Document of

The World Bank

Report No: PAD2362

INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT DOCUMENT

ON A

PROPOSED CREDIT
FROM THE INTERNATIONAL DEVELOPMENT ASSOCIATION
IN THE AMOUNT OF US$ 5 MILLION

A PROPOSED CONTINGENT GRANT
FROM THE CLEAN TECHNOLOGY FUND
IN THE AMOUNT OF USD 9.525 MILLION

A PROPOSED GRANT
FROM THE UNITED KINGDOM DEPARTMENT FOR INTERNATIONAL DEVELOPMENT
IN THE AMOUNT OF USD 5 MILLION

PROPOSED GRANT
FROM THE SIDS DOCK SUPPORT PROGRAM
IN THE AMOUNT OF US$ 1.85 MILLION

TO THE

GOVERNMENT OF SAINT LUCIA

FOR A

RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT

Energy & Extractives Global Practice
Latin America And Caribbean Region

Regional Vice President:	Jorge Familiar Calderon
Country Director:	Tahseen Sayed Khan
Senior Global Practice Director:	Riccardo Puliti
Practice Manager:	Antonio Alexandre Rodrigues Barbalho
Task Team Leader(s):	Karan Capoor

ABBREVIATIONS AND ACRONYMS

BP	Bank Procedures
CTF	Clean Technology Fund
DA	Designated Account
DFID	Department for International Development
DSD	Department of Sustainable Development
DP	Drilling Program
DPSP	Dedicated Private Sector Programs
E&S	Environmental and Social
ECD	Eastern Caribbean Dollar
ECERA	Eastern Caribbean Energy Regulatory Authority
EIRR	Economic Internal Rate of Return
EMC	Exploration Management Consultant
ENPV	Economic Net Present Value
ESA	Electricity Sector Act
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Energy Storage System
FIP	Forest Investment Program
FIRR	Financial Internal Rate of Return
FM	Financial Management
FMSB	Financial Management Sector Board
FNPV	Financial Net Present Value
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIT	Geothermal Implementation Team
GNI	Gross National Income
GoSL	Government of Saint Lucia
GWh	Gigawatt-hour
IDA	International Development Association
IFMIS	Integrated Financial Management Information System
IFR	Internal Financial Report
INDC	Intended Nationally Determined Contribution
IPF	Investment Project Financing
IRR	Internal Rate of Return
kV	Kilovolt
kWh	Kilowatt-hour
LiDAR	Light Detection and Ranging
LUCELEC	St. Lucia Electricity Services Limited
MoA	Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-operatives
MoESD	Ministry of Education, Innovation, Gender Relations and Sustainable Development
MoF	Ministry of Finance, Economic Growth, Job Creation, External Affairs and Public Service

MoIPEL	Ministry of Infrastructure, Ports, Energy and Labor
MW	Megawatt
MWh	Megawatt-hour
NEP	National Energy Policy
NPV	Net Present Value
NURC	National Utilities Regulatory Commission
O&M	Operations & Maintenance
OECS	Organization of Eastern Caribbean States
OP	Operational Policy
PAD	Project Appraisal Document
PCU	Project Coordinating Unit
PDO	Project Development Objective
PMA	Pitons Management Area
PPA	Power Purchase Agreement
PPCR	Pilot Program Climate Resilience
PPG	Project Preparation Grant
PPSD	Project Procurement Strategy for Development
PS	Permanent Secretary
PV	Photovoltaics
RAP	Resettlement Action Plans
RESD	Renewable Energy Sector Development
ROE	Return on Equity
RPF	Renewable Energy Sector Development
SAGS	Steam Above Ground System
SIDS-DOCK	Small Island Developing States (SIDS) Sustainable Energy and Climate Resilience Initiative
SREP	Scaling Up Renewable Energy in Low Income Countries Program
US	United States
USD	United States Dollar

BASIC INFORMATION

Is this a regionally tagged project?	Country(ies)	Financing Instrument
No		Investment Project Financing

[ ] Situations of Urgent Need of Assistance or Capacity Constraints

[ ] Financial Intermediaries

[ ] Series of Projects

Approval Date	Closing Date	Environmental Assessment Category
26-Apr-2018	30-Jun-2024	B - Partial Assessment

Bank/IFC Collaboration	Proposed Terms
No	Repayment of CTF contingent grant will occur within a period not to exceed seven years after comissioning of the geothermal plant.

Proposed Development Objective(s)

The development objective of the Renewable Energy Sector Development (RESD) Project is to support the Government of Saint Lucia to assess the viability of harnessing indigenous renewable energy resources, in particular geothermal energy.

Components

Component Name	Cost (US$, millions)
Exploration Drilling	15.525
Geotechnical Services, drilling infrastructure works, and shared services	4.850
TA for Project Implementation & Capacity Enhancement	2.000

Organizations

Borrower:	Ministry of Finance, Economic Growth, Job Creation, External Affairs and the Public Service Government of Saint Lucia
Implementing Agency:	Ministry of Education, Innovation, Gender Relations and Sustainable Development Project Coordination Unit

PROJECT FINANCING DATA (IN USD MILLION)

[✓] Counterpart Funding	[ ] IBRD	[✓] IDA Credit [ ] Crisis Response Window [ ] Regional Projects Window	[ ] IDA Grant [ ] Crisis Response Window [ ] Regional Projects Window	[✓] Trust Funds	[ ] Parallel Financing

Total Project Cost:	Total Financing:	Financing Gap:
22.375	22.375	0.00
	Of Which Bank Financing (IBRD/IDA): 5.00	

Financing (in US$, millions)

Financing Source	Amount
Borrower	1.000
Clean Technology Fund	9.525
Support for Small Island Developing States (SIDS) DOCK Support Program	1.850
Free-standing Single Purpose Trust Fund	5.000
International Development Association (IDA)	5.000
Total	**22.375**

Expected Disbursements (in US$, millions)

Fiscal Year	2018	2019	2020	2021	2022	2023	2024
Annual	0.01	1.00	0.45	1.43	1.15	0.82	0.14
Cumulative	0.01	1.01	1.47	2.89	4.04	4.86	5.00

INSTITUTIONAL DATA

Practice Area (Lead)

Energy & Extractives

Contributing Practice Areas

Gender Tag

Does the project plan to undertake any of the following?

a. Analysis to identify Project-relevant gaps between males and females, especially in light of country gaps identified through SCD and CPF

Yes

b. Specific action(s) to address the gender gaps identified in (a) and/or to improve women or men's empowerment

No

c. Include Indicators in results framework to monitor outcomes from actions identified in (b)

No

SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category	Rating
1. Political and Governance	Low
2. Macroeconomic	Substantial
3. Sector Strategies and Policies	Substantial
4. Technical Design of Project or Program	High
5. Institutional Capacity for Implementation and Sustainability	Substantial
6. Fiduciary	Substantial
7. Environment and Social	Substantial
8. Stakeholders	Moderate
9. Other	
10. Overall	Substantial

COMPLIANCE

Policy

Does the project depart from the CPF in content or in other significant respects?

[ ] Yes [✓] No

Does the project require any waivers of Bank policies?

[ ] Yes [✓] No

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

Legal Covenants

Conditions

PROJECT TEAM

Bank Staff

Name	Role	Specialization	Unit
Karan Capoor	Team Leader (ADM Responsible)	Coordination	GEESO

Mark Lambrides	Team Leader	Co-TTL	GEE04
Sonia Cristina Rodrigues Da Fonseca	Procurement Specialist (ADM Responsible)	Procurement Specialist	GGO04
Eduardo Franca De Souza	Financial Management Specialist	Financial Management	GGO22
Donghui Park	Team Member	CTF coordination	GGELI
Gerald William Huttrer	Team Member	Geothermal Technical Advisor	GEE04
Gloria Malia Mahama	Safeguards Specialist	Social safeguards Specialist	GSU01
Heike Irina Lingertat	Team Member	Renewable Energy Specialist	GEEX2
Jamil Sopher	Team Member	Financial Advisor	GEE04
Juliana Chinyeaka Victor	Team Member	Results Specialist	GEESO
Leesle Hong	Team Member	CTF and TF coordination	GEESO
Luisa F. Pacheco de Vincenzo	Team Member	ACS Support	GEE04
Martin Schroeder	Team Member	Energy Specialist	GEEES
Michael J. Darr	Safeguards Specialist	Environmental Safeguards	GEN04
Monyl Nefer Toga Makang	Team Member	CTF and Financial	GEESO
Samuel Kwesi Ewuah Oguah	Team Member	System Planning and Integration	GEESO
Thrainn Fridriksson	Team Member	Geothermal Specialist	GEEES

ST. LUCIA
RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT

TABLE OF CONTENTS

I. STRATEGIC CONTEXT

A. Country Context

1. Saint Lucia is an island nation in the Eastern Caribbean. It is an upper middle income country, with a population of approximately 185,000 inhabitants, with a Gross National Income (GNI) per capita and GDP of USD 7,350 and USD 1.43 billion respectively (2015). GDP growth reached 1.8 percent in 2015, but slowed to 0.8 percent in 2016, with transportation and hotels (tourism) largely contributing to the economic growth. The current account deficit has widened recently (2016) and the financial sector continues to be impaired by nonperforming loans and public debt continues to rise reaching 82 percent of GDP (2016) owing to non-concessional interest rates and low growth.[1]

2. The 2008 financial crisis had wide negative impacts on the Eastern Caribbean economies and recovery across the island nations remains fragile. Although Saint Lucia was less affected by the crisis compared to neighboring countries, unemployment in the country reached historically high levels of 24.4 percent in 2014, when youth unemployment, in particular, reached 41.8 percent. By 2016, overall unemployment had fallen to 22.1 percent.

3. The energy sector, particularly electricity, is a key contributor to economic activity and growth as it is essential for many sectors to thrive. While electricity is supplied reliably in Saint Lucia, it remains almost completely dependent on diesel-based generation, resulting in high electricity tariffs and substantial price volatility due to the exposure to world market oil prices (see figure 1 and 2 below). The volatile and high cost of electricity – in recent years in excess of USD 0.33/kWh, while currently USD 0.25/kWh – is a major impediment to investment that erodes the country's competitiveness, even as it seeks to attract a larger share of tourism revenues. High electricity costs weaken growth in business and services, create hardship and burden private consumers, especially the poor, while price volatility discourages local investments. A 2010 survey of businesses indicates that over 55 percent of the firms identified the high cost of electricity as a major constraint to doing business in Saint Lucia[2]. Although oil prices dropped dramatically until early 2016 before stabilizing at levels around USD 45/barrel, a fully diesel-based electricity supply remains costly and insecure as long-term price estimates continue to be both uncertain and significantly above current levels[3].

4. Saint Lucia's future competitiveness and growth potential is therefore highly dependent on its ability to ensure low and stable energy costs without over-dependence on fossil fuel imports and related exposure to global oil price fluctuations. Moreover, utilization of diesel for power generation results in local environmental impacts and also contributes to global climate change due to the emission of greenhouse gases (GHGs). Investments in renewable energy options can contribute to the government's objective of developing indigenous energy resources as a means of diversifying the current power supply mix and ultimately benefiting the consumer through low-cost and stable power supply

[1] See Annex 2 Debt Sustainability Analysis (DSA) for more information and impact of CTF grant on St. Lucia's debt sustainability.
[2] World Bank. 2010. "Enterprise Survey Country Bulletin: Saint Lucia."
[3] The World Bank Commodities Price Forecast (January 2016) estimate crude oil avg. spot prices at USD 55.8/barrel in 2020 and USD 82.6/barrel in 2025.

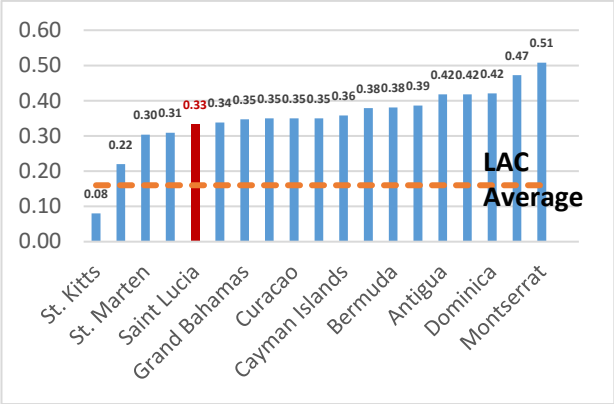

Figure 1: Electricity Tariffs in the Caribbean[4]

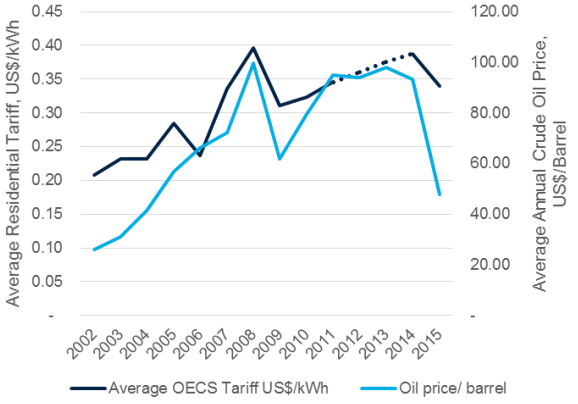

Figure 2: Correlation between OECS Tariffs and Oil Price

B. Sectoral and Institutional Context

5. Saint Lucia is highly dependent on imported fossil fuels to meet its energy demand and apart from limited usage of combustible renewables and waste, virtually all of its energy is imported, mainly from Trinidad and Tobago. Notwithstanding this situation, the island state has significant indigenous resources and potential for wind, solar, and geothermal energy. The dependence on oil for electricity generation and other energy needs leads to highly volatile prices in the sector with generation cost averaging between USD0.18-0.33 per KWh in recent years, as a result of the pass-through of diesel oil cost to the consumer. The overwhelming dependence on imported oil for electricity generation and other energy needs leads to highly volatile prices in the sector, even though the island state has significant resource potential for wind, solar, and geothermal energy which are largely untapped. Continuing on the path of potentially expensive fossil fuel-based generation could undermine the country's economic growth and development trajectory and calls for the consideration of viable, cost-competitive alternatives with the potential to boost competitiveness by reducing the island's vulnerability to highly volatile fuel prices.

6. The power system in Saint Lucia is small, with a peak demand of 60.3 MW and average demand of about 45 MW in 2016[5]. Peak demand has grown 2.2 percent from 2015 and overall power demand has increased at an average of less than 1 percent annually over the past five years[6]. St. Lucia Electricity Services Limited (LUCELEC) is majority privately owned and has the concession (established in 1994) to generate, transmit and distribute electricity in Saint Lucia until 2045. In addition to the government's 12.44 percent direct equity stake in LUCELEC, public institutions own an additional 33.12 percent through the National Insurance Corporation and the Castries City Council. New legislation, including the Electricity Supply Act and National Utilities Regulatory Commission (NURC) Act of 2016, allow LUCELEC to maintain their monopoly including fossil-fueled generation, but open opportunities for independent power producers (IPPs) for renewable energy generation.

Box 1: Enabling Environment for IPPs in Renewable Energy Generation

A clear policy and regulatory environment needs to be in place for a private sector Independent Power Producer (IPP) to invest in the development of generation from geothermal resources. Typically, private

[4] Source: Caribbean Electric Utility Services Corporation (CARILEC) Electricity Tariff Survey 2014 from www.investstlucia.com/downloads

[5] According to LUCELEC's Annual Report 2016 (http://www.lucelec.com/sites/default/files/documents/LUCELEC-2015-AnnualReport.pdf)

[6] Ibid.

investors will seek to confirm that the current legal and regulatory framework fully supports a privately-led geothermal power development, as well as project financing. Relevant pieces of enabling legislation including the Electricity Supply Act and its amendments and the new Geothermal Act (in preparation) will be key to their due diligence. Other requirements may include: (i) Attorney General's legal opinion if a waiver of sovereign immunity is required; (ii) confirmation that Saint Lucia is signatory to and has ratified international arbitration conventions (such as the New York Convention on Arbitral Awards) to ensure enforceability of international arbitration and other awards; and (iii) assurances with respect to currency convertibility and free transfer of funds (e.g. to redeem dividends to foreign shareholders).

7. In 2016, LUCELEC sold 348 GWh of electricity, a 3.2 percent increase from 2015, which was distributed among its 65,974 customers comprising 58,867 residential customers and 7,088 commercial and industrial customers[7]. To meet demand, LUCELEC operates 88.4 MW name-plate generation capacity at a single power plant, the diesel-fueled Cul De Sac Power Station, with actual firm generation capacity of approximately 68MW[8]. LUCELEC also operates and maintains a 66 kV transmission and 11 kV distribution network. LUCELEC's 66 kV transmission network runs close to the location of the areas of potential geothermal interest. In 2016, LUCELEC added 75 kW of solar PV generation capacity, which complements the approximately 500 kW of existing distributed solar PV throughout the country. The company further plans to add another 3 MW of utility scale solar PV.

8. Saint Lucia needs to make a firm investment decision on new and replacement capacity no later than 2020. This timeframe is important because of the need for sufficient lead time to procure the capacity to replace the aging existing diesel power plant. Based on current consumption and growth rates, and the old age and condition of the current 68 MW actual capacity diesel plant, Saint Lucia and LUCELEC need to make a firm investment decision on new capacity expansion no later than 2020. The utility has indicated a willingness to consider alternatives to the default option of a tri-fuel (natural gas, light fuel oil, or heavy fuel oil) fossil-based power plant in a manner consistent with GoSL's policy objectives.

9. Saint Lucia has completed initial geothermal surface exploration surveys, which indicate the presence of a possible geothermal resource with the potential of supporting an estimated 30 MW of generation capacity. While this is an exciting prospect, it signals the need for exploration drilling activities to explore and confirm the quality of the resource. Early geothermal drilling activities to assess the quality of the geothermal resource are inherently extremely risky ventures. Private geothermal developers typically require a higher risk premium in order to be compensated for the higher exploration risks borne by their early stage investments. International geothermal development experience shows that successful geothermal development has often relied strongly on public sector investments, with private sector investors entering the project at a more mature exploration and development phase, when the early resource risk has been significantly mitigated[9]. Studies conducted by the World Bank have indicated that access to low-cost financing at the upstream phases of project development has the highest impact on the likely end-price of electricity.[10]

10. Drawing upon the lessons of global good practice, the GoSL will invest public sector resources to underwrite drilling wells during the high risk initial exploration stage. The results of the drilling activities will provide invaluable input into the country's medium-to-long-term power generation plan, and will inform the country's upcoming investment decisions that will help determine the optimal mix of the different

[7] Ibid.
[8] Ibid.
[9] World Bank/ESMAP. "Comparative Analysis of Geothermal Resource Risk Mitigation Mechanisms: A Global Survey." Washington DC, 2016. Available at: *www.esmap.org/node/56863*
[10] ps://www.esmap.org/sites/esmap.org/files/DocumentLibrary/FINAL_Geothermal%20Handbook_TR002-12_Reduced.pdf

technologies available: thermal options versus renewable options, including geothermal, wind and solar. A viable and high quality geothermal resource, if confirmed through the drilling activities, will make it easier to attract private sector investment in subsequent phases of project development. However, given the small size of Saint Lucia's energy sector and the relatively limited investment opportunities for further scale-up, concerns remain that even if the resource is proven, it may still be challenging for Saint Lucia to attract private sector investment in subsequent phases of project development. For this reason, GoSL has recognized the need for active market engagement with the geothermal industry to create and sustain their interest. When accompanied by balanced agreements appropriately structured to allocate risks between public and private sectors, a well-structured process to manage geothermal resource and development risks can lead to significant cost savings that contribute to sustainable and affordable generation providing value for money for energy consumers. De-risking the field in this manner with the public sector assuming the initial drilling risk instead of the private sector which demand a high risk premium to compensate for taking the upstream risk, would reduce overall costs and increase the likelihood of attracting private investment reduces the need for private risk capital that comes at a much higher cost than public funding given the risk premium required by private investors to conduct exploration drilling.

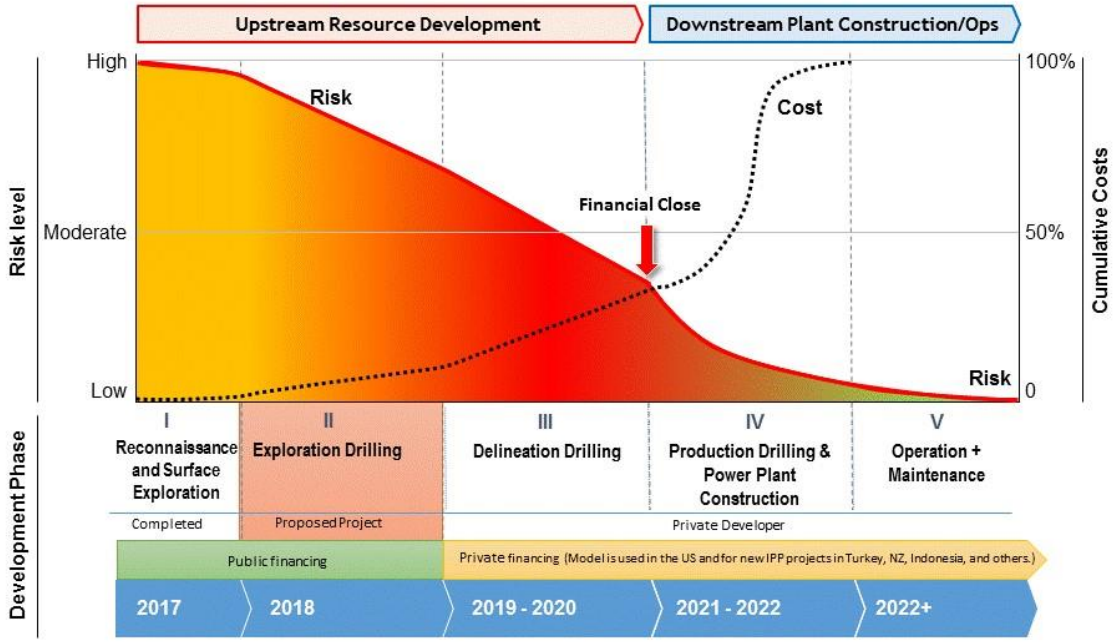

Figure 3: Geothermal Project Development Phases

11. Provided that the exploration drilling phase demonstrates a geothermal resource of high quality, the GoSL would invite a qualified private sector IPP developer to invest private capital into further developing the project's subsequent phases in a timely manner. The private sector developer would be expected to invest its own capital, within an agreed timeline, to conduct any additional drilling or other activity to confirm availability of sufficient quantity of steam to support a feasible and bankable generation capacity. The private developer would also invest in production and injection wells prior to developing the steam collection infrastructure and the power plant.

12. If successfully confirmed and developed, a geothermal facility of an estimated 30 MW is likely to be at a scale that is cost-effective, and will help Saint Lucia transform its energy sector from negligible levels of

renewable energy today, to as high as 65-70 percent of renewable energy generation. Furthermore, along with geothermal energy, the share of renewables can be even higher if solar and wind resources are also developed at scale and properly integrated into the grid with additional battery storage capacity. If geothermal or other renewables are viable, it would avoid locking-in carbon-intensive, oil import dependent electricity generation for years to come. If geothermal energy is found to be unviable, the country will need to invest in a scale-up of solar and wind power and will need to integrate these intermittent resources with investment in additional battery storage capacity in order to integrate these in the grid. In each scenario, investment in battery storage capacity can help maximize the amount of dispatchable renewable energy and minimize the need for new fossil fuel generation.

13. Given the inherent uncertainty of exploration drilling, it is plausible that the proposed project will be inconclusive about the quality of the resource, or find that there is insufficient resource capacity to support viable and cost-effective power generation. In the event that the results of the Drilling Program (DP) do not confirm the projected geothermal resource, the government may tap additional resources (from IDA and elsewhere) to support the scale-up of renewable solar energy to help meet its renewable energy targets. In a no geothermal scenario, the costs of solar technology and battery storage are assumed to continue to decline, making a solar-plus-storage combination a viable complement to a smaller sized investment in tri-fuel fossil generation.

C. Higher Level Objectives to which the Project Contributes

14. The proposed Renewable Energy Sector Development Project in Saint Lucia is fully consistent with the objectives of the World Bank's OECS Regional Partnership Strategy (RPS) for the period 2015-2019. The high-level objective of the RPS is to assist the countries in laying the foundation for a return to sustainable inclusive growth after the negative effects of the global financial crisis in line with the Bank's twin goals of poverty reduction and shared prosperity. In order to achieve this objective, the RPS identifies three thematic areas for support (a) enhancing productivity, competitiveness and employment; (b) modernizing the public sector; and (c) building social and climate resilience. To this end, the RPS will support activities aimed at contributing to more predictable and lower energy prices to enhance competitiveness and inclusion and specifically mentions the objective of advancing geothermal development in the region.

15. The proposed project is consistent with GoSL's national energy policy objectives and will enable a process leading to the implementation of Saint Lucia's Nationally Determined Contributions (NDC) adopted in connection with the 2015 COP 21 Paris climate change agreements. The development of indigenous geothermal energy will reduce the need for fossil fuel imports, thereby contributing to greater fiscal sustainability. More stable and cheaper electricity will translate into electricity costs for household consumers and for the productive sectors, thereby increasing their competitiveness. Presently, Saint Lucia's diesel power plant is located at one location, making power supply vulnerable to extreme climate events, such as hurricanes. With the introduction of a geothermal plant, it would enhance Saint Lucia's climate resilience through lowering the risk of energy supply disruptions due to extreme weather events.

