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INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED CREDIT
IN THE AMOUNT OF SDR 12.3MILLION
(US\$17.2 MILLION EQUIVALENT)

AND

A PROPOSED CONTINGENT RECOVERY GRANT IN THE AMOUNT OF US\$9 MILLION AND A
PROPOSED GRANT IN THE AMOUNT OF US\$0.953 MILLION
FROM THE CLEAN TECHNOLOGY FUND

TO THE

THE COMMONWEALTH OF DOMINICA

FOR THE

DOMINICA GEOTHERMAL RISK MITIGATION PROJECT

February 12, 2019

Energy and Extractives Global Practice
Latin America And Caribbean Region

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CURRENCY EQUIVALENTS

(Exchange Rate Effective Jan 31, 2019)

Currency Unit:

SDR0.71392875 = US\$1

US\$1.4006999 = SDR 1

FISCAL YEAR

July 1 – June 30

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ABBREVIATIONS AND ACRONYMS

AfD	Agence Française de Développement (<i>French Development Agency</i>)
ARAP	Abbreviated Resettlement Action Plan
CARICOM	Caribbean Community
CCI	Clinton Climate Initiative
CDB	The Caribbean Development Bank
CDF	Community Development Fund
CEO	Chief Executive Officer
CO ₂	Carbon Dioxide
CO	Carbon Monoxide
COO	Chief Operating Officer
CPA	Country Poverty Assessment
CS	Consumer Surplus
CTF	Clean Technology Fund
DA	Designated Account
DCF	Discounted Cash Flow
DFID	Department for International Development
DGDC	Dominica Geothermal Development Company
DL	Disbursement Letter
DOMLEC	Dominica Electricity Services Limited
DPSP	Dedicated Private Sector Program
DSCR	Debt Service Coverage Ratio
ECD	Eastern Caribbean Dollar
EIA	Environmental and Impact Assessment
EIRR	Economy Internal Rate of Return
EHS	Environmental, Health and Safety
EPC	Engineer-Procure-Construct
ESA	Electricity Supply Act
ESMP	Environmental and Social Management Plan
ESMAP	Energy Sector Management Assistance Program
ESIA	Environmental and Social Impact Assessment
ESMS	Environmental and Social Management System
EU	European Union
FC	Financial Controller
FDI	Foreign Direct Investment
FMA	Financial Management Assessment
GBV	Gender-based Violence
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GGDP	Global Geothermal Development Plan
GoNZ	Government of New Zealand

GoCD	Government of the Commonwealth of Dominica
GRS	Grievance Redress Service
GSPSs	Growth and Social Protection Strategies
GWh	Gigawatt hour
HC	Hydrocarbons
H ₂ S	Hydrogen Sulfide
IBRD	International Bank for Reconstruction and Development
ICF	International Climate Fund
IDA	International Development Association
IEA	International Energy Agency
IFRS	International Financial Reporting Standards
IFC	International Financial Corporation
IRC	Independent Regulatory Commission
IRR	Internal Rate of Return
kWh	Kilowatt Hour
LAC	Latin America and the Caribbean
LACEG	LAC Energy and Gender
LCOE	Levelized Cost of Electricity
LCCRDS	Low Carbon Climate Resilient Development Strategy
LGPP	Large Geothermal Power Plant
LRP	Livelihood Restoration Plan
MTPNP	Mornes Trois Pitons National Park
MW	Megawatt
MWh	Megawatt hour
NDC	Nationally Determined Contribution
NRDS	National Resilient Development Strategy
NPV	Net Present Value
NO _x	Nitrogen Oxide
OECS	Organization of Eastern Caribbean States
OE	Owner's Engineer
O&M	Operation and Maintenance
OM	Owner's Engineer
PAPs	Project-affected-persons
PDO	Project Development Objective
PDNA	Post-disaster Needs Assessment
PM	Particulate Matter
PM	Project Manager
PO	Project Officer
PP	Power Plant
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PPSD	Project Procurement Strategy for Development

