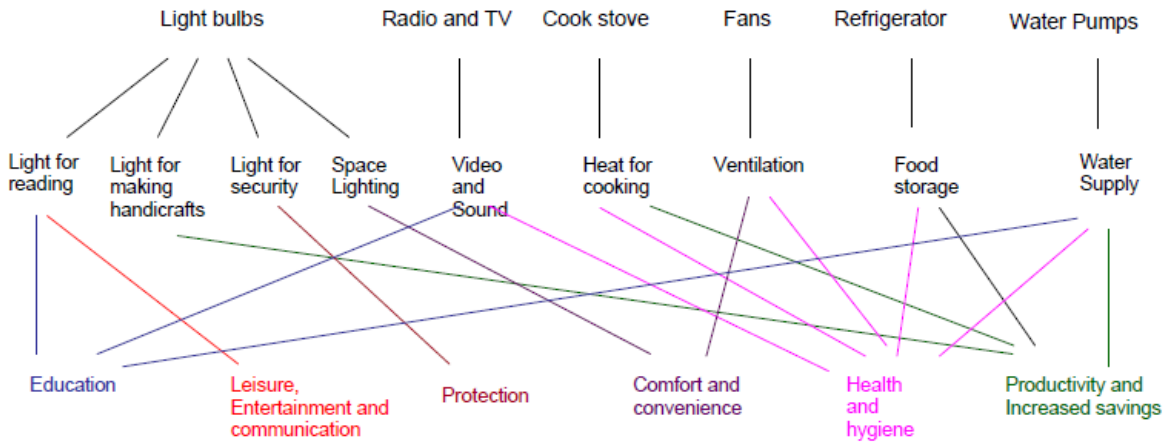
[70] Sadeque, Rysankova, Elahi, Soni: Scaling up Access to Electricity: The Case of Bangladesh, World Bank Livewire, 2014

more frequently fed and grow at a faster speed. In places without electricity, women need 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 save them significant time. The battery duration was reported to be the most important quality for female-headed businesses and households.

- Some studies also show a 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 A5.1 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 impacts 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.[71] 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 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, the 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, which are 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 effectively reach women. For example, the Bangladesh RERED project has been

[71] 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.

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 particularly relevant for off-grid electrification market development programs. These programs (as in Haiti's case) 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.[72]

- **Reducing time used on domestic chores.** Electricity is not an end in 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.[73]
- **Providing additional support for women to use electricity for productive uses.** There is mixed evidence overall on the extent to which 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, the impact on income generation may be limited.[74] Additional measures to reduce other barriers may therefore be needed. For example, the Bank-supported Mali Household Energy and Universal Access project has successfully supported a partnership with microfinance institutions to support women's micro-enterprises using newly provided electricity services.

7. The current 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,	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).

[72] See World Bank/SEforALL: Global Tracking Framework, 2015
[73] ESMAP: 2013. Integrating Gender Considerations into Energy Operations. World Bank, 2013
[74] 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. The informal nature of many women's enterprises is linked to problems of access to credit, equipment, and other support services.

can serve as an important barrier for them to access off-grid electricity services.	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.
<u>Reduce time women spend on domestic chores.</u> 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. The project's service oriented approach provides an opportunity for bundling electricity service provision with leasing or other forms of financing for these energy efficient appliances.
<u>Support income-generating activities by women.</u> There is a growing evidence on how women's integration in off-grid energy 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 municipal 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.

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ANNEX 6. ECONOMIC AND FINANCIAL ANALYSIS

1. **The EIRR is above Haiti's country hurdle rate (2 percent)**. All project components and considered RE "system types" have EIRR well above Haiti's hurdle rate, which is 2 percent according to the latest World Bank method (see per Box A6.1). They are sufficiently robust against the vast majority of scenarios, even in the no-carbon case. Therefore, the total project net 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-financed projects' co-financing net benefits that have been analyzed for the SREP IP and are also positive and sufficiently robust. Naturally, the EIRRs including carbon benefits are higher (from 11 to 54 percent for base case carbon values) than under the no-carbon case (from 10 to 52 percent). Following World Bank standard procedure, both have been calculated.[75]

Box A6.1. New country threshold rate used for SREP economic analysis:

Haiti's Social Discount Rate of 2 percent

As per Fay et al (2016), World Bank Analysis now requires 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 the past. In part, this is to reflect the recent period of low-interest rates and GDP growth rates across the globe, as well as de facto emerging market borrowing rates.

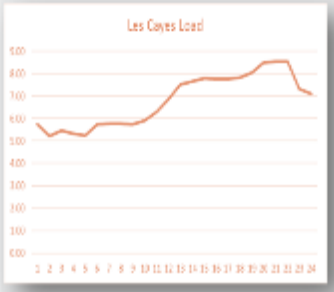
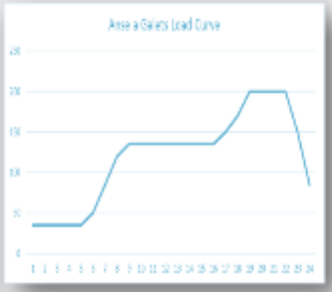
Therefore, a set additional scenarios was prepared for the economic analysis, with a new base case EIRR of 2 percent instead of the 10 percent used for SREP Investment Plan: Per-capita consumption growth is usually approximated by growth of real GDP per capita. IMF 1980-2014 (per capita GDP PPP) cum 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**. 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 on result), average growth rate of (real) per-capita GDP by least-squares regression gives 0.35 percent, so the social discount rate would be 0.7 percent.

2. **The main project benefit type is the reduced spending on energy**, thanks to the "with project" least-cost RE electricity generation, which partially substitutes (A) baseline diesel fuel use in the case of existing village and co-generation diesel generators, and (B) substitutable non-electrical energy uses.

3. **The probable share of these different baseline energy uses differs by component and target site**: For instance, many of the Component 1 beneficiaries already have some access to diesel-generated electricity (albeit to varying degrees, depending on site and user), while the vast majority of Component 2 beneficiaries are households who presently use no AC electricity. This has been reflected in project component costs, benefits and net benefits. This is one of the reasons why the share of actual sites and beneficiaries will determine the actual total project net

[75] 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), 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 new, 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. Therefore, 25-year cash flows were added to the standard 20 years for all municipal grid cases (excluding the small "over the counter" systems of Sub-component 2.c).

benefits. For instance, carbon benefits for Sub-component 2.c have been estimated with the assumption of close to 100 percent UNFCCC 2015[76] "Type I Users", while Component 1 benefits assume a mix of "Type I-IV". On the cost side, a similar differentiation between components, sub-components and probable sites is called for: Those Component 1 sites with an existing and functioning low voltage distribution grid infrastructure, and several diesel generators, will have a relatively low net cost of adding a given share of PV (and storage), compared to the subset of potential green-field village micro-grids under Sub-component 2.a. For the latter, all-in Capex are obviously much higher, but Net Benefits are still positive at the 2 percent hurdle rate.