II. PROJECT DEVELOPMENT OBJECTIVES

A. PDO

16. The development objective of the Renewable Energy Sector Development (RESD) Project is to support

the Government of Saint Lucia to assess the viability of harnessing indigenous renewable energy resources, in particular geothermal energy.

B. Project Beneficiaries

17. The proposed project has great transformation potential, which could bring social, economic, and health benefits arising from clean and cost effective renewable energy. Direct project beneficiaries include all existing and prospective electricity customers in the country, and, in particular, residential household customers, who will greatly benefit from lower and more stable electricity prices once diesel generation capacity used for baseload needs is displaced with cost-efficient indigenous geothermal capacity. The displacement of polluting diesel generation capacity with renewable geothermal energy will reduce the carbon footprint of electricity generation in Saint Lucia, with both global and local environmental benefits.

C. PDO-Level Results Indicators

Key Results Indicators

18. The following are the expected key results of the proposed project:

(a) Evidence provided to the GoSL for its decision on whether to proceed with the development of the geothermal power plant;
(b) If geothermal resource is confirmed, the government will invite a qualified private sector entity for further development; and
(c) Knowledge and capacity built to address regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration.

Intermediate Results Indicators

19. The following are the expected intermediate results of the proposed project:

(a) Exploration Management Consultant (EMC) in place;
(b) Drilling contract signed for DP;
(c) A technical advisory panel led by EMC and relevant stakeholder representatives established; and
(d) A minimum of two slim exploratory wells drilled to a depth of around 2,000 meters.

III. PROJECT DESCRIPTION

20. Geothermal development in Saint Lucia has a long history and there have been numerous efforts to explore the country's resources in the past. The Sulphur Springs area in the south-western part of the island had long been considered the center of geothermal potential in Saint Lucia. It has been studied since 1951 via reconnaissance investigations sponsored by the United Nations, and via drilling in the 1970s and 1980s. The previous drilling in the Sulphur Springs area did not validate all major field characteristics necessary to confirm commercial viability, and the location of the previous areas of interest lay in Sulphur Springs within the Pitons Springs within the Pitons Management Area (PMA), which is a UNESCO-designated World Heritage Site.

21. From 2014 to 2016 the Government of Saint Lucia (GoSL), with support from the World Bank and the Government of New Zealand, identified and carried out a new surface exploration campaign. The findings from these surface exploration studies suggest the possible existence of a geothermal reservoir that had not been identified by previous studies. The geoscientific studies included geologic mapping, geochemical sampling of thermal waters, aeromagnetic surveys, a LiDAR survey, and magneto-telluric studies. The synthesized results of these investigations revealed the existence of a 1,000-2,000 meter thick low electrical resistivity horizon overlying a higher resistivity body. The low resistivity horizon extends broadly beneath an area bounded by Fond St. Jaques on the northeast, Belle Plaine on the northwest, and Saltibus on the south. This horizon has been interpreted to be impermeable, altered rock created by contact with fluids and/or gaseous emanations from an underlying geothermal reservoir. The subsurface electrical resistivity patterns in this area are consistent with the existence of a geothermal reservoir. However, the lack of major surface manifestations in the prospect area is a risk factor that needs to be mitigated prior to proceeding with the full financing and development of a geothermal power plant. This potential resource is located approximately 10-15 km ESE of the Sulphur Springs (Area 1a and 1b in figure 4), which makes it possible and attractive to pursue exploration drilling outside of the PMA.

22. Following international good practice, GoSL plans to implement the drilling program using public resources to finance the drilling of two to five deep exploration wells to a depth of around 2000 meters). The proposed project intends to confirm the quality of the geothermal resources through a publicly financed exploration drilling program in the areas (Areas 1a and 1b of Figure 4) where recently concluded preliminary surface studies suggest the possible existence of a geothermal reservoir.[11] Given the high risk involved in the early stage of the geothermal project, public sector de-risking of the field by funding the initial exploration drilling needed to confirm the characteristics and profile of the resource base is needed. This will in turn mitigate some of the early stage high resource risks associated with developing the first geothermal power plant in Saint Lucia, thereby strongly improving the overall economics of geothermal development and facilitating attracting additional private investment for subsequent stages of development. A DP report at the conclusion of the drilling phase will provide sufficient data and information to determine, with a relatively high degree of confidence, whether a geothermal resource of sufficient quality for further development exists. If a high quality geothermal resource is confirmed, the GoSL would invite a qualified private sector Independent Power Producer (IPP) developer to invest private capital into further developing the project in a timely manner. The proposed operation also includes financing for geotechnical services and enabling shared infrastructure for the drilling program, as well as for implementation support and technical assistance.

23. The private sector developer would be expected to invest its own capital for any necessary next stages of delineation drilling and flow tests that may be needed to confirm availability of sufficient quantity of steam to support a feasible generation capacity. If found feasible, the government and the private developer will finalize agreements such as the Geothermal Development Agreement (GDA) and the Power Purchase Agreement (PPA), followed by the developer's investment in production and injection wells and subsequently, in the steam collection infrastructure and the power plant.

24. The proposed project has two components. Component 1 consists of (a) the design, validation, launch, implementation and supervision of a drilling program, to be undertaken by the GoSL; and (b) the procurement of shared infrastructure which will facilitate the integration of renewable energy in Saint Lucia's power system. Component 2 will include implementation capacity enhancement activities and a TA program to strengthen the GoSL's implementation, technical, and fiduciary capacity to support the program.

[11] Soufriere Geothermal Resource – Integrated Exploration Report

A. Project Components

Component 1: Exploration Drilling for Resource Discovery, EMC, Geotechnical Services, Drilling Infrastructure Works, and Shared Infrastructure (total USD 20.375 million). This component will finance the following activities:

25. Component 1 of the proposed project comprises all activities related to the geothermal exploration drilling to assess and confirm the suitability for development of an estimated 30 MW geothermal power plant.

Subcomponent 1.1: Exploration Drilling and EMC (total USD 15.525 million: USD 8.572 million contingent grant and USD 0.953 million project preparation grant from CTF, USD 5 million DFID grant, USD 1 million IDA credit).

26. The subcomponent will support the appointment of a drilling contractor to confirm a drilling program, conduct drilling activities of estimated two to five slim-holes at a depth of approximately 2,000 meters, and confirm the quality of geothermal resource. Drilling at this depth will help transect the low resistivity horizon and penetrate the presumed reservoir. These drill holes will yield significant information regarding rock types, temperatures, fluid and gas chemistry as well as indications regarding rock permeability. Though these drill holes may eventually become usable for injection, they will probably not be appropriate for thermal fluid/steam production. It is anticipated that the precise locations of these drill holes will be identified in the Pre-Feasibility Report which is being undertaken and financed by the ongoing Geothermal Resource Development Project (GRDP) (P149959), a TA program supported by the World Bank.

27. Exploration drilling entails a certain degree of unpredictability, and good practice examples from Turkey, Armenia, Philippines, and Nicaragua, indicate that proper implementation of a drilling campaign requires flexible design and the ability to accommodate adjustments to the original drilling plan based on initial findings. For example, the location or results of the initial first or second drilling well(s) might prove to be inconclusive and an additional well(s) may be needed for final confirmation. Decisions on any needed adjustments will be made by the government based on recommendations by its appointed technical team led by the EMC and in consultation with the drilling contractor. In addition, the cost of drilling wells to target depth will be sensitive to the time it takes to drill the wells as drilling contracts are generally time-based. Delays may occur during drilling for a variety of reasons, e.g. due to subsurface conditions that cannot be predicted prior to drilling, when permeable formations are intersected and need to be plugged by cement to continue drilling. Such adjustments and delays may impact the drilling program's ultimate cost, and for this reason, a small level of contingency has been built into the design of this component, including for cost and financing estimates.

28. A report on the quality of the geothermal resource measured against technical indicators (see box 2 below) will be produced at the end of the drilling program by the drilling contractor. The report will be validated by the EMC in close consultation with the technical advisory panel and the decision to proceed to the next stage will be made by the GoSL taking into account the technical indicators and other factors, including private sector readiness. The information captured in the DP report will also help facilitate knowledge sharing and capacity building within the wider Caribbean region.

Box 2:Technical Indicators for well-testing

Technical Indicators for well-testing
a) At least two wells drilled at a depth of approximately 2,000 meters; b) Temperature logs collected (static and dynamic) allowing determination of formation temperature and the temperature of producing aquifers (if present); c) Pressure logs collected and well head pressure after heating measured;

d) Drilling parameters (most importantly loss of circulation) carefully collected throughout the full depth of the well;
e) Samples of the geothermal fluid (steam and liquid) collected and analyzed;
f) Drill core retrieved and lithology and hydrothermal alteration logged; and
g) Observed lithology, alteration and subsurface temperature correlated to surface exploration data.

29. This subcomponent will finance the services of an EMC firm (referred to above), to be engaged by the project for a period of 24-30 months to help procure and oversee the drilling program on behalf of the government. GoSL is mindful of the time constraints that LUCELEC faces to make necessary investments that will define the country's energy mix over the next 15 to 20 years. This makes it imperative to begin the process of conducting geothermal exploration as soon as possible and to implement the exploration process efficiently to obtain sufficient and timely data and information about the resource for a qualified private developer to make a decision about investing private resources for its further development. The terms of reference of the EMC will be prepared under the current TA program and the procurement process of a qualified consultant will be financed using grant resources, e.g. the CTF Project Preparation Grant (PPG) and other grant resources, such as those provided by SIDS-DOCK, DFID and the contingency recovery grant of Clean Technology Fund (CTF) under this subcomponent.

30. The EMC will a) prepare the tender documents for the drilling contractor so that the procurement process and evaluation can be conducted and the selected contractor can be appointed immediately upon effectiveness of the proposed project; b) review the findings from the Pre-Feasibility study under preparation and finalize the Pre-Feasibility report; c) convene a technical advisory panel comprising of multidisciplinary stakeholders to guide the implementation of the drilling program, including any changes to the plan during implementation; and d) Finalize the exploration drilling report in close cooperation with the drilling contractor, on the basis of which a qualified private developer will be invited to invest in the next phase of the geothermal development process, including any delineation drilling. EMC staff will include those familiar with application and supervision of World Bank fiduciary guidelines (including social and environmental safeguards, financial management and procurement). In addition, the EMC will provide on-the-job mentorship to local staff, including those from the Renewable Energy Unit, to enhance local project management capacity. Access to land required to conduct the drilling program, including any costs of land acquisition required for implementation of the DP, will be financed directly by the GoSL.

Subcomponent 1.2: Geotechnical Services, Drilling Infrastructure Works, and Shared Infrastructure (total USD 4.85 million: USD 4 million IDA credit and USD 0.85 million SIDS-DOCK grant).

31. This subcomponent will finance geotechnical services and drilling infrastructure works (access roads, well pads, water supply, etc.). The exact scope, location and costs of these investments for the envisaged drilling program will be identified and defined in the Pre-Feasibility study and confirmed by the EMC in consultation with the drilling contractor. The pre-Feasibility study is currently underway as part of an ongoing World Bank TA support.

32. The proposed project includes provision for public investment in shared infrastructure services which will enable the proper integration of renewable energy, such as geothermal, solar and/or wind into the grid. Costs related to shared infrastructure services will include a share of costs related to transmission interconnects and the purchase and installation of battery storage capacity.

33. Battery storage will provide necessary capacities to deliver sufficient spinning reserve to replace stand-by diesel generating capacity during off-peak hours; and to allow for ramp-up of diesel generation in order to complement geothermal energy to meet peak loads. In addition, battery storage can help improve grid stability to enable the future addition of intermittent renewable energy resources. By the time geothermal generation is expected to come on-line, battery storage prices are expected to decline considerably from current levels, offering the possibility of more storage capacity in that time-frame for the same level of investment. Sufficient battery storage capacity will allow LUCELEC to minimize the needs for investment in diesel generators that would otherwise be required to provide spinning reserve coverage for integration of geothermal energy and other renewables[12]. This will result in significant savings in diesel fuel costs, which could then be passed on to consumers. Battery storage will also help integrate intermittent renewables to the grid. Currently available data indicate a likely cost of USD 400-500/kWh for storage capacity using lithium-ion batteries. This implies a cost of around USD 3 to 3.75 million for 7.5 MWh of storage capacity installed, and up to USD 5 million if up to 10 MWh of storage capacity is to be installed.[13] The cost of battery storage is anticipated to decline in future years.

Component 2: Implementation Capacity Enhancement, Technical Assistance, and Market Engagement (total USD 2 million: USD 1 million GoSL co-financing and USD 1 million SIDS-DOCK grant).

34. Given the time sensitivity and the technical nature of the geothermal exploration process, Component 2 will include resources to support a dedicated Geothermal Implementation Team (GIT), alongside the Renewable Energy Unit in the Department of Sustainable Development. The GIT will have at its disposal the EMC team to provide the project with technical implementation capacity, and will procure or second persons with dedicated fiduciary capacity (e.g. Financial management, procurement and safeguards capacity). In addition, this component will include technical assistance to provide studies and reports that will be necessary to fill any gaps in market, regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration.

Subcomponent 2.1: Support for Geothermal Implementation Team

35. Saint Lucia is in the process of establishing a dedicated GIT alongside the Renewable Energy Unit in the Department of Sustainable Development (DSD) within the MoESD. DSD/GIT will provide overall project management and technical inputs on behalf of GoSL, and will be responsible for safeguards, procurement, and financial management services. This subcomponent will finance a) the recruitment costs of GIT staff, e.g. project director and officers, including, as needed, additional capacity from specialists in applying World Bank social and environment guidelines, as well as additional procurement and financial management capacity; b) operational costs related to the establishment and operations of the GIT and its technical and fiduciary functions; and c) training programs for GoSL officials, including staff of the Department of Sustainable Development, GIT, and LUCELEC. The training programs, which may include observational study tours, will provide structured learning workshops on a variety of topics associated with geothermal and renewable energy development, e.g. the geothermal exploration process, grid operations to integrate renewable energy, evolving models for energy delivery, as well as World Bank-related fiduciary, social, and environmental issue.

[12] For a geothermal power plant of 30 MW base-load generation capacity, assuming 2 x 15 MW generating units built by the developer, spinning reserve would be required to cover the loss of a single generator for as long as it would take to start and run up sufficient stand-by diesel generating capacity to replace the lost generator. Battery storage could provide sufficient spinning reserve to cover the start and run up of sufficient stand-by diesel generating capacity. The start-up would probably take around 20 minutes, but due to the fact that the MW output of the battery would decline as the charge is drawn down, a conservative estimate of 30 minutes has been applied. Thirty (30) minutes of 15 MW power would require 7.5 MWh of storage capacity.

[13] This estimate does not include battery replacement costs, which are expected to come down further over the next several years.

The subcomponent will also finance c) GIT's gender integrating activities, with collaboration from the relevant stakeholders, which will promote job creation and training to provide equal opportunity to persons from both genders; and d) development of a communication strategy regarding the opportunities presented by the geothermal exploration drilling project and address any community concerns (e.g. concerns regarding potential impacts related to the development of geothermal energy.

Subcomponent 2.2: Technical Assistance and Market Engagement.

36. While much of the emphasis of the project will be on demonstrating the technical viability for geothermal development, notably by drilling exploratory wells, the project will also support activities to improve the market conditions for investing in geothermal. These activities will focus on the policy environment (laws and regulations), cost of service comparisons, grid integration studies, and other market engagement efforts. The ongoing Eastern Caribbean Energy Regulatory Authority (ECERA) is supporting the review and preparation of a broad set of regulations for the power sector. ECERA support will not include analysis specific to the needs for geothermal power production. Several other analyses and technical assessment activities to be supported by this subcomponent are essential to ensuring that the market conditions are adequate to attract investment for a geothermal power project. With resources provided under the proposed project, GoSL will review existing electricity legislation and draft geothermal specific laws and regulations that are essential for the proper governance of geothermal resources and power generation. The analysis and recommendations will be developed in coordination with the National Utility Regulatory Commission (NURC). Other areas include the specification of battery requirements, including replacement, operation and maintenance, disposal and regulatory support, as needed. The precise scope of these assessments will be prepared during the project preparation phase and the necessary breadth and depth of the efforts will be adjusted to comply with the available budget ($2 M), while ensuring the top priorities for achieving the PDO are met. The following studies and activities will be supported under this subcomponent:

37. **Legal and Regulatory Analyses.** The revised Electricity Supply Act (ESA) allows for limited competition in renewable energy generation, including for geothermal power. However, the specific legislation and regulations that govern the exploration for geothermal resources and the production of geothermal power have not been implemented. This subcomponent will finance studies to ascertain and recommend the necessary laws and regulations to create the market conditions conducive to geothermal exploration and generation. This activity will be undertaken in coordination with the Ministry of Infrastructure, Ports, Energy and Labor (MoIPEL), which is the lead agency for ECERA project in Saint Lucia. Further, on regulatory matters it will coordinate with the National Utility Regulatory Commission (NURC) which has responsibility for implementing energy sector regulations. In addition, a cost of service study will be financed in cooperation with LUCELEC.

38. **Evolving business model of LUCELEC.** The potential for a dramatic increase of renewable energy sources in Saint Lucia's energy mix has critical implications for LUCELEC's financial and operational planning processes. The revised Electricity Supply Act (ESA) allows LUCELEC to retain its monopoly in fossil fuel generation, but allows for competition in renewable energy generation. It is important to study how LUCELEC can develop an attractive value proposition consistent with the deployment of renewables in Saint Lucia. In this context, the increase in renewable energy generation will dramatically change LUCELECs business with implications for its operating model going forward. This includes not only addressing the role of geothermal energy and grid-connected renewables such as solar and wind, but also the role of decentralized customer-site rooftop and community solar as well as energy efficiency. Commissioned studies will evaluate and develop a financial model to quantify and better understand the financial implications of renewable energy generation, energy efficiency measures, and distributed generation on the utility and ratepayers, and to align utility return

motivations with the country's policy goals.

39. **Integrating Renewables into the grid.** The proposed construction of a privately owned and operated geothermal power plant and future addition of solar and wind power will bring with it the need to assess requirements for investment in the grid and to enhance grid operating capacity. Other operational planning decision areas could be such as forecasting renewable energy deployment, ensuring robustness of decisions to integrate uncertain renewable load quantities, incorporating the non-dispatchability of renewables into planning, the specification of battery requirements, accounting for location-specific factors, estimating the impact on transmission and distribution investments, and integrating in renewables into planning across generation, transmission, and distribution as well as the specifications of battery requirements.

40. **Market engagement activities.** Given the limited scale opportunities for power generation in Saint Lucia, which would limit potential private sector interest, GoSL is taking the issue of securing private sector participation seriously. GoSL, along with LUCELEC, will engage with private sector entities in the geothermal market through reports, presentations, prospects, and other materials presented at industry and financier conferences, road shows, workshops and using various media and communication channels to bring the project to the attention of potential investor and developer communities and help secure the interest of potential developers to participate in subsequent phases of geothermal development. Market engagement will be conducted to obtain and benchmark relevant market data from similar projects, and to generate reports with information including costs and Power Purchase Agreement (PPA) terms, which will be invaluable inputs to ensure that Saint Lucia obtains value-for-money from its geothermal development process. Sustained engagement would provide an opportunity for GoSL to meet and interact with private sector representatives (international project developers) as well as with representatives of civil society in Saint Lucia (e.g. Consumers Association), to share and discuss the ongoing progress and findings of the DP process. Finally, GoSL and LUCELEC, along with their transaction advisors providing technical, financial and legal support, will engage with private developers to prepare for negotiation of key documents and agreements for subsequent stages of project development, e.g. Geothermal development agreement, Power Purchase Agreement (PPA), etc.

B. Project Cost and Financing

41. The total project cost is USD 22.375 million, comprising of USD 5 million of IDA credit, USD 8.572 million of CTF contingent grant, USD 0.953 million of CTF PPG, USD 5 million of grant funding from DFID, USD 1.85 million of grant funding from SIDS-DOCK and co-financing of USD 1 million from the GoSL.[14] Table 1 presents a breakdown of the project costs by funding sources, throughout all phases through power plant development. The current phase (USD 22.375 million) is represented by Components 1 and 2, and will help leverage an additional USD 151.5 million from the private sector, if the project is fully developed. Cost shaded areas, in the table, represent expenditures that have been incurred in the now completed surface exploration phase and estimates for the delineation drilling, production drilling and power plant construction, and are presented for informational purposes only. These costs are not part of the proposed drilling project, but are reflected as estimates for the overall geothermal investment, including expected private sector investments.

[14] The amounts reflected for CTF and SIDS DOCK funding are net of MDB fees as per applicable guidelines for grants.

Table 1: Indicative Project Cost and Funding Sources (USD 22.375 million)

ACTIVITY	PROJECT COST	GoSL/ IDA Credit	DFID Grant	SIDSDOCK Grant	CTF DPSP	GEF/ Others	Private developer
Surface Reconnaissance (ongoing TA)	3.6	0.3		1		2.3	
COMPONENT 1							
Exploration Drilling for Resource Discovery	15.525	1	5		9.525		
Shared Services	4.85	4		0.85			
COMPONENT 2							
TA and Project Implementation Capacity Enhancement	2	1		1			
TOTAL PROJECT COST	**22.375**	**6**	**5**	**1.85**	**9.525**	**0**	**0**
Delineation drilling incl. flow test	28.5						28.5
Production Confirmation Drilling*	28.5						28.5
Power Plant, SAGS, and make-up wells over 25-year time period (≈30MW)**,	94.5						94.5
TOTAL PROJECT COST INCL. PRVATE SECTOR INVESTMENT	**178.1**	**6.3**	**5**	**3**	**10**	**2.3**	**151.5**

* indicative cost estimates, to be refined during project preparation
** illustrative costs, subject to revision based on feasibility study

C. Lessons Learned and Reflected in the Project Design

42. The proposed project addresses lessons learned from prior geothermal projects globally and from interaction with well-reputed geothermal developers. Studies conducted by the World Bank have indicated that access to low-cost financing at the upstream phases of project development, namely, the exploration phase, which is the riskiest and most uncertain part of geothermal development, has the highest impact on the likely end-price of electricity once geothermal capacity displaces diesel-based generation.[15] Unless concessional financing for de-risking much of the exploration process occurs, the alternative would be to attract private resource capital for exploration drilling, which is the riskiest phase of project development. Private resource capital typically commands a higher risk premium to be compensated for the higher exploration risks borne by their early stage investments. The high-risk premium will result in increased cost to the consumer through a higher off-take price of electricity even in the case of successful exploration. For this reason, governments have found it worthwhile to invest public resources to underwrite the high-risk exploration stage.

43. Although the modalities of public sector engagement have differed significantly from one country to another, most geothermal development globally has relied on some form of public funding support to the

[15] https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/FINAL_Geothermal%20Handbook_TR002-12_Reduced.pdf

high-risk upstream development phase. The approach taken in this project, where public funds are used to finance the exploration drilling and private investors will subsequently develop the resource for power production, if feasible, corresponds closely with successful approaches in Turkey and Kenya. Demonstration of the existence of viable geothermal resources through publicly financed initial exploration drilling was, in both cases, key to attracting qualified private sector developers. In the case of Kenya, KenGen's initial investment in exploration activities in Olkaria helped attract Ormat, a private geothermal company, to invest in steam collection and an initial 6 MW power generation facility through OrPower 4. As the private developer grew more familiar with the field at Olkaria III, Ormat gradually invested in further exploration and in additional infrastructure to expand power generation over time to its current PPA supplying 139 MW to Kenya Power.

44. Prior experience with geothermal projects, such as Turkey, Armenia, Philippines, Indonesia and Nicaragua, show that exploration drilling always entails a certain degree of unpredictability. The adopted exploration drilling plan may require adjustments based on initial findings and delays may occur during drilling due to subsurface conditions that cannot be predicted prior to drilling. For this reason, the proposed project is designed with a degree of flexibility, including a small level of contingency for drilling costs to accommodate unpredictable changes or adjustments based on initial findings from the drilling.

45. The challenges faced in attracting qualified private geothermal developers (e.g. in Indonesia and Dominica) indicate the importance of engaging the potential developer community as early as possible to help secure private sector participation and investment in subsequent phases of project development. Given the limited scale opportunities for geothermal power generation in Saint Lucia, which has been demonstrated to limit potential private sector interest in neighboring countries such as Dominica, the proposed project includes a component of technical assistance to conduct market engagement activities and to identify regulatory gaps for private investment in the sector.

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

46. The project is proposed to be implemented by the DSD, within the MoESD. DSD is led by a Permanent Secretary (PS-DSD), and is responsible for renewable energy policy and implementation in Saint Lucia. The PS-DSD will convene an advisory committee comprising of relevant stakeholders, including representatives of the Department of Economic Planning & National Development in the Ministry of Finance, Economic Growth, Job Creation, External Affairs and Public Service (MoF) and the Public Utilities Commission in the MoIPEL, among others, who may be consulted.

47. DSD will establish a dedicated Geothermal Implementation Team (GIT) to be headed by a Project Director who will be accountable to the PS-DSD for all aspects of project implementation and management, including technical and fiduciary coordination. Given GoSL's limited technical capacity for overseeing and implementing a geothermal exploration program of this complexity, the DSD/GIT will procure the specialized capacity and skills of an EMC to enhance GoSL's capacity to implement and oversee the drilling program (DP). The scope of the EMC will include design of specifications for the engagement of a drilling contractor as well as to oversee the drilling campaign. The project design provides for the procurement of the EMC in time for the completion of the pre-feasibility study and the ESIA, so that preparation for the DP can begin in a timely manner, starting with the procurement process of the drilling contractor utilizing approved CTF PPG and SIDS-DOCK funds prior to Board or through retroactive financing of eligible activities defined and agreed with the

Bank prior to Board approval.