PS	Performance Standards
RPS	Regional Partnership Strategy
RAP	Resettlement Action Plan
RF	Results Framework and Monitoring
SAGS	Steamfield Above-ground Systems
SBV	Special Business Vehicle
SEP	Stakeholder Engagement Plan
SE4ALL	Sustainable Energy for All
SGPP	Small Geothermal Power Plant
SIDS	Small Island Developing States
SIA	Social Impact Assessment
SO ₂	Sulfur Dioxide
SOE	Statements of Expenditures
STIs	Sexually Transmitted Infections
TA	Technical Assistance
TSP	Total Suspended Particulates
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United States Dollars



BASIC INFORMATION

Country(ies)	Project Name	
Dominica	Dominica Geothermal Risk Mitigation Project	
Project ID	Financing Instrument	Environmental Assessment Category
P162149	Investment Project Financing	A-Full Assessment

Financing & Implementation Modalities

<input type="checkbox"/> Multiphase Programmatic Approach (MPA)	<input type="checkbox"/> Contingent Emergency Response Component (CERC)
<input type="checkbox"/> Series of Projects (SOP)	<input type="checkbox"/> Fragile State(s)
<input type="checkbox"/> Disbursement-linked Indicators (DLIs)	<input checked="" type="checkbox"/> Small State(s)
<input type="checkbox"/> Financial Intermediaries (FI)	<input type="checkbox"/> Fragile within a non-fragile Country
<input type="checkbox"/> Project-Based Guarantee	<input type="checkbox"/> Conflict
<input type="checkbox"/> Deferred Drawdown	<input type="checkbox"/> Responding to Natural or Man-made Disaster
<input type="checkbox"/> Alternate Procurement Arrangements (APA)	

Expected Approval Date	Expected Closing Date
18-Mar-2019	28-Feb-2026

Bank/IFC Collaboration

No

Proposed Development Objective(s)

The objective of the proposed Project is to help: a) diversify the domestic power generation mix in Dominica by integrating clean, renewable geothermal energy; and b) demonstrate the potential of larger development of the geothermal resource.

Components

Component Name	Cost (US\$, millions)
DEVELOPMENT OF DOMESTIC GEOTHERMAL POWER GENERATION CAPACITY (SGPP)	41.50



CONTINGENT FINANCING IN AID OF ADDITIONAL DRILLING	9.00
TECHNICAL ASSISTANCE FOR ADVANCING LGPP TO DEVELOPMENT STATUS AND SOLICITING PRIVATE SECTOR INVESTMENT	0.95

Organizations

Borrower:	The Government of the Commonwealth of Dominica
Implementing Agency:	Dominica Geothermal Development Company

PROJECT FINANCING DATA (US\$, Millions)**SUMMARY**

Total Project Cost	51.45
Total Financing	51.45
of which IBRD/IDA	17.20
Financing Gap	0.00

DETAILS**World Bank Group Financing**

International Development Association (IDA)	17.20
IDA Credit	17.20

Non-World Bank Group Financing

Counterpart Funding	10.30
Borrower/Recipient	10.30
Trust Funds	21.95
Clean Technology Fund	9.95
Support for Small Island Developing States (SIDS) DOCK Suppo	2.00
Free-standing Single Purpose Trust Fund	10.00
Other Sources	2.00
NEW ZEALAND: Ministry of Foreign Affairs	2.00



IDA Resources (in US\$, Millions)

	Credit Amount	Grant Amount	Guarantee Amount	Total Amount
National PBA	17.20	0.00	0.00	17.20
Total	17.20	0.00	0.00	17.20

Expected Disbursements (in US\$, Millions)

WB Fiscal Year	2019	2020	2021	2022	2023	2024	2025	2026
Annual	0.07	0.78	1.02	1.61	2.45	3.64	4.80	2.83
Cumulative	0.07	0.85	1.87	3.48	5.93	9.57	14.37	17.20

INSTITUTIONAL DATA

Practice Area (Lead)

Energy & Extractives

Contributing Practice Areas

Climate Change

Climate Change and Disaster Screening

This operation has been screened for short and long-term climate change and disaster risks

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

Yes

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

Yes

SYSTEMATIC OPERATIONS RISK-RATING TOOL (SORT)