	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

4. **Baseline diesel value has been estimated as follows**: Depending on time span of analysis, the historic 10- to 30-year average CRUDE OIL hub price has varied between US$50-US$100/BBL, and World Bank predictions for 2020 to 2030 from January 2017 are around US$60/BBL. The historic crude price averages corresponded to DIESEL spot market prices of roughly US$0.50 to US$1/liter. However, the relevant fuel cost for Economic Analysis in case of

[76] CDM Small-scale Methodology: Integrated methodology for electrification of communities. UNFCCC 2015.

Components 1 and 2 is the in situ economic 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 assumed US$0.70/liter (low) and US$1.00/liter (high) local economic value for our fuel-based analysis of benefits. Depending on gen-set size, age and real-life part load characteristics, heat rates and thus fuel consumption for existing counterfactual "no project" gensets under Components 1 and 2 may vary extremely - between 0.25 and 0.5 liter/kWh - and the corresponding baseline minimum value of purely diesel generated power would be between US$0.18 and US$0.50/kWh. The resulting estimate range for operational benefits confirms the alternative, WTP-based valuation of project benefits for the green-field municipal grids and the OGEF systems (which is based on consumer surplus and present revealed spending), and is in accord with the revealed WTP at target sites. The latter is between 20 and 70 cents, based on real life tariffs and project preparation surveys. However, it can even reach values up to US$2/kWh - paid by some existing single users of small co-generation gensets, albeit for small quantities.

5. **Reflecting the high EIRR, Financial analysis also shows high internal rates of return for typical Component 1 and 2 projects**[77] (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 are potentially attractive for private investors. However, it is quite difficult to estimate the WACC (weighted average capital cost = hurdle rate for FIRR) of actual real-life investors, because the risk premium for off-taker and country risks is hard to estimate in a nascent market like Haiti. This is crucial for investment decisions, considering the RE-typical, long time span until breakeven – and 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 DESCOs). In addition, the taxation of RE projects in Haiti is presently in flux, thanks to the Energy Cell TA under the parallel IDA-financed project and SREP project preparation. As a result, financial returns after tax are hard to pin at this stage, which might change soon.[78] However, the examples of EarthSpark and Sigora prove that interested RE-hybrid grid investors do exist in Haiti, even at the higher Capex prevalent in 2015-2016, so that the same FIRR after 2017 (when Capex will be lower) should attract additional investors. However, we cannot be sure how many will seek investment during early project years – so that the risk of private sector uptake remains and is thus raised in the risk section.

6. **In terms of KPI, the SREP project outputs are hard to predict** due to (i) the strong influence of final site selection (and final data of these sites, such as exact beneficiary number – presently we work with a conservative average of active and inactive users), and (ii) the extreme dependence of municipal grid unit cost on site and optimal RE penetration. For instance, the (very probable) **Jeremie** site calls for a high PV penetration scenario, with PV capacity and storage size roughly at par with peak demand (3MW), 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 or medium penetration PV 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) is hard to

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

[78] The new budget approved by the Parliament envisages a tax exemption for renewable energy products and related applications, excluding batteries (currently taxed at 20 percent), from October 2017 onwards.

predict. For the most probable values of KPI for Component 1, we assume a mix of the three most probable cases illustrated in Table A6.2 below: (i) Jeremie high penetration (with 3-6k users) + (ii) additional two sites with low to medium penetration with about 15k users each (active + half of inactive). For the SREP Project's Component 1, this results in total Capex of about US$12M for hardware at about 100,000–150,000 beneficiaries, 5-10 MW PV (and about 3-4 MWh storage capacity in terms of Li-ion batteries), leading to about 8-20 GWh annual RE generation added to the CTF-only case.

Table A6.1. Main KPI of SREP Program Components 1 and 2[79], and conversion factors used for CBA

A. SREP+CTF	systems	HH	people	MWp	GWh/a	GWh/10a	CO2 [t/a]*	CO2 [t/10a]	CO2 t equiv. lifetime
Component 1	**2**	**20,000**	**100,000**	**5.0**	**8.3**	82.5	**10,300**	103,000	206,000
Component 2*	**900,000**	**180,000**	**900,000**	**23.3**	**33.8**	**338.1**	**91,228**	**912,279**	**1,683,649**
Component 2a+c: HH & Village Grids	*900,000*	*180,000*	*900,000*	**9.0**	*13.1*	*130.5*	66,958	*669,578*	***1,198,249***
*Component 2b: SU/PU***	*counted separately*	*counted separately*	*counted separately*	14.3	20.8	207.6	**24,270**	242,700	**485,401**
sum	**900,002**	**200,000**	**1,000,000**	**28.3**	**42.1**	**421**	**101,528**	**1,015,279**	**1,889,649**

equivalent conversion factors	people/HH	HH/system	MWp/HH	GWh/MWp/a*	CO2 T/HH	CO2 T/GWh	LF	yield	h/d
Component 1	5	10,000	0.000250	1.65	0.515	1,248	19%	1,650	4.5
Component 2 including SuPu	5	0.2	0.000130	1.45	0.507	2,698	17%	1,450	4.0

Illustrative Component 1 Small Grid: "Jeremie" Site - and typical Hybrid Small Grid System Layout Options for it:

7. Due to the present price range of PV, fuel and (Li-ion) batteries, municipal 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 the difference in financial and economic KPI, and (b) The CBA and pre-feasibility system design face a fundamental trade-off between the standard economic indicators used in RE projects.

8. This trade-off can be discussed most easily by simplifying the many possible system configurations into 3 typical "classes" of RE Hybrids (see table above), according to their PV penetration (or RE share): High, Medium and Low, as shown in the tables below.

9. The basic trade-off between those Hybrid system classes is, that higher PV shares lead to (A) lower LEC, fuel usage and thus O&M cost on the one hand (which is good) - but also to lower NPV and IRR on the other (which is bad).