48. The GIT Project Director, through the EMC, will convene a multidisciplinary technical advisory panel to guide the final design, implementation and the need for adjustments related to the exploration drilling program. The technical advisory panel will include representation from the drilling contractor, LUCELEC, PMA and other experts to facilitate discussion and resolution of issues and to provide input, advice and recommendations related to the exploration drilling program, including on any adjustments that need to be made in the drilling campaign. The DSD through the GIT will also engage frequently with private sector geothermal developers and representatives of civil society (e.g. the Consumers Association) to inform and consult with these stakeholders about the progress of the exploration drilling process and implications for future development.

49. As the project's lead implementing agency, DSD will have the responsibility of managing the process of implementing the project consistent with World Bank guidelines, procedures and practices for environment and social safeguards (including resettlement, if needed), procurement, disbursement, accounting, and financial management. In the interim, and until final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the Project Coordination Unit (PCU) linked to the MoF, and/or through the engagement of specialized consultants with the necessary skills. It is to be noted that the PCU currently administers all existing World Bank loans and grants, including for the ongoing GRDP TA project, and has dedicated staff that benefit from the experience of implementing World Bank projects for the past 15 years. However, the PCU is overloaded with heavy responsibilities, making it important to consider dedicated alternatives to support the DSD in performing the fiduciary requirements that are expected due to the additional workload and the complexity arising from the proposed highly specialized geothermal exploration project.

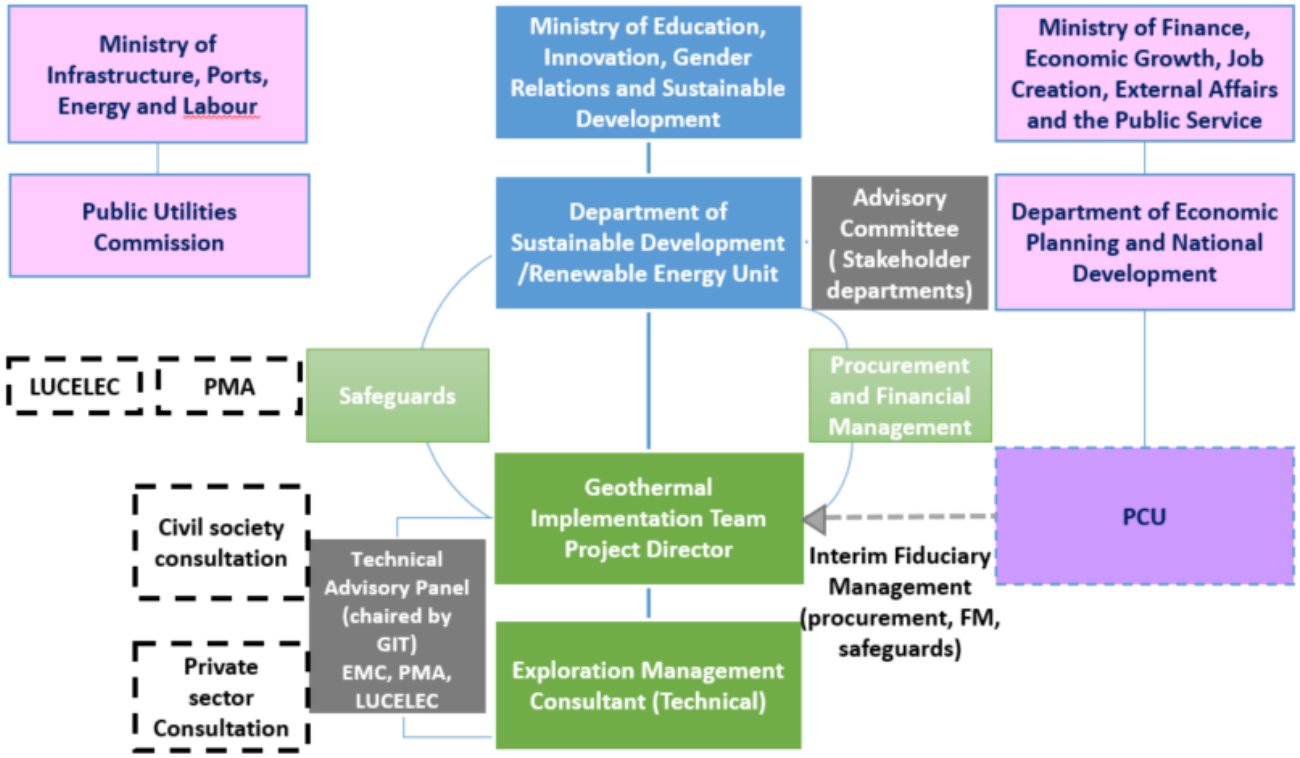

Figure 4: Project Implementation Arrangements

50. LUCELEC will play a key role in the geothermal power off-take and its integration in the electricity supply system to support the GoSL's renewable energy policy goals. However, despite the utility's strong experience in power sector operations, neither the GoSL nor LUCELEC has prior experience in geothermal development or in negotiating a suitable off-take agreement. Nonetheless, once completed, LUCELEC, as system operator, will integrate the geothermal plant's output into the domestic electricity network. As DP implementation progresses, the GoSL will explore alternative models for future implementation, including, among others, a Special Purpose Vehicle (SPV) to implement the geothermal project or, alternatively other arrangements, e.g. a joint venture with the government and/or LUCELEC working in strategic partnership with a qualified private developer.

B. Results Monitoring and Evaluation

51. A results and monitoring framework to document and measure the project's development impact has been discussed with GoSL and the co-financiers, and will be confirmed during appraisal and negotiations. The results and monitoring framework will identify results indicators for the project as a whole, as well as intermediate results. The implementing agency and the Bank will confirm target values for the various results indicators and the project implementation manual will document the arrangements for results monitoring with institutional responsibilities.

C. Sustainability

52. The Government has expressed its strong support for the development of renewable energy, including geothermal resources, with the intention of handing over further development of the geothermal project to a qualified private sector project developer after the completion of the drilling program. To this end, GoSL has been working with a range of developing partners to conduct a systematic and phased risk-based approach to project development, including identifying and undertaking various enabling and capacity strengthening activities. Having properly concluded the surface exploration studies, the government is launching both the Environmental and Social Impact Assessment (ESIA) and the Pre-Feasibility study for geothermal power development.

53. LUCELEC's time-frame for decision-making on its future generation capacity and the engagement of the private sector will need the exploration process to be implemented efficiently. The proposed project will provide ongoing support to the GIT in the areas of implementation, procurement and financial management. In addition, designed implementation support activities will provide structured learning workshops on a variety of topics associated with geothermal and renewable energy development, and the EMC will provide on-the-job mentorship to local staff (including those from the Renewable Energy Unit) to enhance local project management capacity. GoSL has prepared and will review and revise various initial financial models in anticipation of project agreements, and will develop a draft concession agreement/Geothermal Development Agreement (GDA) and a draft Power Purchase Agreement (PPA) for the off-take of the geothermal power output which will be required for subsequent engagement with a suitable private developer. After the exploration project is initiated, the GoSL will explore alternative models for future implementation, including a Special Purpose Vehicle (SPV) to implement the geothermal project or, alternatively, a joint venture with the government working in strategic partnership with a private entity. Finally, the project is designed to increase knowledge and capacity for expanding renewables, beyond geothermal energy development. The capacity created for renewable energy development will benefit Saint Lucia regardless of the results of the exploration process.

D. Role of Partners

54. Development partners share a common understanding of the opportunities and challenges attached to geothermal development in Saint Lucia, and will continue to play an important role going forward. Concessional finance and grants provided by IDA, DFID, CTF, and SIDS-DOCK are critical to enabling public sector financing of the geothermal exploration phase without placing undue burden on the government budget. The proposed project provides an ideal platform for current partners to come together and deploy their respective support in complementarity with one another and based on their respective comparative advantages. This platform with a shared understanding of the role geothermal energy can play in transforming St Lucia's energy future, promises to greatly enhance the effectiveness and impact of any one partner working alone.

55. The Dedicated Private Sector Program (DPSP) was established under the umbrella of the Clean Technology Fund (CTF), with a view to finance programs or operations that can deliver scale in terms of development results and impact, private sector leverage and investment from CTF financing. On October 28, 2013, the CTF Trust Fund Committee approved an allocation of USD 115 million dollars for Phase I of a Utility-Scale Renewable Energy Program with the objective of mitigating drilling risks in geothermal project development. These funds were earmarked for projects in CTF pilot countries, and specific allocations were made for projects in Chile, Colombia, Mexico and Turkey. During its June 2014 meeting, CTF Trust Fund Committee approved an additional envelope of U120 million to scale up of the Utility Scale Renewable Energy Program, through extending support to additional countries, including in the Caribbean region. The pipeline of CTF DPSP Utility Scale Renewable Energy - geothermal is presented as follows:

Table 2: CTF Dedicated Private Sector Programs for geothermal project development (as of 12/16)

Program/Project	Country / Region	Public/Private	CTF Funding (USD million)
Geothermal Development Lending Facility (GeoDELF)	Turkey	Public	25
Geothermal Development Project	Turkey	Public	40
Geothermal Financing and Risk Transfer Facility	Mexico	Public	20
Utility Scale Renewable Energy: Geothermal	Colombia	Public	10
Utility Scale Renewable Energy: Geothermal	Chile	Private	20
Utility Scale Renewable Energy: Geothermal	Indonesia/Philippines	Private	30
Concessional Finance Program for Geothermal Generation	Kenya	Private	30
Utility Scale Renewable Energy: Geothermal*	Kenya	Private	20
Utility Scale Renewable Energy: Geothermal - Sustainable Energy Facility	Eastern Caribbean	Public	20
Utility Scale Renewable Energy: Geothermal*	Dominica/St Lucia	Public	20
Geothermal Exploration and Transmission Improvement Program	Nicaragua	Public	10
Total			235

** Projects pending approval of the CTF Trust Fund Committee*

56. As a beneficiary country, Saint Lucia will leverage CTF resources to mitigate drilling risk in the exploration and development of the proposed geothermal project sufficiently to attract and enable private sector participation on the generation side downstream. A successful program will enable the country to de-risk confirmation of a quality geothermal resource. This, in turn, can help attract private investment to further delineate the dimensions of the resource, and, if viable, develop the necessary infrastructure for steam collection and power generation.

V. KEY RISKS

A. Overall Risk Rating and Explanation of Key Risks

57. The risk assessment focused on the likelihood and the severity of circumstances that: (a) could potentially affect the achievement of the intended results as per the project development objective or (b) face barriers to efficient implementation. The overall project risk is assessed to Substantial primarily owing to the complexity of geothermal development. Additional risks, which have been mitigated in the project design through support for implementation capacity and technical assistance, include St Lucia's limited technical capacity for project implementation, including supervision of geothermal projects as well as dedicated capacity to apply World Bank fiduciary, procurement and safeguards guidelines and resources for technical assistance and studies. Key mitigation measures have been proposed, including implementation of best practices observed from similar projects globally, and including focused technical assistance activities.

58. **Technical Design of Project, high risk rating.** The main risk affecting the development of the project pertains to the adequacy of the geothermal resource. Although surface reconnaissance studies show positive indications of geothermal resources in selected areas, exploration drilling is required to confirm the quality of such geothermal fields for power generation. The program has been designed so that the exploration wells can provide sufficient data to ascertain moving to the next stage of development. The design therefore allows for some flexibility within the drilling program based on initial findings. It is expected that once the quality of the resource is proven, additional drillings (e.g. delineation drilling) will be undertaken to determine feasibility, as well follow-on investments by the developer in production and injection wells, steam collection pipes and the power plant. The nature of exploration drilling is such that the program could be inconclusive or negative about the prospects of a viable geothermal resource.

Risk mitigation measures. This risk will be minimized by applying a systematic, industry standard approach to resource confirmation in the project. The flexibility inherent in the design will allow for some adjustments as needed. If geothermal development is found to be unviable, the battery storage resources financed could help integrate other renewable energy projects in Saint Lucia.

59. **Institutional Capacity for Implementation, substantial risk rating.** Saint Lucia has limited capacity to design and manage a complex geothermal exploration drilling program.

Risk mitigation measures. The Government will procure the expert services of a global firm providing technical and exploration oversight (the "Exploration Management Consultant") to strengthen its capacity. The EMC will remain in place until the end of the drilling program. It will report to the Project Director of the GIT at the Department of Sustainable Development, and will represent the GIT in the technical advisory panel.

60. **Fiduciary, substantial risk rating.** The current PCU within the MoF, which currently manages the procurement of all World Bank projects in Saint Lucia, is familiar with the Bank's fiduciary requirements. However, it is overloaded with current responsibilities, making it unlikely to dedicate the necessary capacity

to handle the additional workload and the complexity arising from the proposed project. For this reason, the fiduciary risk is rated as Substantial. Given the need for efficient and timely implementation for private sector investment, the project will need dedicated capacity for project management and implementation consistent with World Bank guidelines.

Risk mitigation measures. Saint Lucia will create a GIT within the Department of Sustainable Development, which will be responsible for overall project management, including technical oversight, fiduciary management and implementation support. The fiduciary functions of GIT will be performed either by consultants hired for specific tasks or by staff seconded from the PCU that currently provides procurement and financial management services to virtually all World Bank projects in the country.

61. **Difficulty to attract private sector partner(s), substantial risk rating.** Attracting an experienced geothermal developer will require the development of a well-balanced set of concession and PPA agreements to off-take the power in a sustainable and cost-effective manner. GoSL intends to handover further development of the geothermal project to a qualified private sector project developer after completion of the drilling program. Given the relatively small scale of the opportunity in St Lucia, and as evidenced by experiences in neighboring islands, it may be difficult to attract experienced project developers to the island. GoSL has limited experience with renewables and even less experience in attracting IPPs to the sector and LUCELEC's current business model will need to evolve.

Risk mitigation measures. In addition to various enabling pieces of legislation, the government is preparing various model project agreements including a PPA for the off-take of the geothermal power output and a concession agreement for the subsequent engagement with a suitable private developer. The government will also conduct a market sounding so that it can find ways to develop broader interest in the geothermal opportunity in St Lucia in its effort to attract high quality partners to help deliver value-for-money to energy customers. Together with the use of grant and concessional financing for exploration drilling, these measures will make it more likely to attract an experienced private sector project developer as a partner to invest in the subsequent phases of drilling (including production and injection wells), as well as building the steam gathering and other infrastructure needed for power generation. Technical assistance resources will support development of alternative business model(s) for LUCELEC.

62. **Environmental Risks, substantial risk rating.** St. Lucia houses the dramatic Grande and Petite Pitons (sharp-peaked mountains) which symbolize the island. Along with the area near the Sulphur Springs, these comprise the Piton Management Area (PMA), a UNESCO World Heritage site which is a major tourist attraction that contribute significantly to the Saint Lucia economy. In order to maintain this desirable designation, the GoSL has established development limits and criteria for areas of the PMA.

Risk mitigation measures. Preliminary findings from the surface exploration studies indicate the most likely location of the geothermal reservoir to be several kilometers outside of the PMA. The location of impacts from the proposed exploratory drilling program is expected to be either completely outside of the PMA or at the margins of its buffer zone. All the drill locations currently envisaged are well outside the core area of the PMA and may only affect the PMA buffer zone, and all are in areas that allow for geothermal development.

63. **Stakeholders, moderate risk rating.** Poor results on past geothermal energy endeavors starting in the 1970s as well as, potential perceived impacts in the UNESCO World Heritage Site's Piton Management Area (PMA) are a risk. Although the exploration drilling will take place outside the core area of the PMA, there may be community concerns that remain.

Risk mitigation measures. Three sets of formal public consultations regarding proposed geothermal development activities have been conducted by the GoSL with members of the community, regulators and

other stakeholders, including NGOs. The first two sets of consultations were conducted on 18-19th February, 2015 and July 1, 2015 by the then Ministry of Sustainable Development, Energy, Science and Technology at the time that surface exploration activities were launched. Subsequently, after the surface study results were complete and as the drilling project was being designed, a third public consultation was held on 11th April, 2017 by the Department of Sustainable Development.

Since there may still be community concerns that remain, in addition to public consultation with neighboring communities, the project will devise a proactive communication strategy to discuss the opportunities presented by the geothermal exploration drilling project and address any community concerns, e.g. concerns regarding potential impacts within the PMA, or any associated impacts with the exploration process or with resettlement, as part of an Environmental and Social Impact Assessment (ESIA) currently underway. GoSL representatives from the Department of Sustainable Development, the Renewable Energy Unit, the Public Utilities Commission and from the PCU presented project information and answered questions on the following issues that were raised at the April 2017 meeting.

64. **Social and Resettlement Risks, substantial risk rating.** A geothermal power plant requires land acquisition for the power plant, wells, network of interconnecting pipework, a transformer station, and electricity transmission lines to connect to the grid, access roads, and other infrastructure. Land acquisition would occur gradually, starting with a few wells for the exploration and provisions for drilling infrastructure works (access roads, well pads, water supply among others), and followed by the subsequent land needs per the defined phases. Private developers might approach landowners through a 'willing-buyer-willing-seller' approach. Resettlement Policy Framework (RPF) will detail the process for the preparation of the Resettlement Action Plans (RAP) required for the final locations and designs of the subprojects. The RPF document will be consulted and disclosed.

Risk mitigation measures. The project will seek broad community support through timely consultations and set up redress mechanisms to resolve concerns during the project cycle. Consultations results and grievance mechanisms will consider community needs

VI. APPRAISAL SUMMARY

A. Technical Analysis

65. In advance of a full feasibility-level assessment which will be forthcoming only once the drilling campaign is completed, the World Bank conducted preliminary assessment of the impact of the proposed geothermal plant on the cost of generation, reserves, and the adequate size of storage needed. The analysis concluded that if storage is included as planned in the project, the 30 MW geothermal plant envisaged under the project is part of the least-cost mix, displacing both diesel as well as solar and wind. System net present value (NPV) for a 30 MW plant with 17.5 MWh storage is the lowest (USD 35.5 million lower than system costs without geothermal), but has higher capex requirements. The sensitivities analyzed also show geothermal to be a robust option under different scenarios, including to changes in fuel prices. When fuel prices are reduced by 20%, the first 15 MW of the geothermal plant is deployed in 2023 and the second deployed in 2025. A test with 12 test wells that also assumes poor quality resulting in a 15 MW plant was also performed, which effectively increases the cost per kW from USD4,700 per kW to USD5,700 per kW (This effectively increases the cost per kW from USD4,700 per kW to USD5,700 per kW) and found to be acceptable.)

66. GoSL is developing terms of reference to engage an experienced EMC to help manage the exploration drilling process from a technical perspective and to write the specifications to procure the services of an

experienced drilling company. In addition, GoSL will convene a technical advisory panel to guide the drilling process, including to provide any recommendations for adjustments. Given the high risk involved in the early stage geothermal project, public sector de-risking of the drilling phase will strongly improve the overall economics of geothermal development, making it more likely to attract a qualified private developer for subsequent development. As part of its market engagement activities, GoSL will also periodically consult with private sector developers and inform them regarding progress of the exploration drilling program. Upon the completion of the public sector-funded drilling, the delivered exploration drilling report will provide sufficient data and information to confirm with a relatively high degree of confidence whether a geothermal resource of sufficient quality exists.

67. If a high quality geothermal resource is confirmed, the GoSL plans to invite a qualified private sector Independent Power Producer (IPP) developer to invest private capital into further developing the project in a timely manner. The private sector developer would be expected to invest its own capital for any necessary next stages of delineation drilling and flow tests that may be needed to confirm availability of sufficient quantity of steam to support a feasible generation capacity. If found feasible, the government and the private developer will finalize agreements such as the Geothermal Development Agreement (GDA) and the Power Purchase Agreement (PPA), followed by the developer's investment in production and injection wells and subsequently, in the steam collection infrastructure and the power plant.

B. Economic and Financial Analysis

Economic Analysis.

68. A preliminary cost-benefit analysis was carried out taking the economic cost and benefits of the proposed geothermal plant vis-à-vis a diesel plant of equivalent installed capacity, which represents the alternative to the project. Investment and operating costs associated with the latter represents benefits arising from the project. The economic benefits of the geothermal plant consist of the economic value of the power supply from the plant and the avoided cost in CO_2 emissions vis-à-vis thermal powered generation. The economic value of the power supply is estimated as (a) the avoided cost of building and maintaining the 30 MW diesel power plant that will be required in the absence of the geothermal plant, and (b) savings arising from the supply of a cheaper source of power calculated as difference between the customers' willingness-to-pay and the estimated electricity charge resulting from the geothermal project.

69. The analysis aimed to assess the economic cost and benefits associated with the proposed development, with a view to calculating the Net Present Value (NPV) of the monetized value of the economic impact of the project. It is assumed that the geothermal plant will commence operations in January 2023 and operate for 25 years. Assuming an economic opportunity cost of 6 percent,[16] the 30 MW geothermal development yields an economic net present value (ENPV) of USD 81.46 million, which is equivalent to an Economic Internal Rate of Return (EIRR) of 11.6 percent. (For more details on the analysis, See Annex 2)

Financial Analysis.

70. The Financial Analysis was carried out to assess (a) the financial viability of the geothermal project from the perspective of a private developer, and (b) the effect of upstream public support on the electricity tariff. The analysis is based on a financial model, which has been designed to calculate a range of potential off-take prices that could be requested by a private developer, based on specific assumptions including the expected return on equity and the financing structure of the project. All revenues and expenditures are expressed in real 2016 terms. The financial model solves for the tariff that will be required to achieve a Return

[16] Source: Discounting Costs and Benefits in Economic Analysis of World Bank Projects, OPSPQ, 2016

on Equity (ROE or Equity Financial IRR) of 15 percent in real USD terms,[17] with and without grant funding for the exploration drilling phase. This value is assumed for discussion purposes only based on preliminary discussions with the Government.

71. **Financing structure and terms.** The financing structure provides for a public grant for the exploration drilling phase, followed by delineation drilling and flow testing financed through private sector's equity. These initial phases are essential to collect the data necessary to ensure the bankability of the project, and thus precede financial close. Production drilling and plant construction are financed through a mix of debt and equity. It was assumed that the private investor is financed through (a) a 17-year commercial which includes a 3-year grace period, with an annual interest rate of 7 percent, and (b) equity, with a cost of capital of 12 percent. The target capital structure of the private developer's financing is 70:30 debt-to-equity. Corporate income tax is assumed to be 30 percent. Assets are depreciated over 25 years on a straight-line basis, for accounting purposes.

72. **Results of financial simulation.** The results of the financial simulation are provided as follows:

(a) With financing of the drilling campaign through a public sector grant, the project's Financial Net Present Value (FNPV) is USD 44.38 million,[18] which is equivalent to an FIRR of 9.8 percent. The breakeven electricity price output required to achieve the 15 percent target Equity FIRR is equivalent to 0.104 USD per kWh.

(b) Without the grant, the private developer finances the entirety of the geothermal development. The project's FNPV is estimated at USD 73.62 million[19] for a Financial Internal Rate of Return (FIRR) of 10.9 percent. The off-take price needs to be increased to USD 0.135 per kWh to allow the private developer to breakeven that is, to achieve its target Equity FIRR.

73. The provision of the grant allows for a reduction of the off-take price by 23 percent, from USD 0.135 per kWh to USD 0.104 per kWh. Moreover, assuming a fixed off-take price of USD 12 per kWh for illustration sake, the private developer's equity rate of return varies from 12.9 percent (without grant), to 18.5 percent (with the public grant). This confirms the thesis that the absorption of some of upstream development risk through by the public sector not only reduces uncertainty, but also increases the returns of a potential private developer, creating an opportunity to transfer the surplus to end user customers, through a lower power price. (See discussion of detailed assumptions in Annex 2)

C. Financial Management

74. As lead implementing agency, DSD will have the responsibility of managing the process of implementing the project consistent with World Bank guidelines, procedures and practices for environment and social safeguards (including resettlement if needed), procurement, disbursement, accounting, and financial management. In the interim, and until final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the Project Coordination Unit linked to the Department of Economic Planning & National Development within the MoF, or through the engagement of specialized consultants with the necessary skills.

[17] Assuming an inflation differential of 3 percent between the US and Saint Lucia, this is equivalent to an expected return of 18 percent in nominal terms.

[18] Assuming a financial discount rate of 6.25 percent, which is the weighted average cost of capital of the private developer, based on the underlying financing structure.

[19] The discount rate is the weighted-average-cost-of-capital of 7.38 percent, based on the capital structure which assumes no grant support

It is to be noted that the PCU currently administers all existing World Bank loans and grants, including for the ongoing GRDP TA project, and has dedicated staff that benefit from the experience of implementing World Bank projects for the past 15 years. However, the PCU is overloaded with heavy responsibilities, making it important to consider alternatives to support the DSD in performing the fiduciary requirements likely through the additional workload and the complexity arising from the proposed highly specialized project.