Risk Category

Rating

1. Political and Governance

● Moderate

2. Macroeconomic

● Substantial



3. Sector Strategies and Policies	● Moderate
4. Technical Design of Project or Program	● Substantial
5. Institutional Capacity for Implementation and Sustainability	● Substantial
6. Fiduciary	● Substantial
7. Environment and Social	● Substantial
8. Stakeholders	● Substantial
9. Other	● Substantial
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		✓
Performance Standards for Private Sector Activities OP/BP 4.03	✓	
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

Sections and Description

Financing Agreement; Schedule 2 - Project Execution; Section I. Implementation Arrangements; A. Institutional Arrangements; Par. 1: The Recipient shall cause DGDC to operate and maintain, throughout Project implementation, a Project team to be responsible for the overall implementation, management, monitoring and evaluation of the Project with qualified and experienced staff in sufficient numbers, as well as with adequate funds, facilities, services and other resources acceptable to the Association, as further detailed in the Project Operations Manual.

Sections and Description

Financing Agreement; Schedule 2 - Project Execution; Section I. Implementation Arrangements; A. Institutional Arrangements; Par. 4: The Recipient, through the Ministry of Housing and Lands, shall no later than one (1) month after the Effective Date, enter into a separate agreement (Cooperation Agreement) with DGDC, under terms and conditions acceptable to the Association, to facilitate and coordinate the implementation of the Environmental and Social Instruments and the ESAP, including, inter alia, details on the roles and responsibilities for land acquisition, as further detailed in the ARAP. Except as the Association shall otherwise agree, the Recipient shall not assign, amend, abrogate or waive the Cooperation Agreement or any of its provisions.

Sections and Description

Financing Agreement; Schedule 2 - Project Execution; Section I. Implementation Arrangements; B. Subsidiary Agreement; Par. 1: To facilitate the carrying out of the Project, the Recipient shall make part of the proceeds of the Financing allocated from time to time to Category (1) available to DGDC under a subsidiary agreement between the Recipient and DGDC, under terms and conditions approved by the Association ("Subsidiary Agreement") which shall include, inter alia: (a) the roles and responsibilities of DGDC with regard to the implementation of the Project; and (b) the obligation of DGDC to comply with the technical, fiduciary and environmental and social requirements applicable to the Project in accordance with the provisions of this Agreement.

Sections and Description

Financing Agreement; Schedule 2 - Project Execution; Section I. Implementation Arrangements; C. Project Operations Manual; Par. 1: The Recipient shall carry out, and cause DGDC to carry out, the Project in accordance with a manual (the Project Operations Manual), which consists of different schedules setting forth, respectively, rules, methods, guidelines, specific development plans, standard documents, and procedures for the carrying out of the Project, including, inter alia, the following: (a) the detailed description of Project activities, their sequencing and the prospective timetable and benchmarks in relation thereto; (b) the Project administrative, accounting, auditing, reporting, financial, and disbursement procedures, including all pertinent standard documents and model contracts; (c) the plan for the monitoring, evaluation and supervision of the Project; (d) the Environmental and Social Instruments, the Performance Standards, the ESAP and the form of Bi-annual Monitoring Report of the Project; (e) the detailed definition, methodology and content of the Defined Minimum Level of Production; (f) the detailed definition, methodology and content of the Defined Minimum Reinjection Capacity; (g) the grievance redress mechanism; and (h) the performance indicators for the Project.



Sections and Description

Financing Agreement; Schedule 2 - Project Execution; Section I. Implementation Arrangements; D. Environmental and Social Management of the Project; Par. 1 (c): The Recipient shall cause DGDC to provide adequate resources to ensure that the implementation of the Environmental and Social Management System is continued and effective and that the Environmental and Social Management System is operated, and the social and environmental performance of the Project is managed in a manner consistent with the Performance Standards and the Environmental and Social Instruments.

Sections and Description

Financing Agreement; Schedule 2 - Project Execution; Section I. Implementation Arrangements; D. Environmental and Social Management of the Project; Par. 2: The Recipient, through the Ministry of Housing and Lands, shall take all measures to implement the ARAP in a manner and timeframe satisfactory to the Association. To this end, the Recipient shall ensure, inter alia, that: (i) prior DGDC carrying out works which involve resettlement (as determined by the Association), Affected Persons are compensated at replacement costs, resettled and provided with assistance in accordance with the ARAP, as appropriate; and (ii) complaints related to land acquisition are addressed in a timely and adequate manner, as further detailed in the ARAP.