10. At final system design stage (that is, during implementation), this trade-off is usually decided by the investor, in light of many individual factors, which may change over time,

[79] Per the Haiti SREP Investment Plan, the off-grid component (Component 2) is co-financed by SREP, the IDA-financed PRELEN project and CTF, forming a synergetic package (an Investment Plan), where each source of funding is used to maximize leveraging of private sector financing. It is therefore impossible to fully separate the impact of each co-financing source. However, to avoid double-counting in reporting, SREP results and CTF results will be reported separately, with 65% attributed to CTF and 35% to SREP, in line with their relative contribution to funding off-grid energy investments, excluding TA (US$14.22 million for CTF and US$7.62 million for SREP). The IDA-financed PRELEN project mainly contributes with technical assistance and small-scale piloting of innovative ideas and is therefore not a major source of investments. Annex 1 includes expected results for both the Program level and the Project level. Project-level funding is calculated from Program level funding by applying 35% of results to SREP.

including their financial situation (say, liquidity and debt access) and risk aversion, the detailed system data, national regulation (say, maximum tariff or minimum service quality), "subsidy rules" (say, maximum US$/HH), experience with the 3 simplified PV penetration cases and the investors' established relations to EPC contractors (because the control standards for the Medium and High PV Penetration cases are not standardized), expectations about future Capex (because deferring part of the investment can make sense), and many more.

11. If Capex trends hold, however, high RE share systems with PV and Li-ion batteries will win out over the other two options in the medium term. Presently, these systems are more difficult, because system control and Li-ion battery quality issues can be handled only by few expert EPC contractors. Therefore, this is the most important case for demonstration effects.

12. For economic analysis, we 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 EPC contractors and investors (if this route is chosen) 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 number 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 best to have a ring-fenced early demo effect in case 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 Li-ion QA and automated control of distributed generation[80]) might severely reduce the appetite for private sector participation, and increase project cluster risk, if high 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 the first site, and the follow up with 1-2 larger EDH-operated grids (ideally as PPP) in Phase II.

13. By then, the local private sector may have learned that adding PV (and storage) decreases O&M cost and thus also the risk that collected payments (say on an Escrow account) might not suffice to cover future recurrent costs. In this case, they would price off-taker risk at a lower premium. This effect is due to several aspects: (a) By definition, present 100 percent diesel-fueled LEC are larger than resulting diesel cum 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); (b) In addition, future replacements will be much less expensive than present Capex, both for PV and batteries; (c) Finally, the latest knowhow in solid PV system design for optimal O&M has 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.

[80] Automated dispatch strategies for systems with several decentralized vRE generators (such as PV) and possibly batteries + diesel / hydro / other generators inside one grid (for example in Les Cayes) such that there is not one "master" diesel with firm dispatch, but a more complex strategy which allows for higher vRE shares without jeopardizing power stability.

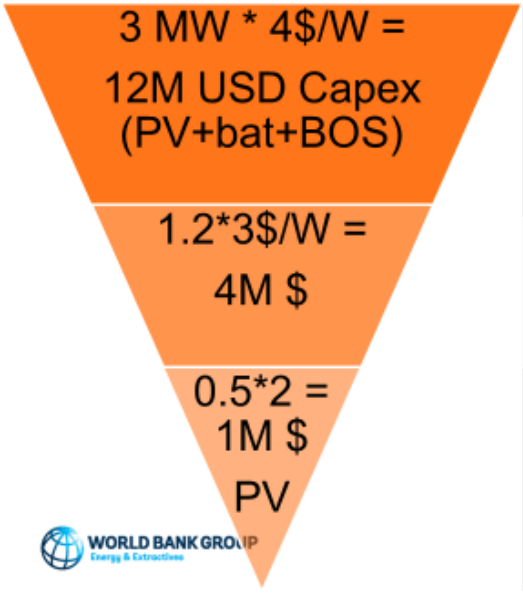
Table A6.2. Example for possible investment amounts Component 1, targeting sites 1-3 of our short list:

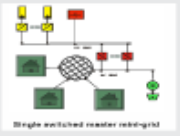
	Site 1	Site 2	Site 3	
	Les Cayes Peak demand 11 MW (incl existing hydro)	**Petit Goave** Peak demand 10 MW	**Jeremie** Peak Demand 3 MW (3-6k users)	**Thus, 3 typical Investment Cases Component 1 that fit a US$12 M budget** [Capex]:
HIGH PV SHARE	For example PV capacity ca. **11 MWp* + battery 11MWh** Unit Cost: 4$/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$**

Table A6.3 and A6.4

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**



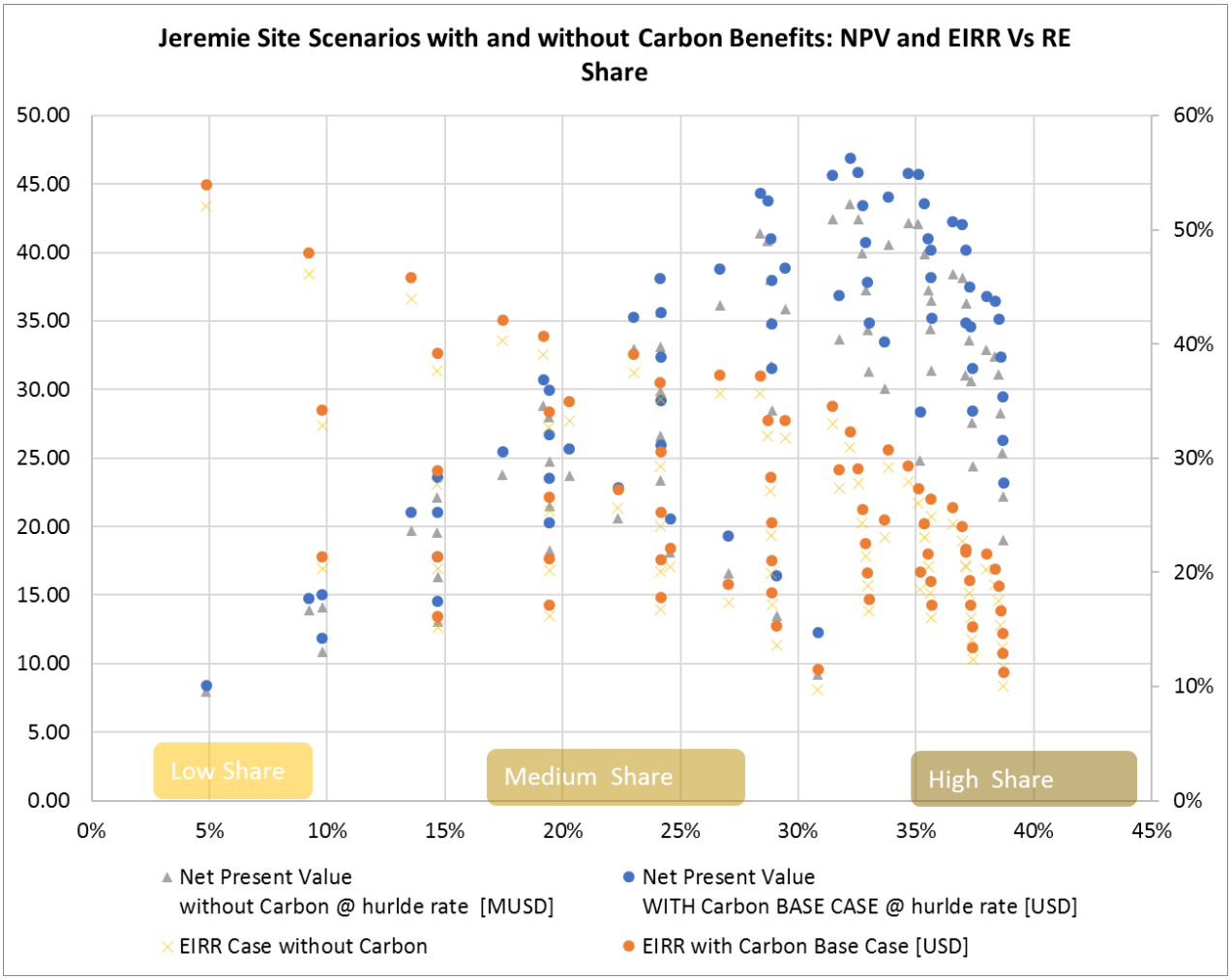
Solar Share „Type 1-3“	Typical Hybrid Minigrid topology	RE „Integration Requirements“
High P ≥100% of peak demand E ≥25%		1. Complex control ! 2. Large battery
Medium P ≈40% of peak demand E ≈10%		1. Basic control 2. Small battery
Low P ≈20% E ≈5%		1. Control can stay as is 2. No battery needed