75. The Bank performed a financial management assessment of the proposed project in accordance with OP/BP 10.00 and the financial management practice manual issued by the Financial Management Sector Board (FMSB) in March 1, 2010. It was concluded that the MoF will have in place an adequate financial management system that can provide accurate and timely information with reasonable assurance on the status of the funds as required by the Bank, and will execute FM functions until the DSD may be appraised for any alternate arrangements. Any such arrangements will be finalized and appraised prior to Board. The project grant and concessional resources will be administered through a designated account at the Bank of Saint Lucia. Additional details are provided in the Annex 4 for implementation arrangements.

76. Given GoSL's limited technical capacity for overseeing and implementing a geothermal exploration program of this magnitude, the GIT will procure the specialized capacity and skills of an EMC to enhance GoSL's capacity to implement and oversee the drilling program. The scope of the EMC will include design of specifications for the engagement of a drilling contractor as well as to oversee the drilling campaign. The project design provides for the procurement of the EMC in time for the completion of the pre-feasibility study and the ESIA, so that preparation for the DP can begin in a timely manner, starting with the procurement process of the drilling contractor utilizing approved CTF PPG and SIDS-DOCK funds prior to Board or through retroactive financing of eligible activities defined and agreed with the Bank prior to Board approval.

77. The World Bank is currently reviewing DSD's current financial management capacity, with this process expected to conclude prior to Board submission. In the interim, and until implementation arrangements by the DSD are appraised and finalized prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the PCU within the MoF, or through the engagement of specialized consultants with the necessary skills. (see Annex 4 for additional details)

D. Procurement

78. The World Bank is currently reviewing DSD's current procurement management capacity, with this process expected to conclude prior to Board submission. In the interim, and until final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the PCU within the MoF, or through the engagement of specialized consultants with the necessary skills.

79. Staff from the PCU attended the workshop held in Grenada in the beginning of November 2016, which was dedicated to the Bank's new procurement guidelines. The PCU staff have now been trained and acquainted with the new framework and its application and methods. The DSD in consultation with the PCU will prepare the Project Procurement Strategy for Development (PPSD), which is a project-level strategy document prepared by the borrower that describes how procurement in Investment Project Financing (IPF) operations supports the development objectives of the project and delivers value for money. The PPSD will be reviewed and agreed upon with the Bank before the completion of IDA and CTF negotiations prior to Board submission. The DSD and the PCU have been informed of the need to start to prepare the PPSD document and the Bank has offered its support on this preparation.

E. Social (including Safeguards)

80. The World Bank is currently reviewing DSD's current capacity to supervise projects following World Bank requirements for social safeguards, and this process is expected to conclude prior to Board submission. In the interim, and until implementation arrangements by the DSD/GIT are appraised and finalized prior to Bank Board approval, the DSD/GIT will be supported in fulfilling safeguards functions for the proposed project through the engagement of specialized consultants with the necessary skills, in addition to the PCU within the MoF.

81. The project is anticipated to have social and environmental impacts that will trigger OP/BP 4.01 (Environmental Assessment), as well as OP/BP 4.04 (Natural Habitats), OP/BP 4.36 (Forests), OP 4.09 (Pest Management), OP/BP 4.11 (Physical Cultural Resources) and OP/BP 4.12 (Involuntary Resettlement). A comprehensive ESIA is currently underway specific to the project activities (exploration drilling) which will seek to minimize potential environmental and social risks and impacts by preparing an Environmental Management Plan consistent with OP/BP 4.01 and aligned with OP/BP 4.04. Forests, Pest Management, and Physical Cultural Resources have been triggered as precautions because associated project activities may include earth-moving activities, clearing for access roads, and incidental use of pesticide or herbicide.

82. The proposed project location will involve drilling targets in the prospect zones within the denominated Area 1a and 1b, located near the villages of Belle Plaine and Saltibus. Areas 1a and 1b are located outside of the Pitons Management Area (PMA, an UNESCO World Heritage Site) but a small part of Area 1a overlaps the PMA's Buffer Zone. Areas 1a and 1b are fairly large zones (more than 1 square kilometer) and the specific drilling locations will be chosen with input from the ESIA to minimize impact.

83. Although the general drilling areas are known, the specific areas for the drill sites, access roads and other ancillary facilities are not known in sufficient detail at this stage. The project will prepare an RPF prior to appraisal, with a follow-up Resettlement Action Plan (RAP) or an Abbreviated Resettlement Action Plan (ARAP) will be prepared during implementation. These instruments will be disclosed in-country and at the Bank Infoshop and will be implemented consistent with applicable World Bank guidelines prior to the commencement of any civil works.

F. Environment (including Safeguards)

84. The World Bank is currently reviewing DSD's capacity to supervise projects following World Bank requirements for environment safeguards, and this process is expected to conclude prior to Board submission. In the interim, and until implementation arrangements by the DSD/GIT are appraised and finalized prior to Bank Board approval, the DSD/GIT will be supported in fulfilling safeguards functions for the proposed project through the engagement of specialized consultants with the necessary skills, in addition to the PCU within the MoF.

85. The project is anticipated to have social and environmental impacts that will trigger OP/BP 4.01 (Environmental Assessment), as well as OP/BP 4.04 (Natural Habitats), OP/BP 4.36 (Forests), OP 4.09 (Pest Management), OP/BP 4.11 (Physical Cultural Resources) and OP/BP 4.12 (Involuntary Resettlement). A comprehensive ESIA is currently underway specific to the project activities (exploration drilling) which will seek to minimize potential environmental and social risks and impacts by preparing an Environmental Management Plan consistent with OP/BP 4.01 and aligned with OP/BP 4.04. Forests, Pest Management, and Physical Cultural Resources have been triggered as precautions because associated project activities may include earth-moving activities, clearing for access roads, and incidental use of pesticide or herbicide.

86. The proposed project location will involve drilling targets in the prospect zones within the

denominated Area 1a and 1b, located near the villages of Belle Plaine and Saltibus. Areas 1a and 1b are located outside of the Pitons Management Area (PMA, an UNESCO World Heritage Site) but a small part of Area 1a overlaps the PMA's Buffer Zone. Areas 1a and 1b are fairly large zones (more than 1 square kilometer) and the specific drilling locations will be chosen with input from the ESIA to minimize impact. As noted in the Limits of Acceptable Change (LAC) document, geothermal development is allowed even within the PMA outside of the Sulphur Spring area, "subject to an Environmental Impact Assessment" (section 13.4). Excluded from the proposed project is another area with geothermal potential (Area 2) which is located within the Sulphur Springs area (the core of the PMA), which would have presented very complex environmental challenges.

87. Exploration drilling work will require construction of infrastructure for ancillary work such as well pads, access roads and water supply. The proposed drilling technique in the exploration phase will likely use a diamond core rig and slim-hole borings, which will minimize potential impacts because the footprint required for drilling and access are much smaller in comparison to full-size production-stage wells. Slim-hole well pads can be as small as 100 square meters, and the needs for water supplies are also minimal (1,200-gallon tanker trucks can suffice).

88. Potential impacts from new road construction will be the main environmental concern. Careful road design will be required, including screening for forest areas, species of concern, and effects on areas with natural habitat. Access roads can be little more than farm tracks, although the project terrain is rugged and some new roads will be required, particularly in Area 1a where existing roads traverse only the ridge tops and do not reach the valley floors. The area is highly prone to landslides, so special attention should be paid to minimize landslide potential when cutting new access roads, and good construction practice should be employed to minimize erosion impacts. Typical construction related impacts such as dust, noise, and worker health and safety would also be expected. Other impacts specific to geothermal exploration activities could occur from poor management of drilling fluids, chemicals, and sanitary wastes, as described in the relevant WBG EHS Guidelines. Community health and safety issues could arise from access, traffic and for emergency response.

G. World Bank Grievance Redress

89. 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 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/en/projects-operations/products-and-services/grievance-redress-service*. For information on how to submit complaints to the World Bank Inspection Panel, please visit www.inspectionpanel.org.

VII. RESULTS FRAMEWORK AND MONITORING

Project Development Objectives

The development objective of the Renewable Energy Sector Development (RESD) Project is to support the Government of Saint Lucia to assess the viability of harnessing indigenous renewable energy resources, in particular geothermal energy.

Project Development Objective Indicators

Indicator Name	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
Name: Evidence provided to the GoSL for its decision on whether to proceed with the development of the geothermal power plant	Yes/No	N	Y	Once	Drilling Report	GoSL
If geothermal resource is confirmed, the GoSL will invite a qualified private sector entity for further development	Text	no private investor identified	Agreement concluded (e.g. geothermal concession agreement).	Once	Agreement concluded (e.g. geothermal concession agreement and/or PPA).	GoSL
Name: Knowledge and capacity built to address regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration	Text	Negligible institutional capacity in and knowledge of renewable energy and its integration.	Dedicated Geothermal Implementation Team (GIT) within the Department of Sustainable Development of the MoESD established and functional. Knowledge about legal and regulatory aspects and energy market of renewables increased.	Annually or more often as required	Technical, procurement, and other reports	GoSL

Indicator Name	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection

Intermediate Results Indicators

Indicator Name	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
Name: Exploration Management Consultant (EMC) in place	Yes/No	N	Y	Once	Contract appointing EMC	GoSL
Name: Drilling contractor in place	Yes/No	N	Y	Once	Contract for drilling company signed	GoSL
Name: Technical panel established	Yes/No	N	Y	Once or as often as panel meetings take place	Minutes of technical panel meeting or discussions	GoSL
Name: Minimum of two slim exploratory wells drilled to a depth of ca. 2,000 m	Yes/No	N	Y	Upon drilling of well(s)	Drilling started	GoSL
Name: GIT established and functional	Yes/No	N	Y	Once	Project report	GoSL
Name: Number of studies, market sounding tours and trainings to enhance institutional	Number	0	5	Once	Project report	GoSL

Indicator Name	Unit of Measure	Baseline	End Target	Frequency	Data Source/Methodology	Responsibility for Data Collection
capacity of GoSL						

Target Values

Project Development Objective Indicators

Indicator Name	Baseline	End Target
Evidence provided to the GoSL for its decision on whether to proceed with the development of the geothermal power plant	N	Y
If geothermal resource is confirmed, the GoSL will invite a qualified private sector entity for further development	no private investor identified	Agreement concluded (e.g. geothermal concession agreement).
Knowledge and capacity built to address regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration	Negligible institutional capacity in and knowledge of renewable energy and its integration.	Dedicated Geothermal Implementation Team (GIT) within the Department of Sustainable Development of the MoESD established and functional. Knowledge about legal and regulatory aspects and energy market of renewables increased.

Intermediate Results Indicators

Indicator Name	Baseline	End Target
Exploration Management Consultant (EMC) in place	N	Y
Drilling contract signed	N	Y
Technical panel established	N	Y
Minimum of two slim exploratory wells drilled to a depth of ca. 2,000 m	N	Y
GIT established and functional	N	Y
Number of studies, market sounding tours and trainings to enhance institutional capacity of GoSL	0.00	5.00

ANNEX 1: CLEAN TECHNOLOGY FUND

St. Lucia
Renewable Energy Sector Development Project

Table 3: Summary of CTF Impact Indicators[20]

Indicator	CTF- leveraged project[21]	Nationally Determined Contributions Target by 2030
New installed power generation capacity from renewable energy sources	30 MW (Geothermal + batteries will enable even more RE integration)	NA (NDC does not set target for RE installed capacity)[22]
Additional power generation	237,000 MWh per year	200,008 MWh per year[23] (If successful, RESD Project will help exceed NDC target)
Tons of GHG emissions reduced or avoided -Tons per year - lifetime (25-year cumulative)	123,463 tCO_{2eq}/yr 3.08 million tCO_2eq	22,750 tCO_{2eq}/yr 0.57 million tCO_2eq (If successful, RESD Project will help exceed NDC target)
Financing leveraged through CTF funding [USD million]	**Total funding: USD 173.875 m** CTF: USD 9.525 m DFID: USD 1.000 m SIDS-DOCK: USD 5.000 m GoSL: USD 1.850 m IDA credit: USD 5.000 m Private investment: USD 151.500 m	The NDC target is presented as conditional upon availability of adequate climate finance
CTF leverage ratio	1:16	NA
Cost effectiveness - CTF cost effectiveness (CTF funding per ton CO_2eq avoided over 25 years) - Total project cost effectiveness (Total funding per ton CO_2eq avoided over 25 years]	3.22 USD/tCO_2eq 57.92 USD/tCO_2eq	NA

[20] **Clarification**: The scope of the proposed project will be limited to the confirmation of whether geothermal resources at the selected sites are suitable for power generation. CTF funding will be solely applied to drilling, shared infrastructure, geo-technical services and consultancies. Hence, the output of the project is not electricity generation. If adequate resources are confirmed, the data will be used to prepare and finalize the feasibility study for the power plant which will be financed by a qualified private developer.
[21] The results presented in this column have been produced implying causality and attribution between the activities presented for support under the proposed operation, and the potential generation of electricity in Saint Lucia. The figures illustrated represent the expected results from financing and operating a 30 MW geothermal plant with an assumed load factor of 90%.
[22] Without geothermal, the RE target will need to be met using only solar and wind resources. Assuming 50% from wind (25% capacity factor) and 50% from solar (20% capacity factor), the output targets imply the need for 90 MW of new RE installed capacity.
[23] 50% of RE generation by 2030. Estimated with assumptions: i) 348 GWh of LUCELEC's electricity sales in 2016 as a proxy of generation output; ii) 1% annual increase in electricity generation until 2030; (iii) assuming 50% wind and 50% solar with 25% and 20% capacity factors, respectively.

A. EXECUTIVE SUMMARY

1. **GoSL plans to provide public financing for geothermal development by mobilizing and using grant and concessional financing for the drilling campaign as a tool for assessing resource risk associated with geothermal exploration and development.** International geothermal development experience demonstrates the value of public sector financing of the early geothermal development phase, with private sector investors investing later, during a more mature phase of development, once the quality of the resource has been proven. If the drilling campaign confirms the quality and potential viability of the resource, it will make it less risky for an experienced private sector project developer to invest in subsequent lower risk phases of geothermal development, including drilling delineation, injection and production wells as well as building the steam gathering and other infrastructure needed for power generation.

2. **By reducing some of the resource risk, public financing of exploration drilling will also reduce the risk premium that would otherwise be commanded by private capital to conduct the early and riskiest phase of geothermal development.** This phased risk management approach to geothermal development will reduce the risk of subsequent private investors. The provision of grant and concessional financing to support GoSL's public financing of drilling exploration wells will also lead to a cost savings that can contribute to sustainable and affordable generation on terms that provide value for money for Saint Lucia's energy consumers. Compared to a privately funded exploration drilling campaign, the use of grant and concessional funding will lead to a reduction of the eventual modeled off-take price by an estimated 30 percent. Once the qualitative and quantitative characteristics of the geothermal resource are deemed adequate for power generation, the financial analysis of the project demonstrates that geothermal power production is a competitive alternative to diesel-based base-load solutions with electricity output price ranging between 0.104 (with grant) and 13.5 USD per kWh (without grant), clearly showing the additionality and value of grant, contingent grant and concessional resources in reducing the risk of private sector participation and enabling transformation of the energy sector through geothermal development.

B. PROJECT DESCRIPTION AND RESULTS INDICATORS

B.1. Project Background

3. **Saint Lucia is one of six Caribbean island countries that make up the Windward Islands—the southern arc of the Lesser Antilles chain—at the eastern end of the Caribbean Sea.** It is an island nation with a population of approximately 185,000 inhabitants in 2015, for a Gross National Income (GNI) per capita, and Gross Domestic Product (GDP) of USD 7,350 and USD 1.43 billion respectively. The country's economy has historically relied on agricultural exports, but due to high production costs and declining competitiveness, economic growth and development is now primarily driven by the success of its tourism industry and associated activities.

4. **The energy sector, which is highly dependent on diesel-based generation for electricity generation, is a key contributor to economic activity and growth in Saint Lucia.** While electricity is supplied reliably, with an electrification rate of approximately 98 percent, the energy sector's exposure to prices in the global petroleum market results in high electricity tariffs and substantial price volatility. The volatile and high cost of electricity - -above USD 0.33/kWh in recent years, and at a level more than twice the Latin American average -- is a major impediment that erodes the country's competitiveness. Saint Lucia's future competitiveness and growth potential is thus highly dependent on its ability to ensure low and stable energy costs and to reduce its over-dependence on fossil fuel imports and related exposure to global oil price fluctuations. Recent

completion of surface exploration points to promising geothermal reserves and these recent findings have made the full exploration of this indigenous base-load potential a high priority for the government, the power utility and other stakeholders. Developing the geothermal potential will help Saint Lucia meet and possibly exceed its domestic as well as its international targets for renewable energy development under its NDC climate change commitments. Along with battery storage capacity, geothermal energy will also help Saint Lucia integrate and dispatch intermittent additional wind and solar energy generation.

B.2. Project description, including proposed transformation and rationale for CTF financing

5. **The proposed project consists of** (a) a publicly-funded Drilling Program (DP) to assess the presence of geothermal resources for power generation and determine its characteristics to de-risk the project for private sector participation in the subsequent phases of the geothermal development; and (b) the procurement of shared infrastructure services including battery storage capacity to provide additional spinning reserve, and improve grid stability after addition of future intermittent renewable energy resources.

6. **The project funding will comprise USD 9.525 million of CTF funds in the form of a USD 0.525 million Project Preparation Grant (PPG) and a USD 8.572 million contingent grant to support preliminary exploration drilling.** Should viable geothermal resources be confirmed through the DP and the subsequently private sector-led drilling phase, this upstream support to geothermal resource validation will lead to a transformational change of the power sector in Saint Lucia. The difficulty to secure risk capital to carry-out the drilling program, and the risk premium on equity required by private developers at this stage, remains a significant barrier to the development of base-load indigenous geothermal energy in a cost-effective manner. Unlocking targeted grant and concessional resources in this key area will support the mobilization of private sector resources for geothermal development and climate mitigation on a small island state, which is itself very vulnerable to climate change.

7. **Geothermal project risks are the highest in the initial stages, when information regarding the available resource is scarce.** This risk decreases as exploration and test drilling are undertaken to confirm the presence and characteristics of the geothermal resource, and the results of delineation drilling provide a more precise estimate of the anticipated energy output. Significant resource risk along with high upfront costs and long lead times from inception to generation are among the challenges that deter private sector investor from financing geothermal projects.

8. **The mobilization of CTF funding for the project will contribute to** (a) effective mitigation of the resource risk, (b) reduction in private investors' risk perception leading to lower risk premiums for capital and eventually, allow for (c) a levelized cost of geothermal below alternative fossil-fuel base-load technologies. Ultimately, this will enhance Saint Lucia's energy security, and provide for a reduction in greenhouse gases emissions through the displacement of alternative fossil fuel power generation.

9. **The following are the expected key results of the proposed project:**

   (a) Evidence provided to the GoSL for its decision on whether to proceed with the development of the geothermal power plant;

   (b) If geothermal resource is confirmed, the government will invite a qualified private sector entity for further development; and

   (c) Knowledge and capacity built to address regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration

10. **The following are the expected intermediate results of the proposed project**:

(a) Exploration Management Consultant (EMC) in place;

(b) A technical advisory panel led by EMC and relevant stakeholder representatives established;

(c) Contract with drilling company signed for exploration drilling program; and

(d) A minimum of two slim exploratory wells drilled to a depth of around 2,000 meters.

11. **The expected CTF results indicators of the project are:**

(a) New installed power generation capacity from renewable energy sources (30 MW) and additional power generation (237,000 MWh per year); and

(b) Tons of GHG emissions reduced or avoided (123,463 tCO_2eq/yr, 3.08 million $tCO_2eq$for 25 year cumulative).

B.3. Project Components

12. **The proposed project has two components.** Component 1 consists of (a) the design, validation, launch, implementation and supervision of a drilling program, to be undertaken by the GoSL; and (b) the procurement of shared infrastructure which will facilitate the integration of renewable energy in Saint Lucia's power system. Component 2 will include implementation capacity enhancement activities and a TA program to strengthen the GoSL's implementation, technical, and fiduciary capacity to support the program.

Component 1: Exploration Drilling for Resource Discovery, EMC, Geotechnical Services, Drilling Infrastructure Works, and Shared Infrastructure (total USD 20.375 million). This component will finance the following activities:

13. Component 1 of the proposed project comprises all activities related to the geothermal exploration drilling to assess and confirm viability for development of an approximately 30 MW geothermal power plant.

Subcomponent 1.1: Exploration Drilling and EMC (total USD 15.525 million: USD 8.572 million contingent grant and USD 0.953 million project preparation grant from CTF, USD 5 million DFID grant, USD 1 million IDA credit).

14. **GoSL is mindful of the time constraints that LUCELEC faces to make necessary investments that will define the country's energy mix over the next 15 to 20 years.** This makes it imperative to begin the process of drilling wells as soon as possible and to implement the nest stage of the geothermal development process efficiently to obtain sufficient and timely data and information about the resource for a project developer to make investment decisions for its further development.

15. **The subcomponent will support the appointment of a drilling contractor to confirm a drilling program, conduct drilling activities of two to five slim-holes at a depth of approximately 2,000 meters to confirm the quality of geothermal resource.** It is anticipated that the precise locations of these drill holes will be identified in the Pre-Feasibility Report which is being undertaken and financed by the ongoing Geothermal Resource Development Project (GRDP) (P149959), a TA program supported by the World Bank. The

appointment of the drilling contractor will be finalized by GoSL based on specifications provided by an EMC to be procured under this subcomponent to enhance the technical capacity of the GoSL to provide technical and operational inputs to the drilling contractor and to efficiently implement the DP. The EMC will be appointed using the CTF Project Preparation Grant (PPG) and other grant resources, such as those provided by SIDS-DOCK, DFID and the contingent grant of Clean Technology Fund (CTF).

(See Section III PROJECT DESCRIPTION of the Main PAD Section for more details on the scope of work of the EMC)

16. **A report on the quality of the geothermal resource measured against technical indicators (see box 3 below) will be produced at the end of the DP by the drilling contractor.** The report will be validated by the EMC in close consultation with the technical advisory panel and the decision to proceed to the next stages of project development will be made by the GoSL taking into account the technical indicators and other factors, including private sector readiness. The information captured in the DP report will also help facilitate knowledge sharing and capacity building within the wider Caribbean region.

Box 3: Technical Indicators for well-testing

Technical Indicators for well-testing

a) At least two wells drilled at a depth of approximately 2,000 meters;
b) Temperature logs collected (static and dynamic) allowing determination of formation temperature and the temperature of producing aquifers (if present);
c) Pressure logs collected and well head pressure after heating measured;
d) Drilling parameters (most importantly loss of circulation) carefully collected throughout the full depth of the well;
e) Samples of the geothermal fluid (steam and liquid) collected and analyzed;
f) Drill core retrieved and lithology and hydrothermal alteration logged; and
g) Observed lithology, alteration and subsurface temperature correlated to surface exploration data.

17. **Exploration drilling entails a certain degree of unpredictability, and good practice examples from Turkey, Armenia, Philippines, and Nicaragua, indicate that proper implementation of an exploration drilling program requires flexible design and the ability to accommodate adjustments to the original drilling plan based on initial findings.** For example, the location or results of the initial first or second exploration well(s) might prove to be inconclusive and an additional well(s) may be needed for final confirmation. Decisions on any needed adjustments will be made by the government based on recommendations by its appointed technical team led by the EMC and in consultation with the drilling contractor. In addition, the cost of drilling wells to target depth will be sensitive to the time it takes to drill the wells as drilling contracts are generally time-based. Delays may occur during drilling for a variety of reasons, e.g. due to subsurface conditions that cannot be predicted prior to drilling, when permeable formations are intersected and need to be plugged by cement to continue drilling. Such adjustments and delays may impact the drilling program's ultimate cost, and for this reason, a small level of contingency has been built into the design of this component, including for cost and financing estimates.

Subcomponent 1.2: Geotechnical Services, Drilling Infrastructure Works, and Shared Infrastructure (total USD 4.85 million: USD 4 million IDA credit and USD 0.85 million SIDS-DOCK grant).

18. **This subcomponent will finance geotechnical services and drilling infrastructure works (access roads, well pads, water supply, etc.).** The exact scope, location and costs of these investments will be identified and defined in in the Pre-Feasibility study and confirmed by the EMC in consultation with the drilling contractor. The pre-Feasibility study is currently underway as part of the ongoing World Bank TA support. Resources for this subcomponent will also be used to cover costs related to shared infrastructure services, including toward a share of costs related to transmission interconnects and/or towards costs related to the purchase and installation of battery storage capacity. (See Section III PROJECT DESCRIPTION of the Main PAD Section for more details.)

Component 2: Implementation Capacity Enhancement, Technical Assistance, and Market Engagement (total USD 2 million: USD 1 million GoSL co-financing and USD 1 million SIDS-DOCK grant).

19. **Given the time sensitivity and the technical nature of the geothermal exploration process, Component 2 will include resources to support a dedicated Geothermal Implementation Team (GIT),** alongside the Renewable Energy Unit in the Department of Sustainable Development, which is part of the Ministry of Education, Innovation, Gender Relations and Sustainable Development (MoESD). The GIT will have at its disposal the EMC team to provide the project with technical implementation capacity, and will procure or second persons with dedicated fiduciary capacity (e.g. financial management, procurement and safeguards capacity). In addition, this component will include technical assistance to provide studies and reports that will be necessary to fill any gaps in market, regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration.

Subcomponent 2.1: Support for Geothermal Implementation Team.