Conditions

Type	Description
Effectiveness	Financing Agreement; Article V — Effectiveness; Termination; Par. 5.01. (a): The Recipient and DGDC have adopted the Project Operations Manual in form and substance satisfactory to the Association.
Effectiveness	Financing Agreement; Article V — Effectiveness; Termination; Par. 5.01. (b): The Subsidiary Agreement has been executed and delivered and all conditions precedent to its effectiveness have been fulfilled in a manner acceptable to the Association.
Effectiveness	Financing Agreement; Article V — Effectiveness; Termination; Par. 5.01. (c): The Power Purchase Agreement has been entered into between DGDC and DOMLEC on terms and conditions acceptable to the Association.
Effectiveness	Financing Agreement; Article V — Effectiveness; Termination; Par. 5.01. (d):The Concession Agreement has been entered into between the Recipient and DGDC on terms and conditions acceptable to the Association.
Effectiveness	Financing Agreement; Article V — Effectiveness; Termination; Par. 5.01. (e): The CTF Grant



	Agreement, the SIDS DOCK Grant Agreement, the DFID Grant Agreement, and the Project Agreement, have been executed and delivered and all conditions precedent to their effectiveness (other than the effectiveness of this Agreement) have been fulfilled.
Type Effectiveness	<p>Description</p> <p>Financing Agreement; Article V — Effectiveness; Termination; Par. 5.01. (f): Without limitation to Section 10.02 of the General Conditions, the Recipient and DGDC each furnishes to the Association an opinion or certificate satisfactory to the Association confirming on behalf of the respective party that the Concession Agreement and the Power Purchase Agreement, as applicable to the respective party, have been duly authorized or ratified by the Recipient, DGDC and DOMLEC, as applicable, and are legally binding upon the respective party in accordance with the respective agreement’s terms.</p>
Type Disbursement	<p>Description</p> <p>Clean Technology Fund Grant Agreement; Schedule 2; Section IV. Withdrawal of Grant Proceeds; Par. B. Withdrawal Conditions; Withdrawal Period; 1.(b): Notwithstanding the provisions of Part A above, no withdrawal shall be made for payments made: Under Category (1), for Eligible Expenditures, until and unless the Association has received satisfactory evidence that the existing production and/or rejection wells do not provide, or are forecasted not to provide the Defined Minimum Level of Production and/or the Defined Minimum ReInjection Capacity in form and substance satisfactory to the Association as further detailed in the Project Operations Manual.</p>



DOMINICA
DOMINICA GEOTHERMAL RISK MITIGATION PROJECT

TABLE OF CONTENTS

I. STRATEGIC CONTEXT	1
A. Country Context	1
B. Sectoral and Institutional Context.....	2
C. Higher Level Objectives to which the Project Contributes	5
II. PROJECT DEVELOPMENT OBJECTIVES.....	6
A. PDO	6
B. Project Beneficiaries.....	6
C. PDO-Level Results Indicators	7
III. PROJECT DESCRIPTION.....	7
A. Project Components.....	7
B. Project Cost and Financing.....	8
C. Lessons Learned and Reflected in the Project Design.....	9
IV. IMPLEMENTATION.....	10
A. Institutional and Implementation Arrangements.....	10
B. Results Monitoring and Evaluation	11
C. Sustainability	11
D. Role of Partners.....	12
V. KEY RISKS	12
A. Overall Risk Rating	12
VI. APPRAISAL SUMMARY.....	15
A. Economic and Financial (if applicable) Analysis.....	15
B. Technical	16
C. Financial Management	17
D. Procurement.....	17
E. Social (including Safeguards).....	18
F. Environment (including Safeguards)	20