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 $\approx \frac{1}{3}$ of E	**3 MWp** @ 4 $/W (incl storage) = USD 12 Mio Capex	Very complex automated System Controll including grid forming inverters + DisGen ICT+ Lilon 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 A6.5: Simplification of Tables A6.5 and A6.6:

			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 A6.6: Optimal EIRR for the Jeremie site is at a lower PV Share than Optimal NPV.



Base Case EIRR and KPI for SREP and CTF total project

Table A6.7: CBA Results of most **probable Component 1 System** at 2 percent EIRR (Haiti threshold rate) and 10 percent IRR (as used in 2015 SREP IP): Jeremie Site Key Scenarios

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%

Table A6.8: CBA Results of typical Component 2 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%*	*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%

14. The sensitivity of EIRR and FIRR to key assumptions has 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 described in SREP IP) and (ii) the uncertainty in final sub-project selection for Components 1+2 (as described above).

15. 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 the 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.

16. NPV(FIRR) varies strongly with WACC and exact provider model. As sub-project details notably include the exact ownership structure, risk sharing and business model, this affects NPV at FIRR much more than at EIRR. To illustrate this, we have added a high FIRR (20 percent) and a moderate FIRR (10 percent). 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 long list 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.

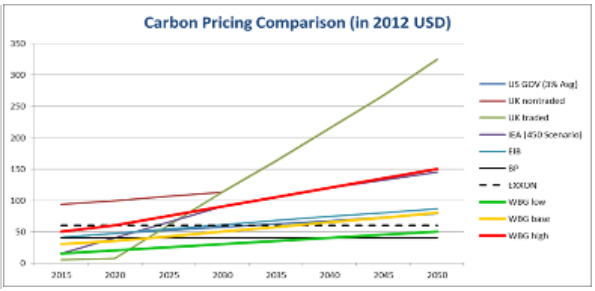
17. **Carbon Benefits:** For the present SREP PAD and the parallel CTF PAD, recommendations from the latest World Bank Guidance (2014) were followed. The analysis includes: (i) a CBA scenario completely without Carbon Benefits; as well as (ii) a BASE CASE and (iii) a LOW CASE scenario for the CARBON PRICE ("Social Value") of the 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).[81] We have calculated carbon savings in several steps:

(1) The 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 which we have cited above) for a broad range of eligible system sizes and categories (CTF types 1-3, and 4 mixed in for productive use water pumping cases).
(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 (again, 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 lifespans 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 larger type 1 SHS and type 2 including typical operations and maintenance replacements and balance-of-system components such as batteries (SHS and off-grid solar savers for SME) and type 3 low-end municipal grids (expected to average 200 Wp/User so that they are treated similar to SHS) and high-end municipal 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 the above-quoted World Bank guidance, separately for the low case, base case and high case carbon value trajectories given there (Table A6.9).
(5) Cum Carbon Benefits increase with Carbon "Social" Value (table and graph above), as confirmed by our example simulation of operational benefits as a function of fuel cost and CO2 Value in Figure A6.1 on the next page.

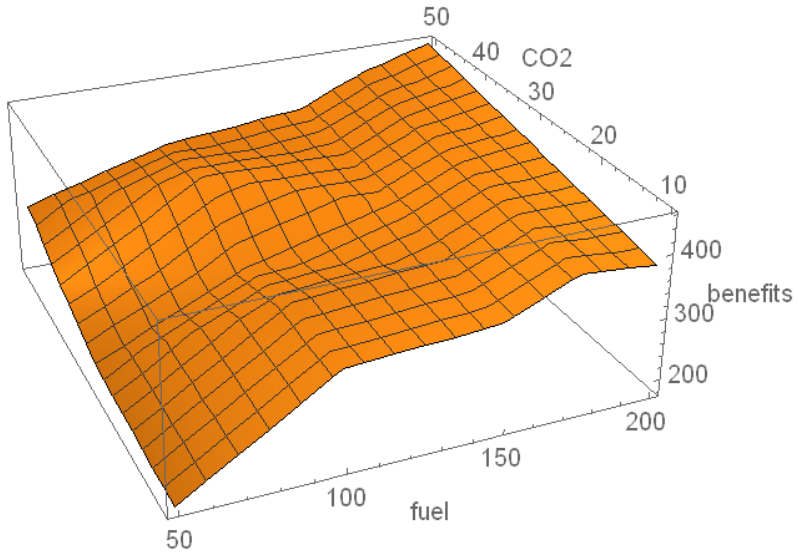
Table A6.9: Carbon Value increases over time

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



[81] 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

Figure A6.1: PV Benefits in Haiti Component 1 Sites increase with carbon value and fuel cost



18. The following key issues are also covered by our analysis:

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

b. Li-ion batteries will play a key role in post project Haiti, but Capex and quality are in flux so those assumptions have a high uncertainty. This is typical for the strong "demo effect" on investment decision and the WACC desired by SREP.