22. This subcomponent will finance GoSL's implementation capacity for the project, including office space, management, staff, consultants, offices supplies, among others, as well as fiduciary skills including financial management and procurement, and resources for monitoring safeguards implementation and results. These include a) the recruitment costs of GIT staff, e.g. project director and officers, including, as needed, additional capacity from specialists in applying World Bank social and environment guidelines, as well as additional procurement and financial management capacity; and b) training programs for GoSL officials, including staff of the Department of Sustainable Development, GIT, and LUCELEC. The training programs, which may include observational study tours, will provide structured learning workshops on a variety of topics associated with geothermal and renewable energy development, e.g. the geothermal exploration process, grid operations to integrate renewable energy, evolving models for energy delivery, as well as World Bank-related fiduciary, social, and environmental issue. The subcomponent will also finance c) GIT's gender integrating activities, with collaboration from the relevant stakeholders, which will promote job creation and training to provide equal opportunity to persons from both genders; and d) development of a communication strategy regarding the opportunities presented by the geothermal exploration drilling project and address any community concerns (e.g. concerns regarding potential impacts related to the development of geothermal energy.

Subcomponent 2.2: Technical Assistance and Market Engagement.

23. While much of the emphasis of the project will be on demonstrating the technical viability for geothermal development, notably by drilling exploratory wells, the project will also support activities to improve the market conditions for investing in geothermal. These activities will focus on the policy

environment (laws and regulations), cost of service comparisons, grid integration studies, and other market engagement efforts. The GoSL will review existing electricity legislation and draft geothermal specific laws and regulations that are essential for the proper governance of geothermal resources and power generation. The analysis and recommendations will be developed in coordination with the National Utility Regulatory Commission (NURC). Several other analyses and technical assessment activities to be supported by this subcomponent are essential to ensuring that the market conditions are adequate to attract investment for a geothermal power project. These include the specification of battery requirements, including replacement, operation and maintenance, disposal and regulatory support, as needed. The precise scope of these assessments will be prepared during the project preparation phase and the necessary breadth and depth of the efforts will be adjusted to comply with the available budget ($2 M), while ensuring the top priorities for achieving the PDO are met.

24. This subcomponent will finance the following studies and activities:

(a) **Legal and Regulatory Studies.** The revised Electricity Supply Act (ESA) allows for limited competition in renewable energy generation, including for geothermal power. However, the specific legislation and regulations that govern the exploration for geothermal resources and the production of geothermal power have not been implemented. This subcomponent will finance studies to ascertain and recommend the necessary laws and regulations to create the market conditions conducive to geothermal exploration and generation. This activity will be undertaken in coordination with the Ministry of Infrastructure, Ports, Energy and Labor (MoIPEL), which is the lead agency for ECERA project in Saint Lucia. Further, on regulatory matters it will coordinate with the National Utility Regulatory Commission (NURC) which has responsibility for implementing energy sector regulations. In addition, a cost of service study will be financed in cooperation with LUCELEC.

(b) **Evolving business model of LUCELEC.** The potential for a dramatic increase of renewable energy sources in Saint Lucia's energy mix has critical implications for LUCELEC's financial and operational planning processes. The revised Electricity Supply Act (ESA) allows LUCELEC to retain its monopoly in fossil fuel generation, but allows for competition in renewable energy generation. It is important to study how LUCELEC can develop an attractive value proposition consistent with the deployment of renewables in Saint Lucia. In this context, the increase in renewable energy generation will dramatically change LUCELECs business with implications for its operating model going forward. This includes not only addressing the role of geothermal energy and grid-connected renewables such as solar and wind, but also the role of decentralized customer-site rooftop and community solar as well as energy efficiency. Commissioned studies will evaluate and develop a financial model to quantify and better understand the financial implications of renewable energy generation, energy efficiency measures, and distributed generation on the utility and ratepayers, and to align utility return motivations with the country's policy goals.

(c) **Integrating Renewables into the grid.** The proposed construction of a privately owned and operated geothermal power plant and future addition of solar and wind power will bring with it the need to assess requirements for investment in the grid and to enhance grid operating capacity. Other operational planning decision areas could be such as forecasting renewable energy deployment, ensuring robustness of decisions to integrate uncertain renewable load quantities, incorporating the non-dispatchability of renewables into planning, accounting for location-specific factors, the specification of battery requirements, estimating the impact on

transmission and distribution investments, and integrating renewables into planning across generation, transmission, and distribution.

(d) **Market engagement activities.** Given the limited scale opportunities for power generation in Saint Lucia, which would limit potential private sector interest, GoSL is taking the issue of securing private sector participation seriously. GoSL, along with LUCELEC, will engage with private sector entities in the geothermal market through reports, presentations, prospects, and other materials presented at industry and financier conferences, road shows, workshops and using various media and communication channels to bring the project to the attention of potential investor and developer communities to help attract and secure the interest of potential developers to participate in subsequent phases of geothermal development. Market engagement will also be used to obtain and benchmark relevant market data from similar projects, and to generate reports with information including costs and Power Purchase Agreement (PPA) terms, which will be invaluable inputs to ensure that Saint Lucia obtains value-for-money from its geothermal development process. Sustained engagement would provide an opportunity for GoSL to meet and interact with private sector representatives (international project developers) as well as with representatives of civil society in Saint Lucia (e.g. Consumers Association) to share and discuss the ongoing progress and findings of the DP process. Finally, GoSL and LUCELEC, along with their transaction advisors providing technical, financial and legal support, will engage with private developers to prepare for negotiation of key documents and agreements for subsequent stages of project development, e.g. geothermal development agreement, Power Purchase Agreement (PPA), etc.

20. **Cost and financing.** The total project cost is USD 22.375 million, comprising of USD 5 million of IDA credit, USD 8.572 million of CTF contingent grant, USD 0.953 million of CTF PPG, USD 5 million of grant funding from DFID, USD 1.85 million of grant funding from SIDS-DOCK and co-financing of USD 1 million from the GoSL. Table 4 presents a breakdown of the project costs by funding sources, throughout all phases through power plant development. The current phase (USD 22.375 million) is represented by Components 1 and 2, and will help leverage an estimated USD 151.5 million of additional financing from the private sector, if the project is fully developed. Cost shaded areas, in the table, represent expenditures that have been incurred for the now completed surface exploration phase and estimates for the delineation drilling, production drilling and power plant construction, and are presented for informational purposes only. These costs are not part of the proposed drilling project, but are reflected as estimates for the overall geothermal investment, including expected private sector investments.

Table 4: Indicative Project Cost and Funding Sources (USD 22.375 million)

ACTIVITY	PROJECT COST	GoSL/ IDA Credit	DFID Grant	SIDSDOCK Grant	CTF DPSP	GEF/ Others	Private developer
Surface Reconnaissance (ongoing TA)	3.6	0.3		1		2.3	
COMPONENT 1							
Exploration Drilling* for Resource Discovery	15.525	1	5		9.525		
Shared Services	4.85	4		0.85			
COMPONENT 2							

Technical Assistance and Project Implementation Capacity Enhancement	2	1		1			
TOTAL PROJECT COST	**22.375**	**6**	**5**	**1.85**	**9.525**	**0**	**0**
Delineation drilling incl. flow test	28.5						28.5
Production Confirmation Drilling	28.5						28.5
Power Plant, SAGS, and make-up wells over 25-year time period (≈30 MW)**	94.5						94.5
TOTAL PROJECT COST INCL. PRVATE SECTOR INVESTMENT	**178.1**	**6.3**	**5**	**3**	**10**	**2.3**	**151.5**

* indicative cost estimates, to be refined during project preparation
** illustrative costs, subject to revision based on feasibility study

C. ALIGNMENT WITH CTF INVESTMENT CRITERIA

26. Both CTF public and private investment criteria have been reviewed to assess the project's alignment with CTF requirements, due to its linkages with the public sector during the DP and with the private sector for the subsequent phases for the geothermal development.

27. **Potential for GHG emission savings**

(a) **Emission reduction potential of the investment.** GHG emission reductions arise from the displacement of an alternative 30 MW fossil fuel-based power generation plant (the business-as-usual scenario) which will be avoided if the viability of geothermal development is ascertained. The potential for GHG emission savings will be realized when the geothermal plant is completed, which would be enabled by the DP supported by the proposed operation. A global default value of around 0.128 ton CO_2eq/MWh[24] is assumed for fugitive GHG emissions for geothermal energy in Saint Lucia. Emission factor for diesel generators is approximately 0.65 tons CO_2eq/MWh, and has been assumed as the proxy emission factor of the alternative thermal generation plant. Based on 90 percent capacity factor and 30 MW installed capacity for both the thermals and the geothermal project, the annual GHG emissions of the geothermal plant is calculated at approximately 30,275tCO_2eq, compared to 153,738 tCO_2eq for an alternative diesel generation plant. This is equivalent to a net GHG emission savings of 123,563 tCO_2eq annually, or 3.1 million tCO_2eq, over 25 years.

(b) **Technology development status.** Once the resource is proven as viable, geothermal power generation is a mature renewable and fossil-free source of energy, capable of providing stable, dispatchable and reliable base-load power at competitive cost. Utility scale electricity generation usually takes place using conventional steam turbines and flash or binary plants depending on the characteristics of the geothermal resource. An estimate of 12 GW of geothermal power capacity has been built around the world, most of it in the last three decades. It is therefore a technically and commercially available technology, with well understood technical issues, capital and O&M costs and well understood operating risks. The development of the geothermal plant will

[24] Source: ESMAP, 2016, *Gases in Geothermal Fluids and Gas Emissions from Geothermal Power Plants, April 2016, ESMAP Technical Report 009/16.*

significantly increase the share of renewable energy in St Lucia's power generation mix, from less than 1 percent currently to approximately 25 percent, if no new development is undertaken. In addition, the provision of battery storage capacity will potentially deliver sufficient spinning reserve to replace the need for a large amount of stand-by diesel generating capacity. It will improve grid stability and facilitate the integration of both the geothermal energy and, in particular, any future intermittent renewable energy resources, thereby contributing to an even more significant reduction of diesel use and related emissions over time.

28. **Cost effectiveness.** The project will utilize USD 9.525 million of CTF co-financing to deliver GHG emissions reductions of 3.08 million tCO_2eq, over 25 years. This is equivalent to a CTF cost-effectiveness ratio of USD 3.22/ tCO_2eq.

29. **Demonstration potential at scale.** CTF support is key to GoSL's NDC strategy to transform its energy mix from nearly 100% fossil fuel to one characterized by well over half from renewable energy sources by 2030. The geothermal DP will help unlock the development of St Lucia indigenous geothermal potential through mitigation of the resource risk, a critical barrier to further development. The success of the DP is a necessary pre-condition to generating interest from private sector investors for the subsequent stages of project development. If successful, it will contribute to the country's objectives of reducing dependency on fossil fuel for power generation and providing a stable and reliable source of baseload energy at a lower cost than alternative fossil-fuel base-load technologies.

(a) **Business as Usual Scenario.** St Lucia's NDC provides for a business-as-usual projections covering the energy, electricity generating and transport sectors provide for GHG emissions increasing from 758 Gg CO_2eq in 2025 to 816 $GgCO_2eq$ in 2030 (from a baseline data of 643 Gg CO_2eq in 2010). These data do not include GHG emissions from Land-Use, Land-Use Change and Forestry. Data specific to the power generation sector are not available.

(b) **Trajectory of reduced emissions from co-financed project alone.** Since the NDC does not disaggregate the contribution of power sector emissions from other sectors, this information is difficult to infer. The country intends to reduce its net emissions by 16 percent (or 121 $GgCO_2eq$) by 2025 and 23 percent (or 188 $GgCO_2eq$) by 2030. If successful, a viable 30 MW geothermal project will help St. Lucia surpass its NDC target of 50% renewable energy by 2030, thereby reducing annual GHG emissions by 123,000 tons of CO_2 equivalent per year, and contributing to achievement of a lower emissions trajectory for the country.

(c) **Trajectory of reduced emissions from the scale-up of the CTF co-financed project.** Among the power generation-specific mitigation measures envisaged to curb the growth of GHG emissions, the country plans to (a) increase the share of renewable energy to 35 percent by 2025 (from less than one percent currently) and by 50 percent by 2030 based on a mix of geothermal, wind and solar resources; and (b) improve grid distribution and transmission efficiency. Given the small size of the power sector in St Lucia, the development of a 30 MW geothermal plant will contribute significantly to the emission reduction targets. As a stable, dispatchable, baseload electricity source, geothermal energy along with battery storage can also be an important part of a strategy to scale-up the integration of other intermittent renewables, thereby further contributing to the opportunity for an even lower trajectory of emissions.

30. **Development impact.** The project will pave the way for the development of clean and reliable base load power, which is expected to reduce the country's reliance on fossil fuels and therefore reduce its

exposure to oil price volatility and boost the competitiveness of its economy. Lower costs for clean energy represent a win-win for the environment and development and can be an important part of a strategy to attract other investments in new service and manufacturing industries. Some of the steam can be used for other productive uses, e.g. for greenhouses for agriculture or horticulture. The geothermal development will substitute a diesel power plant. Investment and operating costs associated with the latter represents benefits arising from the project. The development impact of the geothermal plant consists of the economic value of the power supply from the plant, reduced emissions of air pollutants from energy-related activities and health benefits due to avoided CO_2 emissions vis-à-vis thermal powered generation. A detailed analysis of the economic cost and benefits is presented in Annex 3.

31. **Implementation potential and readiness**

(a) **Country and sector status.** St Lucia has undertaken an ongoing process of comprehensive legislative and regulatory reform of the energy sector under the World Bank's Eastern Caribbean Energy Regulatory Authority (ECERA) Project. This process is intended to clarify any overlapping policy and regulatory provisions governing the power sector. The project supported by key sector policies including the National Energy Policy (NEP) which provides for the diversification of the energy base, the development of indigenous renewable energy, the security of energy supply and reduction of diverse environmental effects; the revised Electricity Sector Act (ESA) which allows for competition in renewable energy generation; and the National Utilities Regulatory Commission (NURC) Act No. 3 of 2016 which creates and an independent energy regulator with responsibility for power and water services regulation and is supplemented by the Appeals Tribunal Regulations and the Dispute Resolution Regulations. Additional regulations under preparation include a geothermal regulatory framework and Environmental and Social Impact Assessment regulations.

(b) **Institutional and implementation arrangements.** The implementation of the project will be overseen by the MoESD, MoIPEL, MoA, and the MoF. The MoESD will implement the project and provide technical input and oversight in coordination with the MoIPEL. The GIT, a dedicated project management unit is to be established within the MoESD, reporting to the Permanent Secretary of Sustainable Development. For this project, GIT will lead project management, contracting of consulting services, safeguards, procurement, disbursement, accounting, and financial management. The fiduciary functions of GIT will be performed by staff seconded from the PCU that provides procurement and financial management services to virtually all World Bank projects in the country.

(c) **Sustainability.** The Government has expressed its strong support for the development of renewable energy in general and geothermal resources in particular, with the intention of handing over further development of the geothermal project to a qualified private sector project developer after the completion of the DP. To this end, GoSL has been working with a range of development partners to conduct a systematic and phased risk-based approach to project development, including identifying and undertaking various enabling and capacity strengthening activities. Having properly concluded the surface exploration studies, the government has launched both the Environmental and Social Impact Assessment (ESIA) and the Pre-Feasibility study for geothermal power development.

32. **Additional cost and risk premium.** CTF financing will primarily be applied to the financing of drilling program, which is critical to obtain sufficient data to mitigate the resource risk, considered too high and difficult to price by traditional financiers. In the absence of this co-financing and provided that private investors are willing to step-in, they are likely to require a higher rate of return on equity as compensation. Preliminary financial projections show that, assuming an indicative equity rate of return of 15 percent as a threshold, the project will require a tariff in the range of USD 0.104 per kWh with the co-financing or USD 0.135 per kWh without the co-financing, (which is 30 percent higher). Assuming a constant tariff of USD 0.104/kWh the required equity rate of return drops from 15 to 10.42 percent, below the market threshold, which, in the absence of a higher tariff, would be a deterrent to private investment. Therefore, contingent grant and concessional funding increases the equity rate of return by approximately 460 basis points, to make the project viable and to attract private investors, while also supporting a competitive tariff for cost-effective energy supply.

33. **Financial sustainability.** Since geothermal energy is an indigenous resource, plant operations and costs are sheltered from the volatility of oil prices, which reduces the need for operating subsidies. The CTF subsidy element is only required to mitigate early stage resource risk, in order to allow for private sector development, without further public support. Once the qualitative and quantitative characteristics of the geothermal resource are deemed adequate for power generation, the financial analysis of the project demonstrates that geothermal power production is a competitive alternative to diesel-based base-load solutions with electricity price output ranging between 0.104 and 13.5 USD per kWh compared to 0.18 USD per kWh, the current average cost of production of the national power utility, LUCELEC and is financially viable under projected market conditions. More details on the financial analysis are provided in Annex 2.

34. **Effective utilization of concessional finance.** Public support for exploration is critical to address the resource risk. In the absence of funding support from government and development partners, risk capital may be the sole source of financing in the initial phases of the project, which will lead to higher off-take price of electricity. Models based on early interest of the private sector in Greenfield sites in St. Lucia and on neighboring island nations have attracted little interest from private investors. Experience in Indonesia has showed that private investors are reluctant to take on the exploration risk, even when they already hold concession rights in a relatively well known concession field. The proposed approach is consistent with international practice, where many countries have elected to directly fund the upstream risky phases.[25] CTF concessional funding will complement concessional financing (IDA credit in the amount of USD 5 million) and grant funding from DIFID (USD 5 million) and SIDS-DOCK (USD 2 million).

35. **Mitigation of market distortions.** The limited scope of the proposed project is intended to crowd in, rather than crowd out private sector investment following public support for early exploration drilling. Without public financing of exploration drilling, private sector participation in geothermal development would either not occur or would be prohibitively expensive. For this reason, CTF and other grant and concessional financing is focused on financing the DP in order to gather sufficient data on the characteristics of the geothermal reservoir. It is anticipated that once the results of the DP are available, St Lucia will be able to attract experienced geothermal developers to undertake the remaining exploration work which is required to design and assess feasibility prior to making a decision to finance, construct and operate the geothermal plant

[25] ESMAP, Technical Report 002/12, Geothermal Handbook: Planning and Financing Power Generation

and its associated facilities. Private sector investment from the project developer will support any additional drilling activities (e.g. delineation drilling), as well as investments in injection and production wells and development of the geothermal field, steam gathering infrastructure and the power plant.

36. **Risks.** We would like to focus on the following main risks.

(a) **Technical Design of Project.** The main risk affecting the development of the project pertains to the adequacy of the geothermal resource. Although surface reconnaissance studies show positive indications of geothermal resources in selected areas, exploration drilling is required to confirm the quality of such geothermal fields for power generation. The program has been designed so that the exploration wells can provide sufficient data to ascertain whether or not further investment is likely to be worthwhile. The design therefore allows for some flexibility within the DP based on initial findings. It is expected that once the quality of the resource is proven, the private developer will also undertake additional drillings (e.g. delineation drilling) to determine feasibility, as well as make follow-on investments in production and injection wells, steam collection pipes and the power plant. The nature of exploration drilling is such that the exploration program could be inconclusive or negative about the prospects of a viable geothermal resource.
Risk mitigation measures. This risk will be minimized by the use of a systematic, industry standard approach to resource confirmation, which will be utilized in the project. The flexibility inherent in the design will allow for some adjustments as needed. In the event that the geothermal development cannot advance further, the project could be amended to support other renewable energy projects in Saint Lucia.

(b) **Institutional Capacity for Implementation.** In spite of its recent history of geothermal exploration in the 1990s, Saint Lucia has limited capacity to design and manage a complex geothermal exploration drilling program.
Risk mitigation measures. The Government will procure the expert services of a global firm providing technical and exploration oversight (the "Exploration Management Consultant") to strengthen its capacity. The EMC will remain in place until the end of the DP. It will report to the Project Director of the GIT at the Department of Sustainable Development, and will represent the GIT in the technical advisory panel.

(c) **Fiduciary.** Given the need for efficient and timely implementation for private sector investment, the project will need dedicated capacity for project management and implementation consistent with World Bank guidelines. The current PCU within the MoF, which currently manages the procurement of all World Bank projects in Saint Lucia, is very familiar with the Bank's fiduciary requirements. However, it is overloaded with current responsibilities, making it unlikely to dedicate the necessary capacity to handle the additional workload and the complexity arising from the proposed project. For this reason, the fiduciary risk is rated as Substantial.
Risk mitigation measures. Saint Lucia will create a GIT within the Department of Sustainable Development, which will be responsible for overall project management, including technical oversight, fiduciary management and implementation support. The fiduciary functions of GIT will be performed either by consultants hired for specific tasks or by staff seconded from the PCU that currently provides procurement and financial management services to virtually all World Bank projects in the country.

(d) **Difficulty to attract private sector partner(s).** GoSL intends to handover further development of the geothermal project to a qualified private sector project developer after completion of the DP.

Given the relatively small scale of the opportunity in St Lucia, and as evidenced by experiences in neighboring islands, it may be difficult to attract experienced project developers to the island. St. Lucia has limited experience with renewables and even less experience in attracting IPPs to the sector. Attracting an experienced geothermal developer will require the development of a well-balanced set of concession and PPA agreements to off-take the power in a sustainable and cost-effective manner.

Risk mitigation measures. In addition to various enabling pieces of legislation, the government is preparing various model project agreements including a PPA for the off-take of the geothermal power output and a concession agreement for the subsequent engagement with a suitable private developer. The government will also conduct a market sounding so that it can find ways to develop broader interest in the geothermal opportunity in St Lucia in its effort to attract high quality partners to help deliver value-for-money to energy customers. Together with the use of grant and concessional financing for exploration drilling, these measures will make it more likely to attract an experienced private sector project developer as a partner to invest in the subsequent phases of drilling delineation, injection and production wells as well as building the steam gathering and other infrastructure needed for power generation.

(e) **Environmental Risks.** St. Lucia houses the dramatic Grande and Petite Pitons (sharp-peaked mountains) which symbolize the island. Along with the area near the Sulphur Springs, these comprise the Piton Management Area (PMA), a UNESCO World Heritage site which is a major tourist attraction that contribute significantly to the Saint Lucia economy. In order to maintain this desirable designation, the GoSL has established development limits and criteria for areas of the PMA.

Risk mitigation measures. Preliminary findings from the surface exploration studies indicate the most likely location of the geothermal reservoir to be several kilometers outside of the PMA, the location of impacts either completely outside of the PMA or at the margins of its buffer zone. All the drill locations currently envisaged for support under this project are well outside the PMA and in areas that allow for geothermal development. Since there may still be community concerns that remain, in addition to public consultation with neighboring communities, the project will devise a proactive communication strategy to discuss the opportunities presented by the geothermal exploration drilling project and address any community concerns, e.g. concerns regarding potential impacts within the PMA, or any associated with the exploration process or with resettlement.

(f) **Stakeholders.** Poor results on past geothermal energy endeavors starting in the 1970s as well as, potential perceived impacts in the UNESCO World Heritage Site's Piton Management Area (PMA) are a risk. Although the exploration drilling will take place outside the protected area, there may be community concerns that remain.

Risk mitigation measures. To take into account the concerns and perceptions of stakeholders, the project will design and implement a communication strategy to be implemented throughout the phases of the project.

(g) **Social and Resettlement Risks.** A geothermal power plant requires land acquisition for the power plant, wells, network of interconnecting pipework, a transformer station, and electricity transmission lines to connect to the grid, access roads, and other infrastructure. Land acquisition would occur gradually, starting with a few wells for the exploration and provisions for drilling infrastructure works (access roads, well pads, water supply among others), and followed by the subsequent land needs per the defined phases. Private developers might approach landowners

through a 'willing-buyer-willing-seller' approach. Resettlement Policy Framework (RPF) will detail the process for the preparation of the Resettlement Action Plans (RAP) required for the final locations and design of the project. The RPF document will be consulted and disclosed.

Risk mitigation measures. The project will seek broad community support through timely consultations and set up redress mechanisms to resolve concerns during the project cycle. Consultations results and grievance mechanisms will consider community needs and concerns.

37. **Consistency with FIP, PPCR and SREP investment criteria.** The project is aligned with the Pilot Program Climate Resilience (PPCR) support and investment strategy in the country, which is articulated around enhancing resilience to climate change though minimizing environmental degradation and protecting climate sensitive and critical infrastructure. The development of indigenous renewable energy resources will help the country transition to a green economy and contribute to climate resilience. There are no Forest Investment Program (FIP) or Scaling Up Renewable Energy in Low Income Countries Program (SREP) programs in the country.

38. **Stakeholder engagement.** A multidisciplinary technical advisory panel with representatives from the drilling contractor, LUCELEC, PMA and other experts is being created, and its recommendations and advice will be taken into consideration for implementation by the GIT. In addition to consultation with communities potentially affected by any involuntary resettlement, the project will devise a proactive communication strategy to discuss the opportunities presented by the geothermal exploration drilling project and address any community concerns, e.g. concerns regarding potential impacts within the PMA.

39. **Public Consultations.** GoSL has been actively pursuing policies geared towards reducing Saint Lucia's dependence on fossil fuels for energy generation. Three sets of formal public consultations regarding proposed geothermal development activities have been conducted by the GoSL with members of the community, regulators and other stakeholders, including NGOs. The first two sets of consultations were conducted on 18-19th February, 2015 and July 1, 2015 by the then Ministry of Sustainable Development, Energy, Science and Technology at the time that surface exploration activities were launched. Subsequently, after the surface study results were complete and as the drilling project was being designed, a third public consultation was held on 11th April, 2017 by the Department of Sustainable Development.