G. World Bank Grievance Redress	21
VII. RESULTS FRAMEWORK AND MONITORING	22
ANNEX 1: DETAILED PROJECT DESCRIPTION	28
SOURCE: TECHNICAL ASSISTANCE FOR GEOTHERMAL POWER DEVELOPMENT, FEASIBILITY STUDY, ELC ELECTROCONSULT SPA, 2013.	28
ANNEX 2: MULTI-STAGE GEOTHERMAL DEVELOPMENT CYCLE – ILLUSTRATION OF RISKS AND COSTS	33
ANNEX 3: CLEAN TECHNOLOGY FUND	34
ANNEX 4: IMPLEMENTATION ARRANGEMENTS	48
ANNEX 5: IMPLEMENTATION SUPPORT PLAN	62
ANNEX 6: ECONOMIC AND FINANCIAL ANALYSIS	65
I. FINANCIAL ANALYSIS	65
A. General Methodology	65
B. Key Assumptions and Parameters	66
C. Results of the Financial Evaluation	68
D. Sensitivity Analysis	70
II. ECONOMIC ANALYSIS	72
A. Project Development Impact	72
B. Rationale for Public Sector Provision/Financing	72
C. Value Added of Bank’s Support.....	73
D. Methodology	74
E. Economic Evaluation	75



I. STRATEGIC CONTEXT

A. Country Context

1. **The Commonwealth of Dominica is a small island state in the Eastern Caribbean Region that faces growth and sustainability challenges due to natural hazards and external shocks.** With an area of 750 square kilometers, a population of 73,543¹ and a gross domestic product (GDP) of US\$581.48 million², the Commonwealth of Dominica (Dominica) is an upper-middle income member of the Organization of Eastern Caribbean States (OECS). For years, OECS countries have been trapped in a spiral of low growth, high debt, and limited fiscal space, which have been exacerbated by exogenous shocks, such as natural hazards, the loss of preferential access to the European Union (EU) market and contraction of foreign direct investment (FDI) due to the 2008 global economic crisis. In Dominica, growth has been more elusive than elsewhere³. While historically its economy has been heavily reliant on agriculture, its GDP contribution has declined considerably from 30 percent in the early 1990s to 15 percent in 2016. Poverty remains a pervasive development issue, with a poverty headcount of 28.8 percent at the time of the last Country Poverty Assessment (CPA) conducted in 2009³.

2. **Recurrent meteorological events have severely affected Dominica's economy and pose an ongoing threat to poverty reduction and long-term development.** Average annual losses from weather-related events between 1996 and 2015 are estimated at 7.9 percent of GDP, making Dominica the second most affected country globally during this period. On September 18, 2017, Hurricane Maria hit the island with catastrophic effect. Almost every household and economic sector, was affected. According to the Post-Disaster Needs Assessment (PDNA)⁴, damages totaled US\$931 million and losses US\$382 million, equal to 226 percent of 2016 GDP. The immediate impact on poverty, livelihood and output has been severe. US\$35.1 million of income was lost and the poverty headcount ratio could increase to 42.8 percent without extensive mitigation measures. The overall recovery cost is estimated at US\$1.3 billion. Response from development partners has been immediate, extensive and well-coordinated. The World Bank has arranged for the largest financing support through emergency operations targeting housing and infrastructure recovery as well as agriculture and small businesses.

3. **Building resilience is Dominica's utmost priority and this entails a more diversified and greener energy mix.** Fiscal losses arising from natural disasters and the ongoing challenges of climate change threaten to set back hard-earned development gains and restrain economic growth. Following Hurricane Maria, the Government of the Commonwealth of Dominica (GoCD) has adopted the National Resilient Development Strategy (NRDS), which sets Dominica's mission and pathway towards becoming "*the first climate-resilient country in the world*". Diversifying the energy mix is a key element of this strategy, and this can be better achieved by leveraging the country's large indigenous geothermal potential. As an underground resource, geothermal steam cannot be lost due to weather events and the above-ground

¹ World Bank, World Development Indicators. Statistics are for 2016 (latest available).

² Dominica | Drupal. <https://www.gfdr.org/dominica>.

³ GDP growth over the past twenty years has averaged 2.1 percent per annum against the 2.6 percent observed in other OECS countries, such as Antigua and Barbuda, Grenada, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines (World Bank Annual GDP Growth Data; 1996-2015).

⁴ The PDNA was by the World Bank in collaboration with the United Nations (UN), the Eastern Caribbean Central Bank (ECCB), the Caribbean Development Bank (CDB), and the European Union (EU).



infrastructure can be built with enhanced resilient features. As result, geothermal energy provides an equally green yet more resilient alternative baseload capacity than hydropower, which accounts for a third of Dominica’s installed generation capacity and is fragile to climate events. Geothermal is also largely more cost-efficient and greener than diesel-based capacity, which accounts for a predominant part of Dominica’s energy mix.