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

d. **The main effects at play when updating SREP EIRR and FIRR** from 2015 to 2017 are summarized in the table below:

Table A6.10: Changes since SREP IP

What has changed since SREP IP?	Effect on NPV?	Issues at play
UP: International Crude Oil Price	**DOWN**	Lower diesel fuel costs can readily be used to calculate lower short-run marginal generation cost and LEC [US$/MWh]. Yet it should be noted that international Crude price reductions are not necessarily passed on 100 percent to captive clients on islands and in remote sites. While this can be neglected for the conservative "low thermal generation LEC" in economic analysis, winners and losers must be analyzed in light of existing PPAs, both for EDH and smaller SME clients with gen-set power.
DOWN: Haiti HURDLE RATE used as IRR for NPV calculation (and for LEC)	**UP**	WB meanwhile uses the new method for EIRR HURDLE RATE calculation. Thus, Haiti's new base case country threshold rate is now 2 instead of 10 percent.
DOWN: Base Case Capex PV 2017-2021 slightly down	**UP**	Because appraisal is 2 years after the SREP IP and additional LCR tenders reduce uncertainty. For example, recent PV tenders in Brazil and PPAs signed in Chile suggest a PV LEC well below US$0.8/kWh
Case for small DisGen clearer	**UP**	Hard to quantify but >0
Latest project design considers NPV-based RE tendering, not only cost-based.	**UP**	Hard to quantify but >0
TOTAL EFFECT	Slightly Up	The resulting change in NPV is less than the error margin of NPV resulting from the many input variable uncertainties described in this document.

19. **Operational Benefits of PV** have been calculated under standard, as well as optimized dispatch and PV placement, by adding mixed integer linear programming (MILP)[82] and multi-node line-loss analysis with a Mathematica-based software by iiDevelopment (used successfully in several national vRE optimization studies by GIZ) to the standard Homer Pro cum Excel approach for village power, as illustrated by Figure A6.2 below:

[82] The mathematical optimization method requires solid solutions to the unit commitment problem, also known as the optimal dispatch of N generators.

Figure A6.2: 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 transmission, and thus 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 islanding mode.

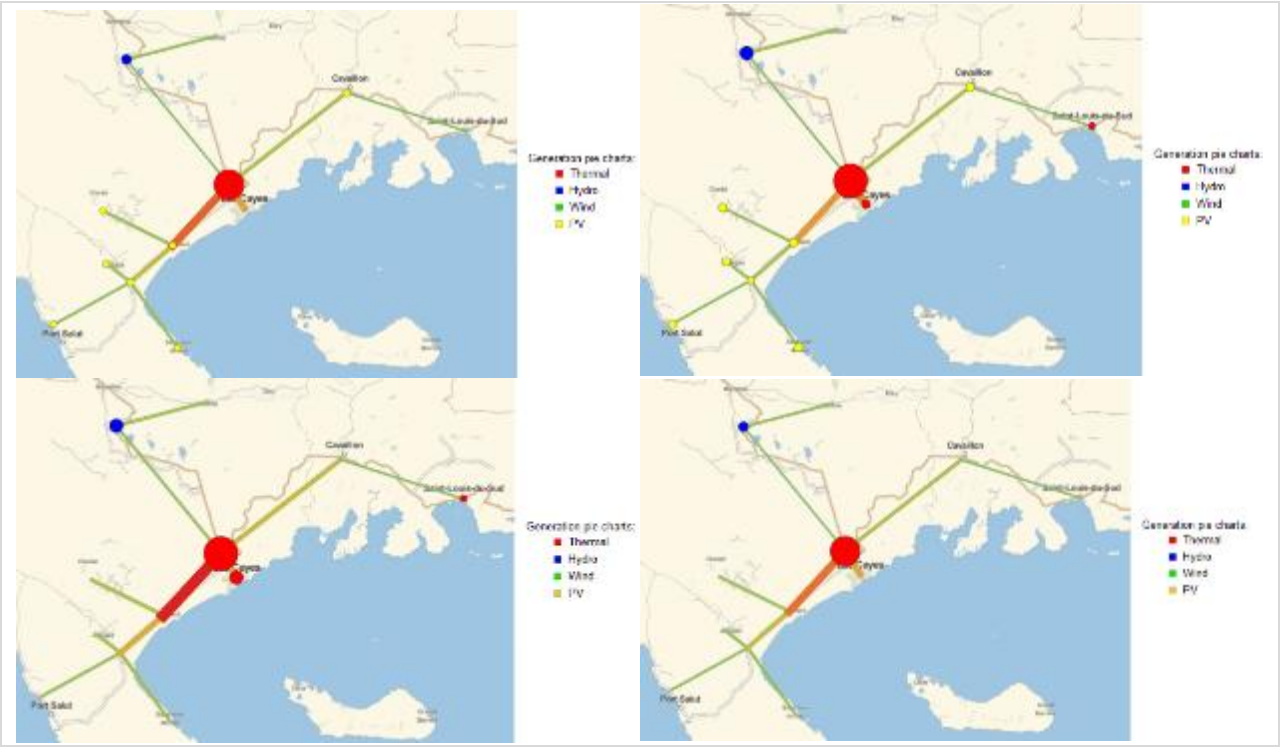
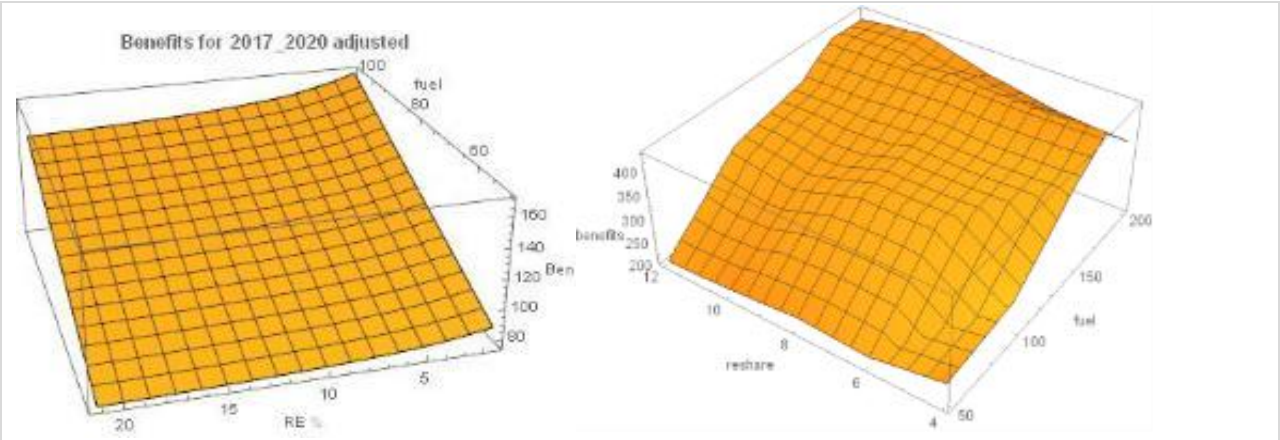


Figure A6.3: The Specific Minimum (sic) Operational Benefits of injecting PV in the potential project site "Les Cayes" vary with RE Share and cost of the saved Fuel. Benefits based on consumer surplus and WTP are higher than the minimum operational benefits.