40. GoSL representatives from the Department of Sustainable Development, the Renewable Energy Unit, the Public Utilities Commission and from the PCU presented project information and answered questions on the following issues that were raised at the April 2017 meeting:

Project beneficiaries

- How many households would the Geothermal Plant be able to provide power for?
- What is the plan for human resource development, including required skills and will there be opportunities for training?

Ownership of geothermal plant and project costs

- Who will have ownership of the Plant?
- How will this Project affect independent power producers?
- What proportion of the cost of the Project will the Government of Saint Lucia bear?
- Was a cost analysis done to compare the cost of energy now and hereafter with the geothermal plant?

- Where would the diesel for 'back-up' generation be sourced from?
- How involved is NURC, the regulator, in this Project?

Location of drilling sites and Environmental and Social concerns

- What is the location of current sites relative to the ones where there was initial drilling conducted in the 1980s?
- Where will the ESIA be conducted? Will there be any drilling within the PMA?
- How will any water quality concerns be handled?
- Can H_2S emissions be controlled during drilling?
- Will directional drilling be explored?

41. GoSL has indicated that it will continue to conduct additional consultations as further progress on project development continues, and that these would include specific discussions with the business community, community leaders, students and youth groups.

42. **Gender considerations.** The project will include a gender perspective by integrating activities that promote job creation and training to provide equal opportunity to persons from both genders. This may include partnerships with technical schools and universities to promote internship programs for students. The technical assistance component will include activities specifically addressing the gender perspective, with a view to strengthen the capacity of the implementation agencies to deliver on that agenda. In addition, the project will explore additional opportunities for gender inclusion, as a part of the appraisal process prior to World Bank Board approval.

D. FINANCING INSTRUMENTS

43. The project will be financed by an IDA credit of USD 5 million, a CTF contingent grant of USD 8.572 million, a CTF Project Preparation Grant of USD 0.953 million along with a DFID grant of USD 5 million, and a SIDS-DOCK grant of USD 1.85 million and co-financing of USD 1 million from the GoSL. The resources will be administered through a designated account at the Bank of Saint Lucia. Wherever feasible, the project will first deploy grant resources, including contingent grant resources, to fund the drilling program followed by concessional financing.

44. The CTF contingent grant is repayable to the CTF, upon the completion of a successful drilling program, where "success" is defined as: a) confirmation of a viable quality resource based on the validated drilling report [drilling indicators defined in box 3, Annex 1], b) private developer(s) on board, and c) successful commissioning of a power plant. For the absence of doubt, the CTF contribution will remain as a grant in the event that the drilling program as defined above is unsuccessful.

45. To enable the recovery of the CTF contingent grant, the GoSL will include provisions for the recovery of up to 100% of the nominal value of the disbursements under the CTF grant as part of the relevant legal agreements, i.e. concession agreement and/or Power Purchase Agreement (PPA) with a qualified project developer keeping in mind the objective of securing a cost-effective PPA tariff. The GoSL may retain the contingent grant for a maximum of seven years after power plan commissioning for any technical or financial contingencies as agreed with the World Bank. Any undisbursed CTF resources upon project close will be returned to the CTF.

E. IMPLMENTATION AND MANAGEMENT PLAN

E.1. Institutional and Implementation Arrangements

46. **The project is proposed to be implemented by the DSD, within the MoESD.** DSD is led by a Permanent Secretary (PS-DSD), and is responsible for renewable energy policy and implementation in Saint Lucia. The PS-DSD will convene an advisory committee comprising of relevant stakeholders, including representatives of the Department of Economic Planning & National Development in the MoF and the Public Utilities Commission in the MoIPEL, among others, who may be consulted.

47. **DSD will establish a dedicated GIT to be headed by a Project Director who will be accountable to the PS-DSD for all aspects of project implementation and management, including technical and fiduciary coordination.** Given GoSL's limited technical capacity for overseeing and implementing a geothermal exploration program of this magnitude, the GIT will procure the specialized capacity and skills of an EMC to enhance GoSL's capacity to implement and oversee the DP. The scope of the EMC will include design of specifications for the engagement of a drilling contractor as well as to oversee the drilling campaign. The project design provides for the procurement of the EMC in time for the completion of the pre-feasibility study and the ESIA, so that preparation for the DP can begin in a timely manner, starting with the procurement process of the drilling contractor utilizing approved CTF PPG and SIDS-DOCK funds prior to Board or through retroactive financing of eligible activities defined and agreed with the Bank prior to Board approval.

48. **The GIT Project Director, through the EMC, will convene a multidisciplinary technical advisory panel to provide input, advice and recommendations related to the exploration drilling program, including on any adjustments.** The panel will include representatives from the drilling contractor, LUCELEC, PMA and other experts in order to facilitate discussion and resolution of issues. The DSD through the GIT will also communicate and engage frequently with private sector geothermal developers and representatives of civil society (e.g. the Consumers Association) to consult with these stakeholders and to keep them informed about the progress of the exploration drilling process and implications for future development.

49. **As the project's lead implementing agency, DSD will have the responsibility of managing the process of implementing the project consistent with World Bank guidelines, procedures and practices**. In the interim, and until such time as final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the Project Coordination Unit (PCU) linked to the MoF, and/or through the engagement of specialized consultants with the necessary skills. It is to be noted that the PCU currently administers all existing World Bank loans and grants, including for the ongoing GRDP TA project, and has dedicated staff that benefit from the experience of implementing World Bank projects for the past 15 years. However, the PCU is overloaded with heavy responsibilities, making it important to consider dedicated alternatives to support the DSD in performing the fiduciary requirements that are expected due to the additional workload and the complexity arising from the proposed highly specialized geothermal exploration project.

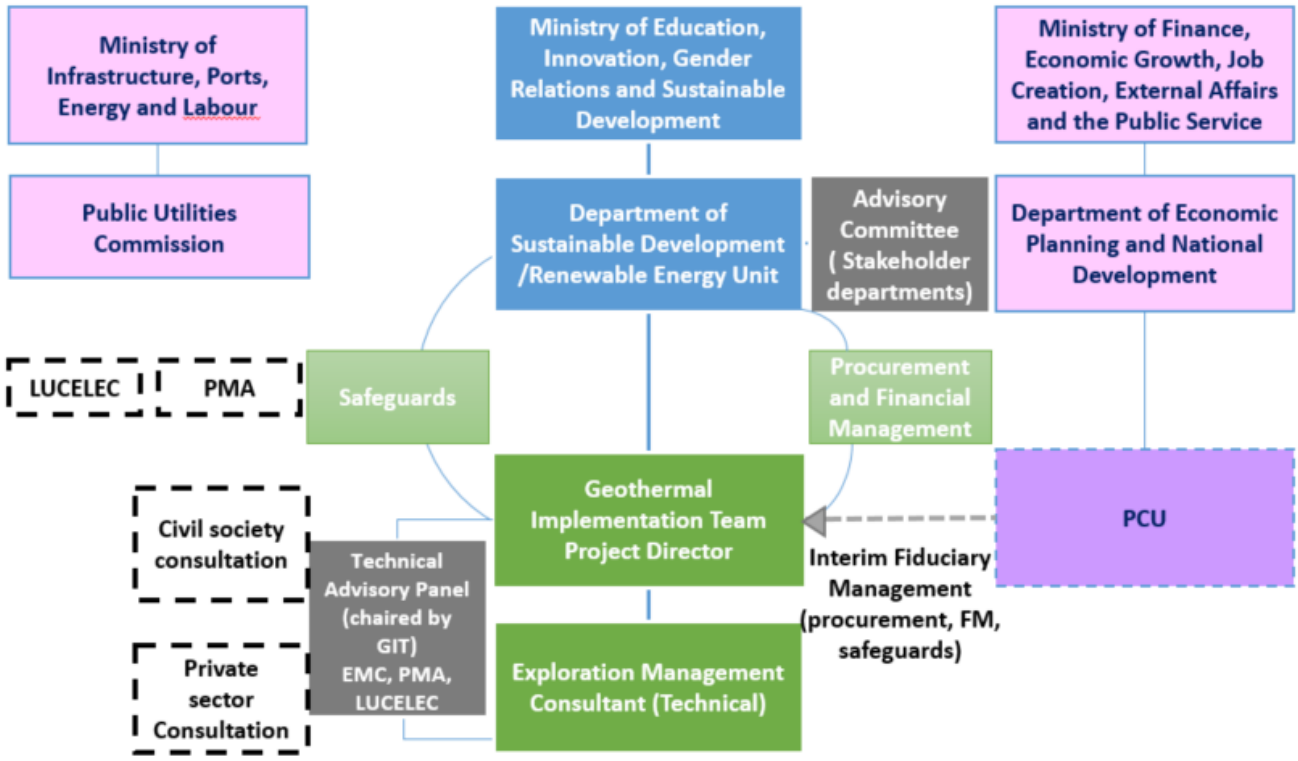

Figure 5: Project Implementation Arrangements

50. **LUCELEC will play a key role in the geothermal power off-take and its integration in the electricity supply system to support the GoSL's renewable energy policy goals.** However, despite the utility's strong experience in power sector operations, LUCELEC does not have prior experience in geothermal development or in negotiating a suitable off-take agreement. Nonetheless, once completed, LUCELEC, as system operator, will integrate the geothermal plant's output into the domestic electricity network. As DP implementation progresses, the GoSL and LUCUELC will explore alternative models for future implementation, including, among others, a Special Purpose Vehicle (SPV) to implement the geothermal project or, alternatively other arrangements, e.g. a joint venture with the government and/or LUCELEC working in strategic partnership with a qualified private developer.

51. **The fiduciary functions of the DSD/GIT will be performed either by consultants hired for specific tasks or by staff seconded from the PCU that currently provides procurement and financial management services to virtually all World Bank projects in the country.** The PCU is comprised of a diverse team of procurement specialists with experience with World Bank guidelines, and conducting procurement under World Bank group funded projects. The GIT in consultation with the PCU will prepare the Project Procurement Strategy for Development (PPSD), which is a project-level strategy document prepared by the borrower that describes how procurement in Investment Project Financing (IPF) operations supports the development objectives of the project and delivers value for money. PPSD will be reviewed and agreed upon with the Bank before the completion of loan negotiations. Staff from the PCU attended the workshop held in Grenada in

the beginning of November 2016 dedicated to the Bank's new procurement regulations. The PCU staff have now been trained and acquainted with the new framework and its application and methods. The PCU was informed of the need to start to prepare the PPSD document and the Bank offered its support on this preparation.

52. **The Bank performed a financial management assessment of the proposed project in accordance with OP/BP 10.00 and the financial management practice manual issued by the Financial Management Sector Board (FMSB) in March 1, 2010.** It was concluded that the MoF, the recipient agency, will have in place an adequate financial management system that can provide accurate and timely information with reasonable assurance on the status of the funds as required by the Bank. The fiduciary arrangements will be carried out by the GIT, and the relevant governmental agencies will oversee the implementation of the project and will provide the necessary technical input and overall oversight.

E.2. Results Monitoring and Evaluation

53. **A results and monitoring framework to document and measure the project's development impact have been discussed with GoSL and the co-financiers, and will be re-confirmed during appraisal and negotiations.** The results and monitoring framework will identify results indicators for the project as a whole, as well as intermediate results. The project implementation manual will document the arrangements for results monitoring with institutional responsibilities. The implementing agency and the Bank will agree on target values for the various results indicators.

E.3. Role of Partners

54. **Development partners share a common understanding of the opportunities and challenges attached to geothermal development in Saint Lucia, and will continue to play an important role going forward.** Concessional finance and grants provided by IDA, DFID, CTF, and SIDS-DOCK are critical to enabling public sector financing of the geothermal exploration phase without placing undue burden on the government budget. The proposed project provides an ideal platform for current partners to come together and deploy their respective support in complementarity with one another and based on their respective comparative advantages. This platform with a shared understanding of the role geothermal energy can play in transforming St Lucia's energy future, promises to greatly enhance the effectiveness and impact of any one partner working alone. The World Bank and the IDB are working in close coordination to promote geothermal development in the Eastern Caribbean without duplication of efforts.[26i]

[26] The Inter-American Development Bank (IDB) in coordination with the Caribbean Development Bank (CDB) has developed the USD 71 million Sustainable Energy Facility (SEF) for the Eastern Caribbean for geothermal development in Grenada, Dominica, St Lucia, St Vincent and the Grenadines and St Kitts and Nevis. IDB and CDB have indicated that they are preparing complementary funding for the SEF using funding from the Green Climate Fund (GCF) of US$ 80 million. The IDB-CDB team has indicated that the SEF could be an option for Saint Lucia to consider for a subsequent phase of project development.

ANNEX 2: ST. LUCIA DEBT SUSTAINABILITY ANALYSIS (DSA)[27]

St. Lucia
Renewable Energy Sector Development Project

A. Macroeconomic performance and background

1. **St. Lucia, a small island developing state (SIDS) of upper-middle income, is the largest economy in the Eastern Caribbean Currency Union (ECCU).** With the erosion of EU trade preferences that began in the 1990s, St. Lucia incrementally shifted away from its traditional reliance on agricultural production to significant reliance on tourism. As with other SIDS facing diseconomies of scale, its narrow production base—combined with low productivity, dependence on imported fossil fuels, and high exposure to natural disasters—have constrained St. Lucia's growth potential. Consequently, the Global Financial Crisis (GFC) highlighted led to a sharp decline in tourist arrivals and receipts, which reverberated into the rest of the economy and led to lower growth outturns. Consequently, unemployment and bank nonperforming loans (NPLs) rose markedly. In response, the government tried to buffer the impact of the GFC through fiscal stimulus measures, including public sector wage increases, and construction spending, which lead to a deterioration in fiscal and current account positions into large deficits, and a substantial increase in public debt.

2. **Supported by improvement in external conditions, the economy has emerged slowly from the GFC.** Economic recovery in the main source markets for tourists (the United States and the United Kingdom) and relatively low oil prices have supported strengthened economic activity. Unemployment has declined, although it remains elevated, and the external current account deficit has narrowed significantly, in part given weakened domestic demand. Additionally, the government has achieved a degree of fiscal adjustment through increased revenues with stronger growth outcomes, the introduction of a VAT, and enhanced tax compliance. Public sector expenditures have been partially contained with the introduction of a public sector nominal wage freeze, and reduced capital outlays that was forced given financing constraints. The banking sector, however, remains encumbered by NPLs, which has contributed to sustained contractions in credit growth. Public sector debt has continued to rise.

3. **Driven by agriculture and construction, GDP growth is estimated to have reached 0.8 percent in 2016, down from 1.8 percent in 2015.** Strong employment growth in agriculture and construction put a dent on unemployment, which declined to 20 percent in the third quarter of 2016. Youth unemployment also fell, but remains very high at 41 percent. However, weakness in tourism, manufacturing, and transportation dampened growth. Exports of goods declined, contributing to widen the current account deficit to an estimated 6.7 percent of GDP in 2016. Inflation was driven down by import prices, and lingered in negative territory over the last 12 months. GDP is projected to grow at 0.5 percent in 2017, driven mostly by continued strong performance in construction and agriculture. Higher import prices, including oil, will cause inflation to rise temporarily and, together with weak tourist expenditures, will contribute to widen external imbalances. With slow progress in cleaning up their balance sheets, banks are expected to further shrink their loan

[27] The annex is largely excerpted from the March 2017 Article IV and DSA for St. Lucia. *NOTE: Later in 2017, the Government will be releasing revised national income and product accounts that will result in a substantial (estimated 20 percent) upward revision in the level of St. Lucia's GDP. This in turn will result in a corresponding marked improvement (about 20 percentage point reduction) in the debt-to-GDP ratio. Consequently, when the next DSA is conducted, the risk assessment is expected to improve (from the current assessment of a high risk of debt distress), however, the DSA cannot be prepared and the risk assessment revised until the data is published.*

portfolio. While the forthcoming budget should bring some clarity about fiscal policies, in the absence of corrective measures, rising interest payments will add to expenditure pressures, leading public debt to an unsustainable path. As commodity prices gradually rise from recent lows, the current account deficit will widen, reflecting low competitiveness. Unless structural reforms are implemented, rigidities in the labor market, high costs of doing business, and low external competitiveness will continue to weigh on growth.

B. Debt Sustainability Analysis (DSA) Background

4. **St. Lucia's debt has been increasing rapidly over the last two decades.** The dramatic rise in public debt began around the time the traditional banana industry collapsed in the mid-1990s and was aggravated by the impact on tourism of the 9/11 terrorist attacks and the global financial crisis. Thus, between FY1996/97 and FY2014/15, public debt rose from 28 to 79 percent of GDP. Public debt as a share of GDP actually declined slightly in FY 2015/16 as a result of improved fiscal performance.

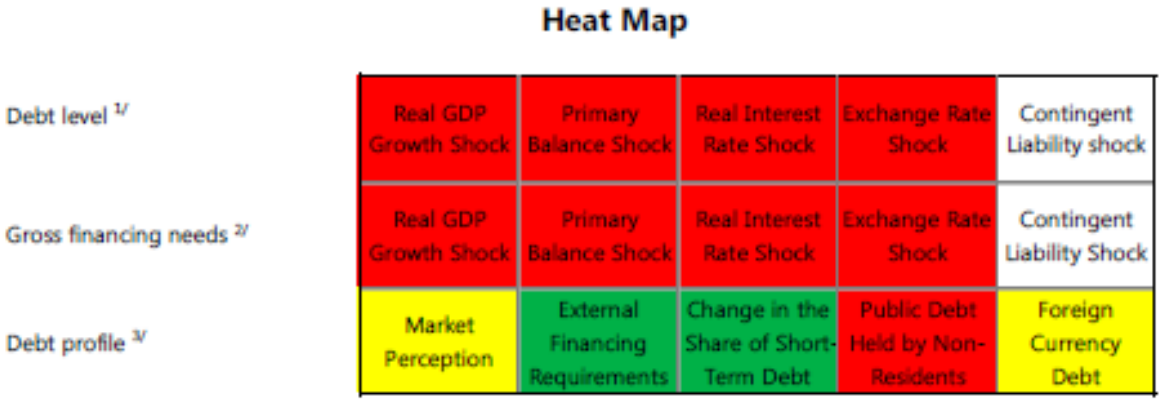

Figure 6: St. Lucia Public Sector DSA Risk Assessment

5. **Central government obligations constitute the largest component of St. Lucia's public debt and have been rising over time.** These obligations include market-based securities, commercial bank bonds and loans, bilateral and multilateral debt, loans from the national insurance scheme (NIC), overdraft facilities, and outstanding payables. Public debt also includes government guaranteed loans from domestic commercial banks and multilateral institutions to statutory enterprises. While central government debt has increased, government-guaranteed debt has declined in recent years.

6. **Despite having access to concessional forms of project financing, the majority of St. Lucia's debt is market-based and used for general budget financing.** Bilateral and multilateral debt amounts to one quarter of total public debt, with the Caribbean Development Bank as the largest creditor. In contrast, the remaining three-quarters of St. Lucia's debt instruments have been issued on commercial terms, of which 35 percent through the ECCU Regional Government Securities Market (RGSM). Other sources are the Trinidad and Tobago securities exchange, the Eastern Caribbean Securities Exchange, other private placements, and bonds and loans issued directly to the NIC.

7. **Central government debt is fairly balanced between domestic and external creditors (52 and 48 percent, respectively as of end-December 2016).** Within domestic debt, non-bank financial institutions (including the NIC) and commercial banks hold the largest shares.

C. Public Debt Sustainability Analysis

8. **Public debt is unsustainable under the baseline scenario as projected debt levels and government financing needs are well above benchmark levels and increase throughout the projection period.** Market access for long-term financing has recently improved, but this could easily change in the absence of stronger policies.

9. **Staff's baseline scenario continues to project an unsustainable debt burden.** Under the baseline macroeconomic framework increasing public debt affects investors' appetite for St. Lucia's debt instruments, thus leading to a gradual reduction in financing for public investment starting in FY 2018/19. Despite this financing constraint, public debt would continue to rise, reaching 95.6 percent of GDP by FY 2021/22 and 112.8 percent of GDP by FY2030/31, thus missing the 2030 debt target of 60 percent of GDP. As mentioned earlier in this staff report, the staff-proposed adjustment would result in a continued decline in public debt, reaching 60 percent of GDP by 2030 as intended by the authorities.

10. **Under DSA adverse shock scenarios, the baseline debt path becomes even less sustainable.** The growth shock, which simulates a one standard deviation adverse shock to real GDP growth over 2016-17, has the most severe outcome among the single shock scenarios, with public debt reaching 103.3 percent of GDP by FY2021/22. Other adverse shock scenarios affect significantly the path of public debt. It is worth noting that the risk posed by an exchange rate shock is mitigated by the near-currency-board arrangement for the Eastern Caribbean dollar. Under the combined macro-fiscal shock public debt would reach 112.4 percent of GDP by FY2020/21. On the other hand, an alternative scenario taking into account staff's recommended adjustment policies would gradually reduce financing needs and the debt-to-GDP ratio.

D. External Debt Sustainability Analysis

11. **Under the baseline scenario, external debt is projected to increase gradually reflecting the expected increase in public debt.** External debt is projected to reach 89 percent of GDP by 2021, up from 83 percent in 2016. Furthermore, the external debt path remains vulnerable to potential adverse shocks. Were key variables to remain at the historical levels seen in the aftermath of the Global Financial Crisis, external debt would be on an upward trajectory reaching 146 percent of GDP by 2021. The adverse shock scenarios also suggest vulnerability— under the growth, interest rate, current account, and combined shock scenarios, external debt rises throughout the forecast period. The most severe effects are observed under the real exchange rate depreciation scenario, which would result in a step increase in external debt to around 124 percent of GDP in the year of the shock and reaching 132 percent by 2021. The vulnerability suggested by this scenario is mitigated by the regional central bank's near-currency board-arrangement.

E. Impact of CTF borrowing

12. **The total CTF request for the project is US $9.525 million, of which US$ 0.953 million would be provided as a grant, and US$ 8.572 million as a contingent grant.** In the event of a successful geothermal development (defined below), the $US 8.572 million grant is recoverable over the period of the relevant concession agreement or Power Purchase Agreement (PPA) with the private sector developer.

13. **The US$ 8.572 million contingent grant component, would only become fully recoverable in the event that a private sector developer successfully develops and commissions a geothermal power plant.** If the drilling exercise is unsuccessful or there is no power plant successfully commissioned, the US$8.572 million remains a non-reimbursable grant. In the event that i) technical indicators during drilling are met, ii) private sector developer(s) is(are) brought on board, and iii) a power plant is successfully commissioned, the Government of St. Lucia intends to have the developer assume responsibility to repay the recoverable grant portion, in which case the grant recovery amount would be backed by the Government and represent a

contingent liability if the private developer were not to pay back the credit. The terms of the contingent grant are highly concessional at zero interest, and only the principal would be reimbursed if a private developer takes the project. The impact on public sector indebtedness, if the government were called upon to cover the payments, was analyzed assuming repayment of the US$ 8.572 million principal amount, with zero interest over the recovery period.

14. **The CTF US$ 8.572 million repayment would account for 0.75% of total external public debt as of end-2016, and would therefore have a minor impact on overall public sector indebtedness.**

Table 5: St. Lucia Public Sector DSA – Baseline Scenario (Debt, Economic and Market Indicators)*

	Actual			Projections					As of January 24, 2017		
	2005-2013**	2014	2015	2016	2017	2018	2019	2020	2021		
Nominal gross public debt	50.5	78.1	77.8	82.9	85.6	88.6	90.9	93.3	95.6	Sovereign Spreads	
Of which: guarantees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	EMBIG (bp)***	483
Public gross financing needs	8.2	16.4	12.2	25.3	22.9	38.5	35.1	45.3	47.8	5Y CDS (bp)	258
Real GDP growth (%)	0.9	0.7	1.6	0.7	0.7	1.5	1.5	1.5	1.5	Ratings	Foreign	Local
Inflation (GDP deflator, %)	3.5	3.9	0.0	-2.4	2.1	0.9	1.5	1.5	1.5	Moody's	n.a	n.a
Nominal GDP growth (%)	4.4	4.7	1.6	-1.7	2.9	2.4	3.0	3.0	3.0	S&Ps	n.a	n.a
Effective interest rate (%)****	5.1	5.2	5.4	6.6	6.1	6.3	6.4	6.6	6.6	Fitch	n.a	n.a

Source: IMF staff.
*Public sector is defined as central government and includes public guarantees, defined as.
**Based on available data.
***EMGJG.
****Defined as interest payments divided by debt stock (excluding guarantees) at the end of previous year.