4. **Restoring growth, accelerating poverty reduction and achieving shared prosperity will require enhancing competitiveness in traditional economic sectors and capturing new ones.** Owing to its rugged terrain and lack of sandy beaches, Dominica has had fewer growth opportunities, for instance as a tourism destination, relatively to other countries in the region. While progressively recovering from the disaster, the country must focus on increasing productivity in traditional economic sectors as well as seizing new ones. This first and foremost requires addressing the inadequacy and high costs of infrastructure services, especially electricity. Overly expensive electricity supply drives up the cost of doing business and is a major drag on productivity and competitiveness for Dominica’s firms. Lower electricity costs would enable a shift to more energy-intensive, higher added-value businesses, such as agro-processing. They would also allow Dominica to better compete price-wise with other Caribbean touristic destinations, as tourism picks up again. A key growth opportunity is associated with developing geothermal energy for exports to neighboring countries; electricity produced domestically could bring large revenues to Dominica and significantly boost its GDP growth.

B. Sectoral and Institutional Context

5. **Dominica has a small power system that relies heavily on diesel to produce electricity.** Prior to the hurricane, Dominica’s installed generation capacity totaled 26.7 megawatt (MW), of which more than 20 MW were diesel-based, encompassing five power stations, mostly in an aging condition. The residual 6.6 MW derived from three small cascading run-of-the-river hydro plants. Baseload needs were approximately 12 MW and were accommodated using hydropower generation and diesel-based generation for the remaining part. Peak load was around 17 MW. The power system is operated by a single, vertically integrated private concessionaire, Dominica Electricity Services Limited (DOMLEC). DOMLEC owns two of the five diesel plants and all three hydroelectric power stations. Previously, its license was exclusive; but, since the approval of the Electricity Supply Act (ESA) in 2006, the Independent Regulatory Commission (IRC) – the regulator – may license other generators. DOMLEC served 36,467 customers, most of which residential, accounting for 98 percent of the island’s population. About 50 percent of sales was from the household sector; the rest was predominantly commercial consumption and only a small share (around 10 percent) industrial.

6. **Dominica’s power system suffered widespread devastation due to Hurricane Maria and recovery is ongoing.** Electricity service completely ceased following the disaster because of the widespread and severe damages to the transmission and distribution (T&D) system. At least 75 percent of the network was damaged or destroyed; damages to generation sites varied from moderate to severe (to hydropower assets). Recovery of the national power system has progressed steadily, although at a slower pace than expected as the magnitude of the challenge clearly exceeds DOMLEC’s human, financing and logistic capacity. The Caribbean Development Bank (CDB) recently approved a US\$15.804 million loan and a US\$0.211 million grant to DOMLEC, which is allowing the company to acquire much needed equipment, manpower and technical capacity to hasten power system rehabilitation. In addition to



physical reconstruction, engineering services will be contracted to carry out a structural analysis of the T&D system and incorporate resilience measures in the rebuilding. A Climate Vulnerability and Risk Assessment will also be completed to guide improvements to the system design and increase resilience to weather events. It is expected that load will be restored to pre-hurricane level in a year time, as customers are reconnected, and businesses return to operate. Afterwards, demand is predicted to increase steadily as the economy picks up again and plans to develop tourism activities, especially in the north of the island, are resumed.

7. **Owing to the reliance on imported diesel, Dominica has historically faced overly high and volatile electricity prices.** As of end of December 2016, the average retail price of electricity in Dominica, at around US\$33 cents/kWh, was among the highest in the world. In addition, customers are exposed to the volatility of international oil prices. As highlighted above, the ramifications of high and rising oil prices run right through the economy. In the last Enterprise Survey conducted by the World Bank⁵, 66 percent of firms in Dominica cited the cost and regularity of electricity as a major or very severe constraint to doing business. High and volatile electricity costs severely hit domestic consumers, and especially the poor. Increased costs of diesel imports create a severe negative impact on the country's balance of trade. Lowering and stabilizing electricity costs was the single most impending priority for Dominica's power sector ahead of Hurricane Maria and is even more so now, as the country needs to seek any opportunity for recovery and accelerated growth.