Source: iiDevelopment

20. The key assumptions for our financial analysis are summarized below. More details on investors by market segments and market development are discussed in the SREP IP.

Figure A6.4: Haiti RE LCOE as per SREP IP Economic Analysis

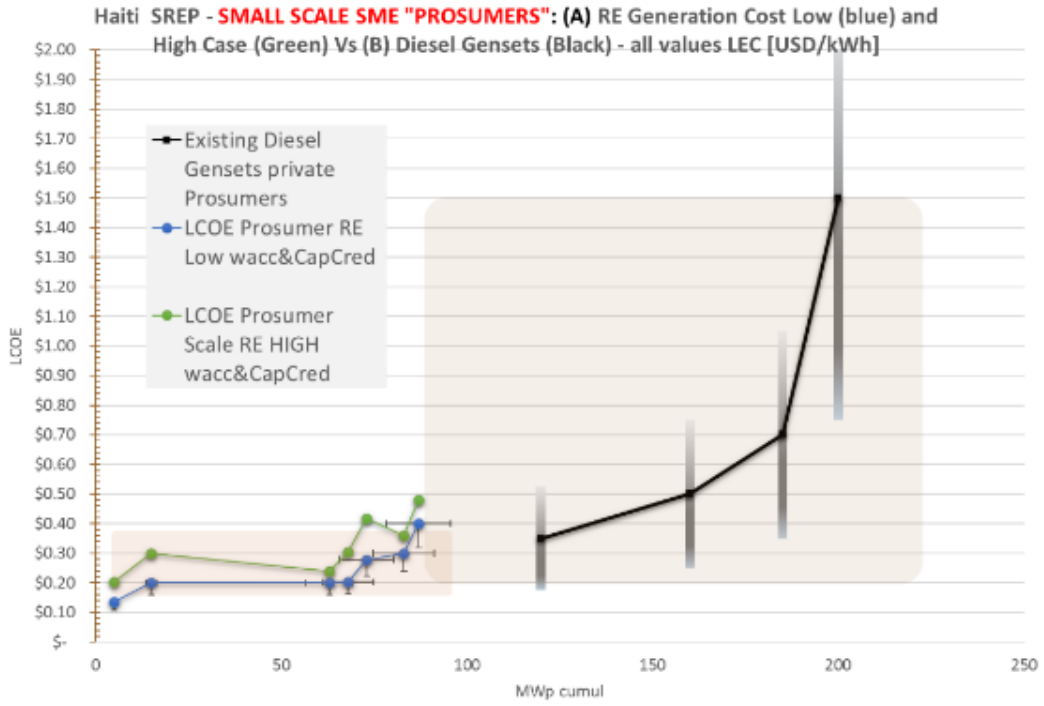
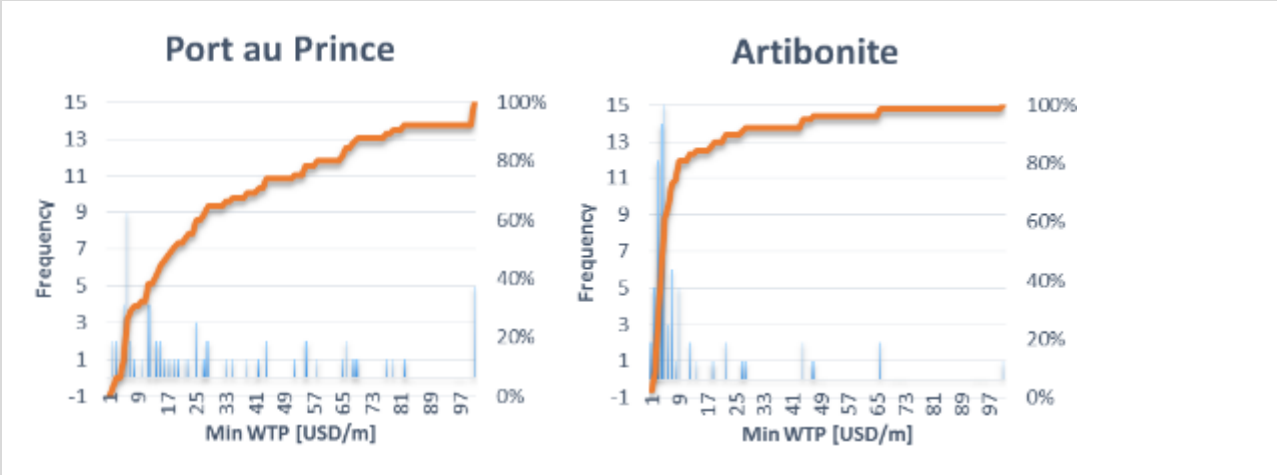


Table A6.11: Haiti willingness to pay – average per department

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).

Figure A6.5: Haiti willingness to pay – Current substitutable energy expenditures = minimum WTP (here: average monthly in Artibonite and Port-au-Prince – all departments were analyzed separately)



Source: Digicel/iiDevelopment Survey (2014)

Table A6.12: SREP Market Segment 6:

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

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

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

Table A6.13: 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

Table A6.14: 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

HAITI: Renewable Energy for All Project

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 whom 50,000 are women) and 1,000 businesses and community services	1,500,000 people (of whom 750,000 are women)
Annual electricity output from RE as a result of SREP interventions (MWh/year)	8,250	123,750
Tons of GHG emissions reduced or avoided **- Tons per year [tCO2eq/yr]** **- Tons over lifetime [tCO2eq]**	10,300 206,000	154,500 3,090,000
Financing leveraged through SREP funding (US$ million, cumulative)	US$4.5 – 12.5 million of which: - IDA: US$4 million - Private sector: US$0 – 8 million - Other: US$0.5 million	US$165 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 on-grid integration of renewable energies;
- 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 the Haiti Investment Plan, the off-grid component is co-financed by SREP, IDA and CTF, forming a comprehensive package (see the Investment Plan below), where each source of funding is used to maximize impact and leverage private sector investment. It is therefore impossible to fully separate the impact of each co-financing source. However, to avoid double-counting in reporting to CIF, SREP results and CTF results will be reported separately.[83] Annex 1 therefore reports results at both the Program level and the Project level.		
Indicator	SREP-funded Project (excluding CTF co-financing)	CTF/SREP-funded Program (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	315,000 people (of whom 157,500 are women) and 3,500 businesses and community services	900,000 people (of whom 450,000 are women) and 9,000 businesses and community services	5,300,000 people (of whom 2,650,000 are women)
Annual electricity output from RE as a result of SREP interventions (MWh/year)	12,000	32,400	210,000
Tons of GHG emissions reduced or avoided - Tons per year [tCO_{2eq}/yr]	32,000	91,000	554,000
- Tons over lifetime [tCO_{2eq}]	590,000	1,680,000	9,820,000
Financing leveraged through SREP funding (US$ million, cumulative)	US$54.5 million of which: • IDA: US$20 million • CTF: US$16 million • Private sector: US$16 million • Other: US$2.5	US$102.5 million of which: • IDA: US$20 million • CTF: US$16 million • Private sector: US$64 million • Other: US$2.5	US$300 million from private sources

[83] 65 percent will be attributed to CTF and 35 percent to SREP, in line with their relative contribution to SREP program funding, excluding TA (US$14.22 million for CTF and US$7.62 million for SREP).

	million	million	
SREP leverage ratio	1 : 6	1 : 12	1 : 35
Co-benefits • Strengthened private sector role and participation in off-grid electrification; • Improved consumer awareness of 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 a low-carbon development pathway.			