Table 6: St. Lucia Public Sector DSA – Baseline Scenario (Contribution to Changes in Public Debt)

	Actual			Projections							
	2005-2013	2014	2015	2016	2017	2018	2019	2020	2021	cumulative	Debt-stabilizing primary balance*****
Changes in gross public sector debt	8.6	0.9	-0.3	5.2	2.7	3.0	2.4	2.3	2.3	17.8	
Identified debt-creating flows	3.8	0.3	1.3	5.7	2.6	3.9	2.1	2.0	1.8	18.1	
Primary deficit	-0.9	-0.1	-1.5	-0.8	-0.1	0.6	-0.8	-1.1	-1.5	-3.7	3.2
Primary (noninterest) revenue and grants	24.9	25.7	27.0	28.0	27.2	27.2	27.2	27.3	27.3	164.3	
Primary (noninterest) expenditure	24.0	25.6	25.5	27.1	27.2	27.8	26.4	26.2	25.9	260.6	
Automatic debt dynamics*	1.7	0.4	2.8	6.6	2.6	3.3	2.9	3.2	3.2	21.8	
Interest rate/growth differential**	1.7	0.4	2.8	6.6	2.6	3.3	2.9	3.2	3.2	21.8	
Of which: real interest rate	1.7	0.9	4.0	7.2	3.2	4.5	4.2	4.5	4.6	28.2	
Of which: real GDP growth	0.0	-0.5	-1.2	-0.6	-0.6	-1.2	-1.3	-1.3	-1.4	-6.4	
Exchange rate depreciation***	0.0	0.0	0.0	…	…	…	…	…	…	…	
Other identified debt-creating flows	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Government and Public Sector Finance	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Contingent liabilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Please specify (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

(e.g., ESM and Euro area loans)										
Residual, including asset changes****	-0.3	0.6	-1.7	-0.6	0.1	-0.9	0.2	0.3	0.5	-0.3

Source: IMF staff.

*Derived as [(r-π(1+g)-g+ae(1+r))/(1+g+ π+g π)] times previous period debt ratio, with r=interest rate, π=growth rate of GDP deflator, g=real GDP growth rate, a=share of foreign currency denominated debt, and e=nominal exchange rate depreciation (measured by increase in local currency value of US. Dollar).

**The real interest rate contribution is derived from the numerator in footnote * as r- π(1+g) and the real growth contribution as -g.

***The exchange rate contribution is derived from the numerator in footnote 5 as ae(1+r).

****Includes changes in the stock of guarantees, asset changes, and interest revenues (if any). For projections, includes exchange rate changes during the projection period.

*****Assumes that key variables (real GDP growth, real interest rate, and other identified debt-creating flows) remain at the level of the last projection year.

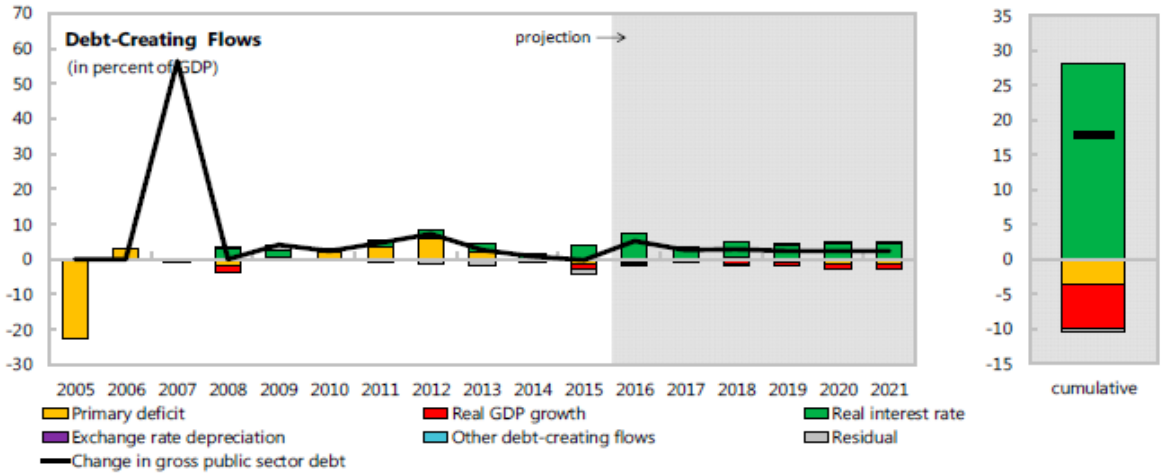

Figure 7: St. Lucia Public Sector DSA –Baseline Scenario

ANNEX 3: PRELIMINARY ECONOMIC AND FINANCIAL ANALYSIS

St. Lucia
Renewable Energy Sector Development Project

1. This annex presents the analysis of the project's development impact in terms of expected benefits and costs, as well as a financial analysis, which aims to demonstrate how a government-sponsored drilling program can de-risk the project, support the mobilization of private sector resources for the development of the project and contribute to the provision of clean and affordable power.

Cost-benefit analysis

2. The exact capacity of the plant will be primarily determined by the number of wells drilled, the flow rate and the temperature of geothermal fluids, the sustainability of the reservoir for power generation and the chemistry of the geothermal fluid. All these parameters are confirmed during the exploration drilling phase supported by the public sector through the proposed project, and the delineation and flow test phase which will be carried out by the private sector, if the results of the DP provide reasonable evidence of the adequate geothermal resources. This analysis assumes the development of a green-field geothermal plant of 30 MW.

3. A cost-benefit analysis was carried out taking the economic cost and benefits of the proposed geothermal plant vis-à-vis a diesel plant of equivalent installed capacity, which represents the alternative to the project. The analysis attempts to assess the economic cost and benefits associated with the proposed development, with a view to calculate the Net Present Value (NPV) of the monetized value of the economic impact of the project.

4. The economic costs were based on estimated capital, operations and maintenance expenditures for a green-field 30 MW geothermal plant. Investment cost were split into mobilization and land acquisition, exploration drilling including associated infrastructure and well testing, delineation drilling and associated flow testing, production drilling and power plant and SAGS construction, and project management and supervision costs. The initial investment cost is estimated at USD 146.5 million (not including future drilling of make-up wells) or approximately USD 4.9 million per MW installed. It is assumed that additional well drilling will be required every five years at the cost of USD 6 million per campaign. Operating and maintenance cost were estimated at USD 2.5 million per annum. Interconnection and battery storage cost are excluded from the scope of the analysis since (a) the procurement, operation and maintenance of interconnection facilities falls under the responsibility of LUCELEC, and (b) the proposed energy storage system will be implemented regardless of the outcome of the geothermal exploration. It is assumed that the geothermal plant will commence operations in January 2023 and operate for 25 years.

Table 7:Total Investment Cost

Investment Category	**Amount** (USD million)
Exploration drilling*	16
Land acquisition	1
Project management and supervision	2

of the exploration drilling phase	
Delineation drilling including flow testing	28.5
Production drilling	28.5
SAGS	10.5
Power plant	60
Make-up wells over the 25-year period	24
Total	**170.5**

*Not including shared services.

5. **The economic benefits of the geothermal plant consist of the economic value of the power supply from the plant and the avoided cost in CO_2 emissions vis-à-vis thermal powered generation.** The economic value of the power supply is estimated as (a) the avoided cost of building and maintaining the 30 MW diesel power plant that will be required in the absence of the geothermal plant, and (b) savings arising from the supply of a cheaper source of power calculated as difference between the customers' willingness-to-pay and the estimated electricity charge resulting from the geothermal project.

6. **The counterfactual.** The geothermal development will substitute a diesel power plant. Investment and operating costs associated with the latter represents benefits arising from the project. The key assumptions related to the development of this alternative project are presented in the table below:

Table 8:Key assumptions of alternative diesel plant

Plant type	Thermal	
Technology	Combustion	
Fuel	Diesel	
Commercial operations	January 2023	
Capacity factor		90%
Capital cost	USD/ kW	600
Fixed O&M cost	USD/ kW- year	15
Heat rate	BTU/kWh	10,000
Heat content for diesel	mmBTU / bbl	5.778
Average cost of fuel	USD/liter	0.75

7. **Willingness-to-Pay.** Saint Lucia's electricity generation sector is dominated by diesel power generation, which represents 99.4 percent of its production, for average production cost of approximately USD 0.18 per kWh (2015 oil prices). Total electrification rate is approximately 98 percent, while transmission and distribution losses are estimated at 9.3 percent. Average electricity rates are estimated at USD 0.34 per kWh for residential customers and USD 0.47 per kWh for commercial and industrial customers.28 The analysis conservatively assumes that the geothermal production will predominantly benefit residential customers, thus the estimated WTP value of USD 0.34 per kWh. Assuming a geothermal production cost of USD 0.10429 per kWh, it can be inferred that the retail tariff associated to the portion of the electricity generated through the geothermal plant is approximately USD 0.264 per kWh, representing and economic saving of USD 0.074 per kWh.

[28]Source: National Renewable Energy Laboratory (NREL), Energy Transition Initiative: island Energy Snapshot – Saint Lucia, February 2015

[29] Value resulting from the financing modelling exercise conducted as part of the financial analysis

8. **Avoided cost of GHG emissions vis-à-vis thermal power.** Modern closed-loop geothermal power plants emit no greenhouse gasses; however, a default global average fugitive GHG emissions from geothermal power plants is assumed at 0.128 tCO_2eq/kWh[30]. In the absence of data on the gas content of the geothermal fluid in the potential geothermal reservoir in the project area, this is the best estimate for a future geothermal power plant in St Lucia. Emission factor for diesel generators is approximately 0.65 tons CO_2eq/ MWh. This data will be considered as a proxy to the emission factor of the alternative thermal generation plant. Based on 90 percent capacity factor and 30 MW installed capacity for both the geothermal project and its fossil-fuel based alternative, the calculated annual GHG emissions of the geothermal plant is approximately 30,275tCO_2eq, compared to 153,738 tCO_2eq for an alternative diesel generation plant. This is equivalent to net GHG emission savings of 123,563 tCO_2eq annually, or 3.1 million tCO_2eq, over 25 years.

Table 9:Summary of Economic Benefits

		Amount (USD million)
Economic costs	**Geothermal development**	
	Capital cost	170.5
	Operations and maintenance cost	62.5
Economic benefits	**Substituted power generation**	
	Avoided capital cost of diesel plant	18
	Avoided O&M (excl. fuel) cost of diesel plant	11.3
	Avoided cost of diesel fuel	1.2
	Electricity price saving based on willingness to pay	407.6
	Environmental externalities	
	Avoided cost of CO_2 emissions vis-a-via thermal	150.5
	Net economic benefit arising from the geothermal project (undiscounted)	**355.6**

9. **Outcome of the economic analysis.** Assuming an economic opportunity cost of 6 percent,[31] the 30 MW geothermal development yields an economic net present value (ENPV) of USD 81.46 million, which is equivalent to an Economic Internal Rate of Return (EIRR) of 11.6 percent.

10. **Financial analysis.** The Financial Analysis was carried out to assess (a) the financial viability of the geothermal project from the perspective of a private developer, and (b) the effect of upstream public support on the electricity tariff. The analysis is based on a financial model, which has been designed to calculate the off-take price that could be requested by a private developer, based on specific assumptions including the expected return on equity and the financing structure of the project. All revenues and expenditures are expressed in real 2016 terms.

11. **Expected return on equity.** The financial solves for the tariff that will be required to achieve a Return

[30]Source: *ESMAP, 2016: Gases in Geothermal Fluids and Gas Emissions from Geothermal Power Plants, ESMAP Technical Report 009/16nts, April 2016, ESMAP Technical Report 009/16.*
[30] ESMAP, Technical Report 002/12, Geothermal Handbook: Planning and Financing Power Generation
[30] The Inter-American Development Bank (IDB) in coordination with the Caribbean Development Bank (CDB) has developed the USD 71 million Sustainable Energy Facility (SEF) for the Eastern Caribbean for geothermal development
[31]Source: Discounting Costs and Benefits in Economic Analysis of World Bank Projects, OPSPQ, 2016

on Equity (ROE or Equity Financial IRR) of 15 percent in real USD terms,[32] with and without grant funding for the exploration drilling phase. This value is assumed for discussion purposes only based on preliminary discussions with the Government.

12. **Financing structure.** The financing structure provides for a public grant for the exploration drilling phase, followed by delineation drilling and flow testing financed through private sector's equity. These initial phases are essential to collect the data necessary to ensure the bankability of the project, and thus precede financial close. Production drilling and plant construction are financed through a mix of debt and equity.

13. It was assumed that the private investor is financed through (a) a 17-year commercial loan which includes a 3-year grace period, with an annual interest rate of 7 percent, and (b) equity, with a cost of capital of 12 percent. The target capital structure of the private developer's financing is 70:30 debt-to-equity. Corporate income tax is assumed to be 30 percent. Assets are depreciated over 25 years on a straight line basis, for accounting purposes.

Table 4: Sources and uses of funds

Sources of funds (USD million)		Uses of funds (USD million)	
With grant			
Grant	19.00	Exploration drilling	16.0
Equity investment	45.45	Land acquisition (GoSL contribution)	1.0
Debt capital	106.05	Project management and supervision	2.0
Total financing	**170.50**	Delineation Drilling incl. flow testing	28.5
		Production drilling	28.5
Without grant		SAGS	10.5
Equity investment	51.15	Power plant + electrical conversion	60.0
Debt capital	119.35	Make up wells	24
Total financing	**170.50**	**Total investment cost**	**170.5**

14. The results of the financial simulation provide as follows:

- With exploration drilling financed through a public sector grant, the project's Financial Net Present Value (FNPV) is USD 44.38 million[33] which is equivalent to an FIRR of 9.8 percent. The breakeven electricity price output required to achieve the 15 percent target Equity FIRR is equivalent to 0.104 USD per kWh.
- Without the grant, the private developer finances the entirety of the geothermal development. The project's FNPV is estimated at USD 73.62 million[34] for a Financial Internal Rate of Return (FIRR) of 10.9 percent. The off-take price needs to be increased to USD 0.135 per kWh to allow the private developer

[32] Assuming an inflation differential of 3 percent between the US and Saint Lucia, this is equivalent to an expected return of 18 percent in nominal terms.
[33] Assuming a financial discount rate of 6.25 percent, which is the weighted average cost of capital of the private developer, based on the underlying financing structure.
[34] The discount rate is the weighted-average-cost-of-capital of 7.38 percent, based on the capital structure which assumesn0 grant support

to breakeven that is, to achieve its target Equity FIRR.

15. **In essence, the provision of the grant allows for a reduction of the off-take by 30 percent, from USD 0.135 per kWh to USD 0.104 per kWh.** Moreover, assuming a fixed off-take price of USD 12 per kWh for illustration sake, the private developer's equity rate of return varies from 12.9 percent (without grant), to 18.5 percent (with the public grant). This confirms the intuition that the absorption of some of upstream development risk through by the public sector not only reduces uncertainty, but also increases the returns of a potential private developer, creating an opportunity to transfer the surplus to end user customers, through a lower price.

ANNEX 4: DETAILED PROJECT DESCRIPTION

St. Lucia
Renewable Energy Sector Development Project

1. Geothermal development in Saint Lucia has a long history and there have been numerous efforts to explore the country's resources in the past. The Sulphur Springs area in the south-western part of the island had long been considered the center of geothermal potential in Saint Lucia. It has been studied since 1951 via reconnaissance investigations sponsored by the United Nations, and via drilling in the 1970s and 1980s. The previous drilling in the Sulphur Springs area did not validate all major field characteristics necessary to confirm commercial viability, and the location of the previous areas of interest lay in Sulphur Springs within the Pitons Springs within the Pitons Management Area (PMA), which is a UNESCO-designated World Heritage Site.

2. From 2014 to 2016 the Government of Saint Lucia (GoSL), with support from the World Bank and the Government of New Zealand, identified and carried out a new surface exploration campaign. The findings from these surface exploration studies suggest the possible existence of a geothermal reservoir that had not been identified by previous studies. In particular, the geoscientific studies included geologic mapping, geochemical sampling of thermal waters, aeromagnetic surveys, a LiDAR survey, and magneto-telluric studies. The synthesized results of these investigations revealed the existence of a 1,000 to 2,000 meter thick low electrical resistivity horizon overlying a higher resistivity body. The low resistivity horizon extends broadly beneath an area bounded by Fond St. Jaques on the northeast, Belle Plaine on the northwest, and Saltibus on the south. This horizon has been interpreted to be impermeable, altered rock created by contact with fluids and/or gaseous emanations from an underlying geothermal reservoir. The subsurface electrical resistivity patterns in this area are consistent with the existence of a geothermal reservoir. However, the lack of major surface manifestations in the prospect area is a risk factor that needs to be mitigated prior to proceeding with the full financing and development of a geothermal power plant. This potential resource is located approximately 10-15 km ESE of the Sulphur Springs (Area 1a and 1b in figure 4), which makes it possible and attractive to pursue exploration drilling outside of the PMA.

3. Following international good practice, GoSL plans to implement the exploration drilling program using public resources to finance the drilling of two to five deep exploration wells to a depth of around 2000 meters). The proposed project intends to confirm the quality of the geothermal resources through a publicly financed exploration drilling program in the areas (Areas 1a and 1b of Figure 4) where recently concluded preliminary surface studies suggest the possible existence of a geothermal reservoir[35]. Given the high risk involved in the early stage of the geothermal project, public sector de-risking of the field by funding the initial exploration drilling needed to confirm the characteristics and profile of the resource base is needed. This will in turn mitigate some of the early stage high resource risks associated with developing the first geothermal power plant in Saint Lucia, thereby strongly improving the overall economics of geothermal development and facilitating attracting additional private investment for subsequent stages of development. A DP report at the conclusion of the drilling phase will provide sufficient data and information to determine, with a relatively high degree of confidence, whether a geothermal resource of sufficient quality for further development exists. If a high quality geothermal resource is confirmed, the GoSL would invite a qualified private sector Independent Power Producer (IPP) developer to invest private capital into further developing the project in a timely manner. The proposed operation also includes financing for geotechnical services and enabling shared

[35] Soufriere Geothermal Resource – Integrated Exploration Report

infrastructure for the drilling program, as well as for implementation support and technical assistance.

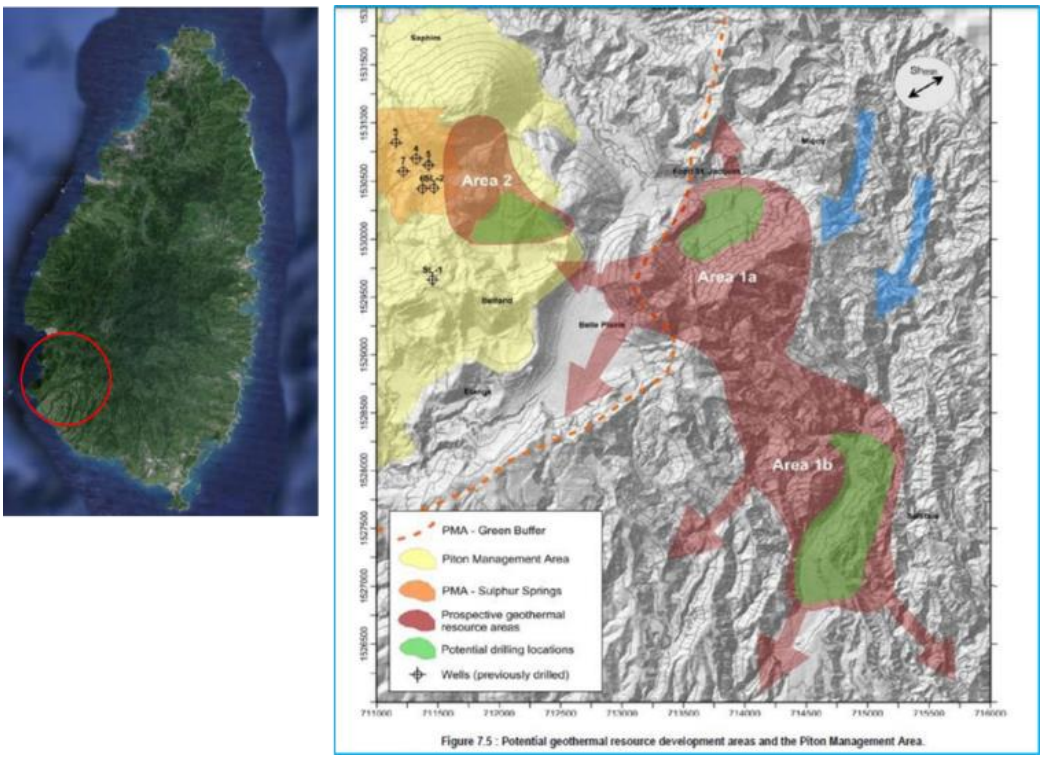

Figure 1: Areas of Potential Geothermal Interest

4. The private sector developer would be expected to invest its own capital for any necessary next stages of delineation drilling and flow tests that may be needed to confirm availability of sufficient quantity of steam to support a feasible generation capacity. If found feasible, the government and the private developer will finalize agreements such as the Geothermal Development Agreement (GDA) and the Power Purchase Agreement (PPA), followed by the developer's investment in production and injection wells and subsequently, in the steam collection infrastructure and the power plant.

5. The proposed project has two components. Component 1 consists of (a) the design, validation, launch, implementation and supervision of a drilling program, to be undertaken by the GoSL; and (b) the procurement of shared infrastructure which will facilitate the integration of renewable energy in Saint Lucia's power system. Component 2 will include implementation capacity enhancement activities and a TA program to strengthen the GoSL's implementation, technical, and fiduciary capacity to support the program.

Policy and Regulatory Context

6. Saint Lucia has made strong international commitments to diversifying its energy mix, notably to achieve a "35 percent renewable energy target by 2025 and a 50 percent target by 2030 based on a mix of geothermal, wind, and solar energy sources" as part of the island nation's NDC to a global effort to mitigate climate change. The country's commitment is reflected in its Sustainable Energy Policy (2001) and Energy Policy (2010), and achieving these targets is a primary goal of the new Electricity Supply Services Act, which will help the country create an enabling environment to achieve this goal.

7. The National Energy Policy (NEP) established the policy framework for reforming the energy sector by

introducing economic regulation, competition and promoting the use of renewable energy. This policy supports diversification of the energy base, development of indigenous renewable energy, security of energy supply, and reduction of adverse environmental effects, including on the climate system. All electricity generation, transmission, distribution and supply in Saint Lucia is guided by the legislative framework of the Electricity Supply Act (ESA). LUCELEC is currently the island nation's sole electricity producer, transmitter and distributor. The ESA, which was revised in 2016, allows LUCELEC to retain its monopoly in fossil fuel generation, but permits competition in renewable energy generation.

8. Saint Lucia has undertaken an ongoing process of comprehensive legislative and regulatory reform of the energy sector. The World Bank's Eastern Caribbean Energy Regulatory Authority (ECERA) Project assists the country in identifying overlapping policy and regulations governing the power sector and developing a series of legislative and regulatory instruments for the reform of the energy sector. These include the draft Electricity Supply Services (ESS) Bill and its supporting instruments such as Model licenses for LUCELEC, Model licenses for Renewable Energy, Customer Service Standards Regulations, Wiring Regulations, Electrical Licensing Authority Regulations, Interconnection Regulations, Grid Code Regulations, Tariff Regulations, Network Licensee Regulations, Licensing Regulations, Fair Competition Regulations, and Fees Regulations. Environmental and Social Impact Assessment (ESIA) regulations, and a Framework for Geothermal Development are being financed under the ongoing Saint Lucia GRDP through GEF/ SIDS-DOCK grant funding.

9. An independent regulator with responsibility for power and water services regulation was created though the approval of the National Utilities Regulatory Commission (NURC) Act No. 3 of 2016. NURC established the independent regulator as being responsible for the issuing of licenses, setting tariffs and rates and approving investments in the energy sector and this regulatory authority was supplemented by the Appeals Tribunal Regulations and the Dispute Resolution Regulations. LUCULEC is guaranteed a consistent return on its investment and electricity tariffs more than fairly compensate LUCULEC for generation, transmission costs and relatively low technical and nontechnical transmission and distribution losses.

10. **The proposed project has two components.** Component 1 consists of (a) the design, validation, launch, implementation and supervision of a drilling program, to be undertaken by the GoSL; and (b) the procurement of shared infrastructure which will facilitate the integration of renewable energy in Saint Lucia's power system. Component 2 will include implementation capacity enhancement activities and a TA program to strengthen the GoSL's implementation, technical, and fiduciary capacity to support the program.

Subcomponent 1.1: Exploration Drilling and Exploration Management Consultant (EMC) (total USD 15.525 million: USD 8.572 million contingent grant and USD 0.953 million project preparation grant from CTF, USD 5 million DFID grant, USD 1 million IDA credit).

11. The subcomponent will support the appointment of a drilling contractor to confirm a drilling program, conduct drilling activities of estimated two to five slim-holes at a depth of approximately 2,000 meters, and confirm the quality of geothermal resource. Drilling at this depth will help transect the low resistivity horizon and penetrate the presumed reservoir. These drill holes will yield significant information regarding rock types, temperatures, fluid and gas chemistry as well as indications regarding rock permeability. Though these drill holes may eventually become usable for injection, they will probably not be appropriate for thermal fluid/steam production. It is anticipated that the precise locations of these drill holes will be identified in the Pre-Feasibility Report which is being undertaken and financed by the ongoing Geothermal Resource Development Project (GRDP) (P149959), a TA program supported by the World Bank.

12. Exploration drilling entails a certain degree of unpredictability, and good practice examples from Turkey, Armenia, Philippines, and Nicaragua, indicate that proper implementation of an exploration drilling

campaign requires flexible design and the ability to accommodate adjustments to the original drilling plan based on initial findings. For example, the location or results of the initial first or second exploration well(s) might prove to be inconclusive and an additional well(s) may be needed for final confirmation. Decisions on any needed adjustments will be made by the government based on recommendations by its appointed technical team led by the EMC and in consultation with the drilling contractor. In addition, the cost of drilling exploration wells to target depth will be sensitive to the time it takes to drill the wells as drilling contracts are generally time-based. Delays may occur during drilling for a variety of reasons, e.g. due to subsurface conditions that cannot be predicted prior to drilling, when permeable formations are intersected and need to be plugged by cement to continue drilling. Such adjustments and delays may impact the drilling program's ultimate cost, and for this reason, a small level of contingency has been built into the design of this component, including for cost and financing estimates.