Introduction

B. 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 per capita of US$829 in 2015 - less than 10 percent of the regional average. 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.[84] 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[85] 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 electricity generation, which leaves the country vulnerable to global oil price fluctuations. The 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. The cost of service from thermal generation is about US$0.30 per kWh, while average electricity tariffs range from US$0.20 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, approximately three times the available generation capacity from EDH (currently 176 MW). 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 for renewable energy resources, which are largely under-developed. For more information, see Sections I-A and I-B of the Project Appraisal Document.

[84] Source: The World Factbook, Central Intelligence Agency, 2017.
[85] Source: World Development Indicators, World Bank.

C. 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 US$30 million for investment funding in EDH grids, municipal grids and individual off-grid systems for productive, community and household uses. The Investment Plan, 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. The 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 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 ORIGINAL Haiti SREP Investment Plan (2015)

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[86]	8-10	0-2	10	6				16	22
2. RE for Port de Paix remonte gri	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. However, project preparation activities led to the identification of transmission bottlenecks in the Port-au-Prince grid, which would prevent the integration of large scale renewable energy (at the scale originally foreseen in the Investment Plan). In addition, the demonstration impact would be diluted due to significant technical losses in the system. Hence, this would not have allowed for users to experience any visible service improvements. 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).[87] 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 southwestern Haiti. Monetary damage was estimated at US$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 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 Gonâve 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 the potential for demonstration impact and replication. Under the Project, 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 a PPP approach was not deemed feasible in the short term (e.g. EDH off-taker 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 Electricity 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 municipal 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 the future. The table below summarizes how SREP grants and CTF commercial financing are expected to leverage and complement each other.

[87] 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 1964 and the third strongest Haitian landfall on record.

Table A7.2: Synergies between SREP and CTF programs

	SREP	CTF	Synergies with CTF
Component 1: Grid-connected distributed Renewable Energy			
1a. PV and battery on EDH isolated grid	Integration of renewables in EDH diesel grids	None	Complementary
1b. Technical assistance for on-grid investments supporting vRE integration		None	Complementary
Component 2: Off-grid distributed Renewable Energy			
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 Program among SREP, CTF and IDA therefore provides a comprehensive package, which explores synergies among each source of funding to maximize impact and private sector leveraging. CTF funding (which is a contingent recovery grant to GOH) is used primarily for equity investments and lending to the private sector. This funding is complemented with SREP and IDA resources, 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. However, in order to avoid double-counting to CIF, the results between SREP and CTF are split in 35:65 ratio, reflecting the ratio of non-TA funding amounts available in each source for off-grid investments (US$14.22 million for CTF and US$7.62 million for SREP). Annex 1 of the PAD, therefore reports on both the overall Program (SREP + CTF + IDA) results, and the SREP Project results.

D. 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 households, businesses and community services.

13. The Project is split in two components as described below; each one of them represents a stand-alone 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 5-12MW 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. municipal grids, stand-alone systems for productive and community uses and solar home systems for households) in areas not served by EDH.

14. A detailed description of the project is presented in Annex 2 of the PAD.

15. **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 show 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 17 percent in rural areas), compared to a regional average of 95 percent (and 85 percent in

rural areas).[88]

16. According to data collected by *Doing Business*[89] getting electricity in Haiti takes an average of 60 days and costs 3,708.5 percent of income per capita. Globally, Haiti stands at 139 in the ranking of 190 economies on the ease of getting electricity.[90] 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 65 percent, and a collection rate of about two-thirds on its billing. Hence, EDH ultimately recovers less than a quarter of the value of the electricity purchased and generated. 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 to electricity, enhance poverty reduction and promote inclusive growth.

17. **Transformative impact.** The Project will contribute to the transformation of Haiti's electricity sector by demonstrating the feasibility of integrating solar PV generation into the Haitian grids. The successful implementation of this project (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 technical assistance and capacity building for grid integration will further support the transformation by contributing to the development of an enabling policy and regulatory framework for private sector participation in RE investments over the medium to long term.

18. At the time of preparing the SREP Investment Plan, a greater emphasis was put on providing solar lanterns and pico PV lighting systems as solutions 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 off-grid distributed RE component (Component 2) 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 slightly lower number of beneficiaries than was originally envisaged.[91] 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.

19. **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

[88] Source: IEA, World Energy Outlook 2016
[89] 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.
[90] Source: World Bank, Doing Business 2017 Equal Opportunities for All - Economy Profile 2017: Haiti
[91] One million beneficiaries as per the Investment Plan, compared to 660,000 people, following project preparation.

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 Electricity Fund (OGEF), 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, and make end-user tariffs more affordable. These interventions will contribute to reducing 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 principally in Africa. Finally, capacity building, institutional strengthening and the establishment of enabling policy, legal and regulatory frameworks will stimulate investments 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.

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

20. **Increased installed capacity from renewable energy sources.** The country's installed capacity - managed by EDH – is about 320 MW (with available capacity of approximately 176 MW and peak demand of 400 MW). The project will facilitate the construction of 5-12 MWp of grid-connected solar PV power and about 8 MWp of additional capacity from RE sources from off-grid systems (i.e. stand-alone solar home systems and mini-grids). This will be equivalent to an aggregate of at least 20 GWh[92] generated annually from renewable energy sources.

21. **Increased access to energy renewable energy sources.** The Project will improve access to electricity services for at least 415,000 people (50 percent of whom are women) and 4,500 businesses and community services through EDH isolated grids, municipal grids and stand-alone solar home systems.

22. **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 to achieve low-carbon development by contributing to the expansion of rural electrification using renewable energy resources. The project will help avoid at least 42,000 tCO_{2eq} every year and 795,000 tCO_{2eq} over the lifetime of the investment.

23. **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 municipal grids, preliminary pre-feasibility simulations (using modelling tools such as Homer, PVsyst, Meteonorm, iiDevelopment's Mathematica-based mixed integer linear optimization, and MS 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, municipal grids and co-generation gensets. At end-user level, willingness to pay (WTP) and market studies carried out during project preparation revealed overall high expenditures on electricity substitutable items, with

[92] This increases to over 40 GWh when also accounting for the impact of CTF financing.

wide variations across regions and customer categories. Commercial customers and large users have a high WTP for stable and reliable electricity supply. But even, urban households in Haiti spend on average about US$30 a month on electricity or electricity substitutes, while rural households spend US$10-20 depending on the department (the poorest proportion of the population, however, spends 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 costs for private businesses which will in turn allow them to offer competitive and affordable electricity services.

24. **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 EDH's isolated grids), and off-grid (providing new access to off-grid households, 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, Sub-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 ensured on supporting female entrepreneurs.

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

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

- Power for 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, as solar-powered cold storage at the fruit collection site can significantly improve quality of these export products;

- Ice production for fishermen, notably 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; 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. the site's topography, aquifer resources).

27. (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.

28. **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) accrued educational and health benefits owing from the improved level and quality of lighting and reduced indoor air pollution from reduced use of kerosene, (iii) reduced GHG emissions from using renewable energy sources, (iv) increased productivity from promoting productive uses of electricity, and (v) increased employment opportunities, mainly related to the construction, operation and maintenance of hybrid mini-grid systems and in distribution and service chains for solar PV products.

29. **Economic and financial viability.** All project components and considered RE "system types" have EIRRs 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 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 modeled Component 1 and 2 projects[93] (between 10 and 40 percent, but depend 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

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

private investors. The economic and financial analyses, including methodology and assumptions are presented in Annex 6.

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

31. 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 undertaking ex-ante variable RE integration analysis for a fragile country/system (usually done empirically or through pilot projects).

32. The Project also leverages synergies with other World Bank operations in Haiti in agriculture, private sector development, education, health and water sectors which support productive and community uses of electricity. Total co-financing is equivalent to US$107 to US$115 million. There are on-going discussions with other potential financiers. 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 1:5.

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

	IDA PRELEN	Other IDA[94]	SREP	CTF (OGEF)	Others	Private sector	Total	SREP Leverage ratio
Component 1: Grid-connected distributed RE	**4**		**11**		**0.5**	**0-8**	**15.5-23.5**	**1:0.4 to 1:1**
1.a. PV and battery (investment+ potentially a guarantee)	3		10.5			0-8		
1.b. On-grid investments supporting vRE integration	1		0.5		0.5[95]			
1.c. Technical Assistance								
Component 2: Off-grid distributed RE	**17**	**3**	**8.62**	**15.65**	**2.5**	**64**	**110.77**	**1:12**

[94] Agriculture, Private sector development, Education and Water projects
[95] ESMAP TA support for variable renewable energy integration and Korea Green Growth Trust Fund

2.a. Mini-grids	2.4		3.62	3	1.5[96]	9		
2.b. Productive and community uses	10	3	1	2		15		
2.c. Households systems			3	7	1[97]	40		
2.d. Technical Assistance and Capacity Building (OGEF Fund Manager and operating expenses)	4.6		1	1.43 2.22				
Total SREP Project	**21**	**3**	**19.62**	**15.65**	**3**	**64-72**	**126.27-134.27**	**1:5**
Additional: small hydro rehabilitation (IP Component 4)[98]	4						4	
Total SREP IP	**25**	**3**	**19.62**	**15.65**	**3**	**64-72**	**130.27-138.27**	

33. Private sector leveraging on Component 1 will only materialize if private investments in on-grid renewables are feasible in Phase II, e.g. through using SREP funds as a guarantee. Private sector leveraging under Component 2 will take the form of private equity and commercial loans. First, all private sector projects supported with SREP grant facilities 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 an additional US$51 million will be invested in SREP and CTF-supported 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.

34. **Gender.** Rural electrification has the potential to improve equality and women's socioeconomic status. The project will ensure gender-sensitive support through 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. A beneficiary feedback mechanism through cell phone surveys, which will provide

[96] 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 Annex 2.
[97] France (Ministry of Education) and Schneider Foundation RE training program and ESMAP TA support for mini-grids and Lighting Global.
[98] While not a part of the SREP project, the 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.

gender disaggregated data, will provide feedback on whether additional measures to support female-headed households are needed. Specific actions will be undertaken to ensure that the gender-differentiated benefits materialize and are properly tracked (see Annex 1 for gender-differentiated indicators and Annex 5 for a gender assessment and actions).

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

36. 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, given 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.

37. Environmental and health co-benefits: A total of 795,000 tons of carbon dioxide (CO_2) emissions will be avoided over the lifetime of the investments. In addition, the Project will lead to reduction in *local* pollution from diesel generators, kerosene lamps, candles and biomass (firewood) that are presently used as sources of energy. 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.

38. Social co-benefits: Education will be promoted more widely and effectively as the provision of electricity to schools and households may 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.

B. Monitoring and Evaluation

39. Overall monitoring and evaluation of the project activities will be the responsibility of MTPTC Energy Cell, using services of the PIU and 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 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.

C. Implementation Readiness

40. **Country/sector strategies**. The 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 GOH's 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.

41. **Institutional arrangements**. The project will be implemented by both the MTPTC Energy Cell, and FDI, which will manage OGEF jointly with a competitively selected International Fund Manager (IFM). On the one hand, the MTPTC Energy Cell will be in charge of implementing both Project Components 1 and 2 (with the exception of Sub-component 2.c - Distributed systems), as well as overall project coordination and oversight, using services from the PIU where deemed useful. On the other hand, FDI and the IFM, acting jointly as the OGEF Fund Manager, will be in charge of implementing Sub-component 2.c (Distributed 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. Other key stakeholders involved in Project implementation are EDH and MEF, including its PPP unit. EDH will be closely involved in the design and implementation of Component 1. MEF will provide an overall support to the project and facilitate inter-institutional coordination. The MEF PPP unit will advise the Energy Cell on transactions involving private sector participation and PPP arrangements. Annex 3 of the Project Appraisal Document provides a detailed description of the implementation arrangements.

42. **Sustainability.** The project will promote sustainable solutions. For the Renewable Energy for the Metropolitan Area project (Component 1), the project will engage the private sector to build and operate the 2-3 solar PV plants. As agreed with the Government, 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; and (ii) receive long-term capacity building through the project that would allow it eventually to take over the plant operation.

43. In addition, the Government is currently exploring the way to improve the performance of EDH, including the isolated grids. Options are to outsource collection and billing or to concession the grid operation to the 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 will be closely monitored. Moving to the next phase, which foresees greater private sector participation, additional measures will be required.

44. 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 mini-grids and off-grid systems, including: poor technical quality of systems/components, inadequate tariffs in municipal grids,

low capacity to operate off-grid 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).