13. A report on the quality of the geothermal resource measured against technical indicators (see table 2 below) will be produced at the end of the drilling program by the drilling contractor. The report will be validated by the EMC in close consultation with the technical advisory panel and the decision to proceed to the next stage will be made by the GoSL taking into account the technical indicators and other factors, including private sector readiness. The information captured in the DP report will also help facilitate knowledge sharing and capacity building within the wider Caribbean region.

Box 4: Technical Indicators for well testing

Technical Indicators for well-testing

a) At least two wells drilled at a depth of approximately 2,000 meters;
b) Temperature logs collected (static and dynamic) allowing determination of formation temperature and the temperature of producing aquifers (if present);
c) Pressure logs collected and well head pressure after heating measured;
d) Drilling parameters (most importantly loss of circulation) carefully collected throughout the full depth of the well;
e) Samples of the geothermal fluid (steam and liquid) collected and analyzed;
f) Drill core retrieved and lithology and hydrothermal alteration logged; and
g) Observed lithology, alteration and subsurface temperature correlated to surface exploration data.

14. This subcomponent will finance the services of an EMC firm (referred to above), to be engaged by the project for a period of 24-30 months to help procure and oversee the drilling program on behalf of the government. GoSL is mindful of the time constraints that LUCELEC faces to make necessary investments that will define the country's energy mix over the next 15 to 20 years. This makes it imperative to begin the process of conducting geothermal exploration as soon as possible and to implement the exploration process efficiently to obtain sufficient and timely data and information about the resource for a qualified private developer to make a decision about investing private resources for its further development. The terms of reference of the EMC will be prepared under the current TA program and the procurement process of a qualified consultant will be financed using grant resources, e.g. the CTF Project Preparation Grant (PPG) and other grant resources, such as those provided by SIDS-DOCK, DFID and the contingency recovery grant of Clean Technology Fund (CTF) under this subcomponent. The EMC will a) prepare the tender documents for the drilling contractor so that the procurement process and evaluation can be conducted and the selected contractor can be appointed immediately upon effectiveness of the proposed project; b) review the findings from the Pre-Feasibility study under preparation and finalize the Pre-Feasibility report; c) convene a technical advisory panel comprising of multidisciplinary stakeholders to guide the implementation of the drilling program, including any changes to

the plan during implementation; and d) Finalize the exploration drilling report in close cooperation with the drilling contractor, on the basis of which a qualified private developer will be invited to invest in the next phase of the geothermal development process, including any delineation drilling. EMC staff will include those familiar with application and supervision of World Bank fiduciary guidelines (including social and environmental safeguards, financial management and procurement). In addition, the EMC will provide on-the-job mentorship to local staff, including those from the Renewable Energy Unit, to enhance local project management capacity. Access to land required to conduct the drilling program, including any costs of land acquisition required for implementation of the DP, will be financed directly by the GoSL.

Subcomponent 1.2: Geotechnical Services, Drilling Infrastructure Works, and Shared Infrastructure (total USD 4.85 million: USD 4 million IDA credit and USD 0.85 million SIDS-DOCK grant).

15. This subcomponent will finance geotechnical services and drilling infrastructure works (access roads, well pads, water supply, etc.). The exact scope, location and costs of these investments will be identified and defined in the Pre-Feasibility study and confirmed by the EMC in consultation with the drilling contractor for the envisaged drilling program. The pre-Feasibility study is currently underway as part of an ongoing World Bank TA support.

16. The proposed project includes provision for public investment in shared infrastructure services which will enable the proper integration of renewable energy, such as geothermal, solar and/or wind into the grid. Costs related to shared infrastructure services will include a share of costs related to transmission interconnects and the purchase and installation of battery storage capacity.

17. Battery storage will provide necessary capacities to deliver sufficient spinning reserve to replace stand-by diesel generating capacity during off-peak hours; and to allow for ramp-up of diesel generation in order to complement geothermal energy to meet peak loads. In addition, battery storage can help improve grid stability to enable the future addition of intermittent renewable energy resources. By the time geothermal generation is expected to come on-line, battery storage prices are expected to decline considerably from current levels, offering the possibility of more storage capacity in that time-frame for the same level of investment. Sufficient battery storage capacity will allow LUCELEC to minimize the needs for investment in diesel generators that would otherwise be required to provide spinning reserve coverage for integration of geothermal energy and other renewables.[36] This will result in significant savings in diesel fuel costs, which could then be passed on to consumers. Battery storage will also help integrate intermittent renewables to the grid. Currently available data indicate a likely cost of USD 400-500/kWh for storage capacity using lithium-ion batteries. This implies a cost of around USD 3 to 3.75 million for 7.5 MWh of storage capacity installed, and up to USD 5 million if up to 10 MWh of storage capacity is to be installed.[37] The cost of battery storage is anticipated to decline in future years.

18. The geothermal plant is large relative to the capacity of the system and the main reason storage is being deployed, is to help meet spinning reserve requirements (i.e. to cover the loss of a unit). Without this, a large number of diesel plants will be sub-optimally loaded to maintain spinning reserves of 15MW.

19. Secondly, it will also help reduce curtailment of wind and solar (depending on installed capacity)

[36] For a geothermal power plant of 30 MW base-load generation capacity, assuming 2 x 15 MW generating units built by the developer, spinning reserve would be required to cover the loss of a single generator for as long as it would take to start and run up sufficient stand-by diesel generating capacity to replace the lost generator. Battery storage could provide sufficient spinning reserve to cover the start and run up of sufficient stand-by diesel generating capacity. The start-up would probably take around 20 minutes, but due to the fact that the MW output of the battery would decline as the charge is drawn down, a conservative estimate of 30 minutes has been applied. Thirty (30) minutes of 15 MW power would require 7.5 MWh of storage capacity.

[37] This estimate does not include battery replacement costs.

during periods of high output and low demand because the geothermal plant will take up a large part of this low demand period.

20. A third issue (not analyzed though) is that depending on how strong or evolved the network in St Lucia is, it is operationally easier to manage reserves with the storage than with multiple units across the island.

Component 2: Implementation Capacity Enhancement, Technical Assistance, and Market Engagement (total USD 2 million: USD 1 million GoSL co-financing and USD 1 million SIDS-DOCK grant).

21. **Given the time sensitivity and the technical nature of the geothermal exploration process, Component 2 will include resources to support a dedicated Geothermal Implementation Team (GIT),** alongside the Renewable Energy Unit in the Department of Sustainable Development, which is part of the Ministry of Education, Innovation, Gender Relations and Sustainable Development (MoESD). The GIT will have at its disposal the EMC team to provide the project with technical implementation capacity, and will procure or second persons with dedicated fiduciary capacity (e.g. financial management, procurement and safeguards capacity). In addition, this component will include technical assistance to provide studies and reports that will be necessary to fill any gaps in market, regulatory, technical, legal, financial, operational and institutional issues supporting renewable energy investment and integration.

Subcomponent 2.1: Support for Geothermal Implementation Team.

22. **This subcomponent will finance GoSL's implementation capacity for the project,** including office space, management, staff, consultants, offices supplies, among others, as well as fiduciary skills including financial management and procurement, and resources for monitoring safeguards implementation and results. These include a) the recruitment costs of GIT staff, e.g. project director and officers, including, as needed, additional capacity from specialists in applying World Bank social and environment guidelines, as well as additional procurement and financial management capacity; and b) training programs for GoSL officials, including staff of the Department of Sustainable Development, GIT, and LUCELEC. The training programs, which may include observational study tours, will provide structured learning workshops on a variety of topics associated with geothermal and renewable energy development, e.g. the geothermal exploration process, grid operations to integrate renewable energy, evolving models for energy delivery, as well as World Bank-related fiduciary, social, and environmental issue. The subcomponent will also finance c) GIT's gender integrating activities, with collaboration from the relevant stakeholders, which will promote job creation and training to provide equal opportunity to persons from both genders; and d) development of a communication strategy regarding the opportunities presented by the geothermal exploration drilling project and address any community concerns (e.g. concerns regarding potential impacts related to the development of geothermal energy.

Subcomponent 2.2: Technical Assistance and Market Engagement.

23. While much of the emphasis of the project will be on demonstrating the technical viability for geothermal development, notably by drilling exploratory wells, the project will also support activities to improve the market conditions for investing in geothermal. These activities will focus on the policy environment (laws and regulations), cost of service comparisons, grid integration studies, and other market engagement efforts. In particular, the geothermal project will review existing electricity legislation and draft geothermal specific laws and regulations that are essential for the proper governance of geothermal resources and power generation. The analysis and recommendations will be developed in coordination with the National Utility Regulatory Commission (NURC). In the meantime, the Eastern Caribbean Energy Regulatory Authority (ECERA) is supporting the review and preparation of a broad set of regulations for the power sector. ECERA support will not include analysis specific to the needs for geothermal power production. Several other

analyses and technical assessment activities to be supported by this subcomponent are essential to ensuring that the market conditions are adequate to attract investment for a geothermal power project. These include the specification of battery requirements, including replacement, operation and maintenance, disposal and regulatory support, as needed. The precise scope of these assessments will be prepared during the project preparation phase and the necessary breadth and depth of the efforts will be adjusted to comply with the available budget ($2 M), while ensuring the top priorities for achieving the PDO are met.

24. This subcomponent will finance the following studies and activities:

(a) **Legal and Regulatory Studies.** The revised Electricity Supply Act (ESA) allows for limited competition in renewable energy generation, including for geothermal power. However, the specific legislation and regulations that govern the exploration for geothermal resources and the production of geothermal power have not been implemented. This subcomponent will finance studies to ascertain and recommend the necessary laws and regulations to create the market conditions conducive to geothermal exploration and generation. This activity will be undertaken in coordination with the Ministry of Infrastructure, Ports, Energy and Labor (MoIPEL), which is the lead agency for ECERA project in Saint Lucia. Further, on regulatory matters it will coordinate with the National Utility Regulatory Commission (NURC) which has responsibility for implementing energy sector regulations. In addition, a cost of service study will be financed in cooperation with LUCELEC.

(b) **Evolving business model of LUCELEC.** The potential for a dramatic increase of renewable energy sources in Saint Lucia's energy mix has critical implications for LUCELEC's financial and operational planning processes. The revised Electricity Supply Act (ESA) allows LUCELEC to retain its monopoly in fossil fuel generation, but allows for competition in renewable energy generation. It is important to study how LUCELEC can develop an attractive value proposition consistent with the deployment of renewables in Saint Lucia. In this context, the increase in renewable energy generation will dramatically change LUCELECs business with implications for its operating model going forward. This includes not only addressing the role of geothermal energy and grid-connected renewables such as solar and wind, but also the role of decentralized customer-site rooftop and community solar as well as energy efficiency. Commissioned studies will evaluate and develop a financial model to quantify and better understand the financial implications of renewable energy generation, energy efficiency measures, and distributed generation on the utility and ratepayers, and to align utility return motivations with the country's policy goals.

(c) **Integrating Renewables into the grid.** The proposed construction of a privately owned and operated geothermal power plant and future addition of solar and wind power will bring with it the need to assess requirements for investment in the grid and to enhance grid operating capacity. Other operational planning decision areas could be such as forecasting renewable energy deployment, ensuring robustness of decisions to integrate uncertain renewable load quantities, incorporating the non-dispatchability of renewables into planning, accounting for location-specific factors, the specification of battery requirements, estimating the impact on transmission and distribution investments, and integrating renewables into planning across generation, transmission, and distribution.

(d) **Market engagement activities.** Given the limited scale opportunities for power generation in Saint Lucia, which would limit potential private sector interest, GoSL is taking the issue of securing private sector participation seriously. GoSL, along with LUCELEC, will engage with private sector entities in the geothermal market through reports, presentations, prospects, and other materials

presented at industry and financier conferences, road shows, workshops and using various media and communication channels to bring the project to the attention of potential investor and developer communities in order to secure the interest of potential developers to participate in subsequent phases of geothermal development. Market engagement will also be used as a means to obtain and benchmark relevant market data from similar projects, and to generate reports with information including costs and Power Purchase Agreement (PPA) terms, which will be invaluable inputs to ensure that Saint Lucia obtains value-for-money from its geothermal development process. Sustained engagement would provide an opportunity for GoSL to meet and interact with private sector representatives (international project developers) as well as with representatives of civil society in Saint Lucia (e.g. Consumers Association) in order to share and discuss the ongoing progress and findings of the DP process. Finally, GoSL and LUCELEC, along with their transaction advisors providing technical, financial and legal support, will engage with private developers to prepare for negotiation of key documents and agreements for subsequent stages of project development, e.g. geothermal development agreement, Power Purchase Agreement (PPA), etc.

25. **Cost and financing.** The total project cost is USD 22.375 million, comprising of USD 5 million of IDA credit, USD 8.572 million of CTF contingent grant, USD 0.953 million of CTF PPG, USD 5 million of grant funding from DFID, USD 1.85 million of grant funding from SIDS-DOCK and co-financing of USD 1 million from the GoSL. Table 3 presents a breakdown of the project costs by funding sources, throughout all phases through power plant development. The current phase (USD 22.375 million) is represented by Components 1 and 2, and will help leverage an estimated USD 151.5 million of additional financing from the private sector, if the project is fully developed. Cost shaded areas, in the table, represent expenditures that have been incurred for the now completed surface exploration phase and estimates for the delineation drilling, production drilling and power plant construction, and are presented for informational purposes only. These costs are not part of the proposed drilling project, but are reflected as estimates for the overall geothermal investment including, expected private sector investments.

ANNEX 5: IMPLEMENTATION AGGRANGEMENTS

St. Lucia
Renewable Energy Sector Development Project

A. Institutional and Implementation Arrangements

1. **The project is proposed to be implemented by the Department of Sustainable Development (DSD), within the Ministry of Education, Innovation, Gender Relations and Sustainable Development (MoESD).** DSD is led by a Permanent Secretary (PS-DSD), and is responsible for renewable energy policy and implementation in Saint Lucia. The PS-DSD will convene an advisory committee comprising of relevant stakeholders, including representatives of the Department of Economic Planning & National Development in the MoF and the Public Utilities Commission in the Ministry of Infrastructure, Ports, Energy and Labor (MoIPEL), among others.

2. **DSD will establish a dedicated Geothermal Implementation Team (GIT) to be headed by a Project Director who will be accountable to the PS-DSD for all aspects of project implementation and management, including technical and fiduciary coordination.** Given GoSL's limited technical capacity for overseeing and implementing a geothermal exploration program of this magnitude, the GIT will procure the specialized capacity and skills of an Exploration Management Consultant (EMC) to enhance GoSL's capacity to implement and oversee the Drilling Program (DP). The scope of the EMC will include design of specifications for the engagement of a drilling contractor as well as to oversee the drilling campaign. The project design provides for the procurement of the EMC in time for the completion of the pre-feasibility study and the ESIA, so that preparation for the DP can begin in a timely manner, starting with the procurement process of the drilling contractor utilizing approved CTF PPG and SIDS-DOCK funds prior to Board or through retroactive financing of eligible activities defined and agreed with the Bank prior to Board approval.

3. **The GIT Project Director, through the EMC, will convene a multidisciplinary technical advisory panel with representatives from the drilling contractor, LUCELEC, PMA and other experts in order to facilitate discussion and resolution of issues and to provide input, advice and recommendations related to the exploration drilling campaign, including on any adjustments that need to be made in the drilling program.** The DSD through the GIT will also engage periodically with private sector geothermal developers and representatives of civil society (e.g. the Consumers Association) to consult with these stakeholders and to keep them informed about the progress of the exploration drilling process and implications for future development.

4. **As the project's lead implementing agency, DSD will have the responsibility of managing the process of implementing the project consistent with World Bank guidelines, procedures and practices for environment and social safeguards (including resettlement, if needed), procurement, disbursement, accounting, and financial management.** In the interim, and until such time as final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the Project Coordination Unit (PCU) linked to the MoF, and/or through the engagement of specialized consultants with the necessary skills. It is to be noted that the PCU currently administers all existing World Bank loans and grants, including for the ongoing GRDP TA project, and has dedicated staff that benefit from the experience of implementing World Bank projects for the past 15 years. However, the PCU is overloaded with heavy responsibilities, making it important to consider dedicated alternatives to support the DSD in performing the fiduciary requirements that are expected due to the additional workload and the complexity arising from the proposed highly specialized geothermal exploration

project.

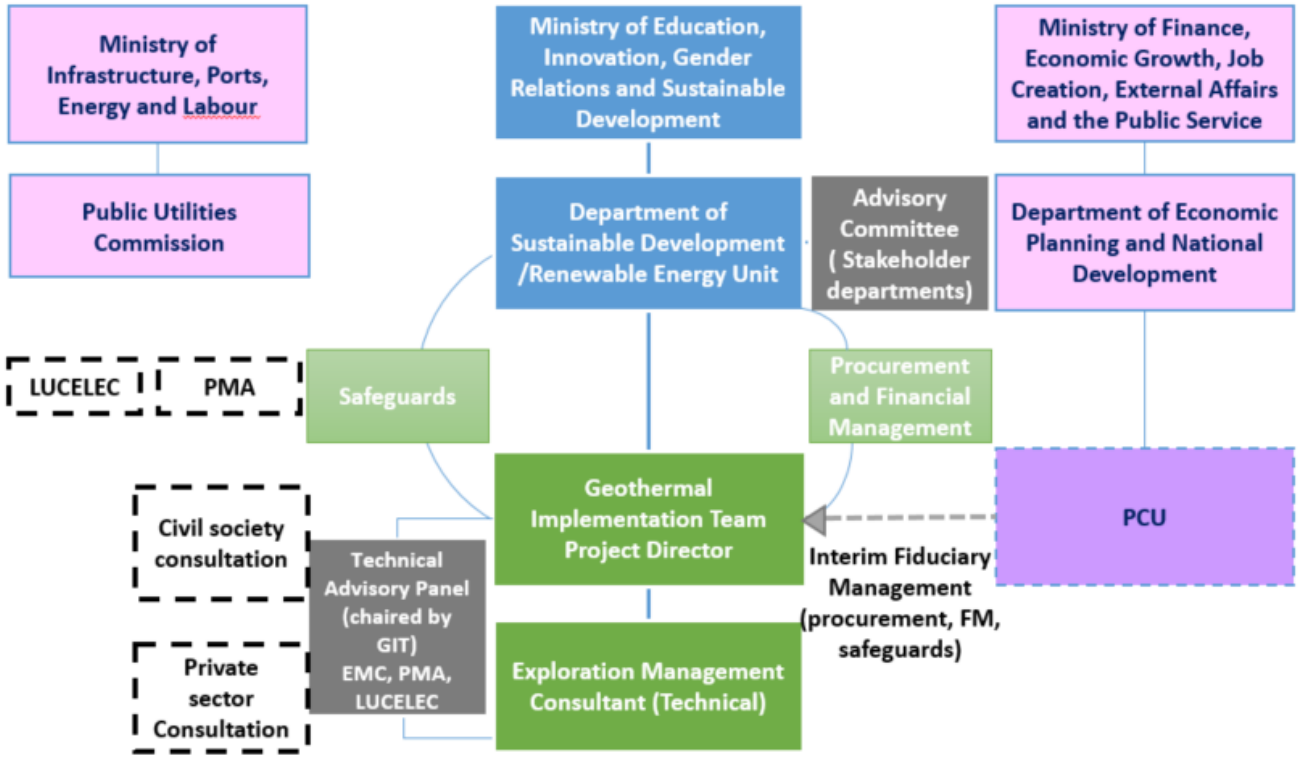

Figure 8: Project Implementation Arrangements

5. **LUCELEC will play a key role in the geothermal power off-take and its integration in the electricity supply system to support the GoSL's renewable energy policy goals.** However, despite the utility's strong experience in power sector operations, LUCELEC does not have prior experience in geothermal development or in negotiating a suitable off-take agreement. Nonetheless, once completed, LUCELEC, as system operator, will integrate the geothermal plant's output into the domestic electricity network. As DP implementation progresses, the GoSL and LUCUELC will explore alternative models for future implementation, including, among others, a Special Purpose Vehicle (SPV) to implement the geothermal project or, alternatively other arrangements, e.g. a joint venture with the government and/or LUCELEC working in strategic partnership with a qualified private developer.

B. Financial Management

6. **Given the need for efficient and timely implementation for private sector investment, the project will need dedicated capacity for project management and implementation consistent with World Bank guidelines.** To mitigate this risk, Saint Lucia will create a GIT within the Department of Sustainable Development, which will be responsible for overall project management, including technical oversight, fiduciary management and implementation support. The fiduciary functions of GIT will be performed either by consultants hired for specific tasks or by staff seconded from the PCU that currently provides procurement and financial management services to virtually all World Bank projects in the country.

7. **The World Bank is currently reviewing DSD's financial management capacity, with this process expected to conclude prior to Board submission.** In the interim, and until such time as final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling

fiduciary functions for the proposed project by the PCU within the MoF, or through the engagement of specialized consultants with the necessary skills.

8. **The Bank performed a financial management assessment of the proposed project in accordance with OP/BP 10.00 and the financial management practice manual issued by the Financial Management Sector Board (FMSB) in March 1, 2010.** It was concluded that the MoF will have in place an adequate financial management system that can provide accurate and timely information with reasonable assurance on the status of the funds as required by the Bank, and will execute FM functions until such time as the DSD may be appraised for any alternate arrangements. Any such arrangements will be finalized and appraised prior to Board. The project grant and concessional finance resources will be administered through a designated account at the Bank of Saint Lucia.

9. **Accounting and Internal Control.** The accounting of the project will be done by the DSD/GIT. The accounting records for the project will be maintained in the accounting system, QuickBooks v2011, and the Government's Integrated Financial Management Information System (IFMIS) called SmartStream will be updated with the project's transaction for the month on a monthly basis through a journal entry. The current finance procedures' manual has clear processes and procedures that, once applied consistently, are adequate to ensure that the financial information is accurate and that funds are only utilized for project purposes. The Financial Procedures Manual should be updated to reflect the specific context of this project.

10. **Budgeting.** The annual budget would be prepared by the DSD/GIT in collaboration with the PCU and other implementing agencies. Project annual budgeting would be based on the cost tables, and would be updated according to the latest information during project implementation. The approved annual budget would be included in the budget estimates, entered into the accounting system, and used for periodic comparison with actual results as part of interim reporting. The approved budget would be shared with the World Bank and would be entered in the government the IFMIS as well as QuickBooks to monitor progress of implementation of the budget.

11. **Reporting.** Internal Financial Reports (IFRs) are required quarterly and should be submitted 45 days after each calendar quarter. Annual external audits are required with each audit covering one fiscal year (ending December 31). The audit reports are due to the World Bank no later than six months after the end of each audit period.

12. **Funds Flow.** A US dollar designated bank account and a local currency, Eastern Caribbean Dollar (ECD) bank account will be opened upon effectiveness of the project at the Bank of Saint Lucia. Both accounts will be segregated accounts. The US dollar bank account will be used to receive IDA and grant funds from the World Bank, as well as make US dollar payments throughout implementation. Funds will be transferred from the US dollar designated account to the ECD bank account to facilitate local currency payments. Both bank accounts will be used only to facilitate payments for eligible activities that relate to the project.

13. **Disbursement method.** Disbursements will be report-based. An advance equivalent to six months forecast will be provided to the designated account (DA) and documentation of the expenditures will be based on subsequent quarterly IFRs. Subsequent IFRs will also provide a forecast for the following six months, on the basis of which the amount of funds to be disbursed will be determined. Further details regarding disbursements are provided in the disbursement letter.

14. **Expenditure Eligibility.** If ineligible expenditures are found to have been made from the designated and/or local ECD accounts, the borrower will be obligated to refund the same. If the designated accounts remain inactive for more than 6 months, the World Bank may reduce the amount advanced. The World Bank will have the right, as reflected in the terms of the Financing and/or Grant Agreement, to suspend

disbursement of the funds if significant conditions, including reporting requirements, are not complied with. Additional details regarding disbursement will be provided in the disbursement letters.

C. Procurement

15. **For Procurement, the World Bank is currently reviewing DSD's current procurement management capacity, with this process expected to conclude prior to Board submission.** In the interim, and until such time as final implementation arrangements by the DSD are appraised prior to Bank Board approval, the DSD will be supported in fulfilling fiduciary functions for the proposed project by the PCU within the MoF, or through the engagement of specialized consultants with the necessary skills.

16. **Staff from the PCU attended the workshop held in Grenada in the beginning of November 2016, which was dedicated to the Bank's new procurement guidelines.** The PCU staff have now been trained and acquainted with the new framework and its application and methods. The DSD in consultation with the PCU will prepare the Project Procurement Strategy for Development (PPSD), which is a project-level strategy document prepared by the borrower that describes how procurement in Investment Project Financing (IPF) operations supports the development objectives of the project and delivers value for money. The PPSD will be reviewed and agreed upon with the Bank before the completion of IDA and CTF negotiations prior to Board submission. The DSD and the PCU have been informed of the need to start to prepare the PPSD document and the Bank has offered its support on this preparation.