8. **Developing geothermal resources can help Dominica overcome key energy sector and development challenges.** As highlighted above, the use of geothermal to diversify the country's energy mix is instrumental to Dominica's resilience agenda. More importantly, switching baseload generation from diesel to geothermal can lower wholesale electricity costs in Dominica significantly. The share of renewables into the energy mix would more than double and greenhouse gas (GHG) emissions would be reduced⁶. As an indigenous resource, geothermal also offers a natural hedge against the price volatility of imported fuels. Finally, the volume of geothermal resources, largely exceeding domestic needs, provides a transformational growth opportunity for the country, if larger capacity is built for electricity export purposes. Electricity could become Dominica's new, most profitable export commodity and Guadeloupe and Martinique – both French territories – have shown interest in importing electricity. Because of its contribution to Dominica's resilience in the most extensive terms, including to climate change, external shocks, competitiveness challenges and poverty, geothermal development is recognized as one of the most strategic undertakings for the country in the post-disaster context⁷.

9. **Dominica has made major progress towards developing the Wotten Waven-Laudat geothermal field in the Roseau Valley.** With the assistance of the European Union (EU), the Government of France, the Regional Councils of Guadeloupe and Martinique and the French Development Agency (Agence Française de Développement - AfD), the GoCD completed surface studies and drilled three slim-hole wells, which confirmed the existence of a geothermal resource that could provide as much as 100 MW of geothermal capacity. The following drilling of two production/injection wells confirmed sufficient steam availability at the wellhead to develop a 7 MW plant. In 2013, the World Bank prepared a Situational/Gap Analysis that evaluated progress made thus far and identified actions to be taken to meet industry and

⁵ World Bank, 2010, evaluation of raw data from Enterprise Survey in Dominica.

⁶ See annex 3 for more details.

⁷ 2018 Article IV Consultation - Staff Report; IMF Country Report; (May 30, 2018).



international standards. Since then, the World Bank, in coordination with other development partners including the Government of New Zealand (GoNZ) and the Clinton Climate Initiative (CCI), has continued to provide technical assistance (TA) to the GoCD to help implement the actions identified in the Situational/Gap Analysis and advance preparation of the green-field site at Wotten Waven-Laudat. In line with industry practice worldwide, the GoCD has decided to embrace a modular expansion of the geothermal field. Specifically, a 7 MW (nominally) small geothermal power plant (SGPP) will first be developed to feed domestic demand. Thereafter, depending on resource availability, a large geothermal power plant (LGPP) with a capacity of 40-100 MW could be developed for supplying electricity exports to Guadeloupe and/or Martinique through undersea cables.

10. **The GoCD seeks to attract private participation to take geothermal development forward.** Annex 2 illustrates the multi-stage exploitation process that is typical for developing geothermal sites and the specific barriers associated with each phase. Green-field sites like Wotten Waven-Laudat pose inherent risks, primarily related to the uncertainty regarding subterranean resource availability and the limited information on the steamfield characteristics. The GoCD has taken the lead and borne the initial and riskier exploratory investments, which have considerably reduced the resource risks associated with SGPP. Nonetheless, it is only natural that the incipient stage of the geothermal market at the regional level, the very small size of the domestic market and the limited human capacity available to the sector still create a perception of a high-risk environment among prospective private investors. Following two failed attempts to enlist a private partner and pressed by the urgent need to displace diesel generation to reduce electricity costs in the country, the GoCD has resolved to develop SGPP with public funding. Even if commercial capital was mobilized, owing to the perceived risks, the cost of financing would likely be high, putting pressure on the price of electricity produced at Wotten Waven-Laudat. Going forward, only the private sector can develop LGPP and achieve the scale at which Dominica expects to expand its geothermal capacity. Nonetheless, prospects for LGPP are inextricably linked to SGPP. In addition to accommodating a national goal, a SGPP that is successfully developed and operated will be key to prove the capability of the geothermal field and boost confidence among prospective developers vis-à-vis the viability of a more complex subsequent LGPP operation.

11. **The GoCD has established the Dominica Geothermal Development Company Ltd. (DGDC), a special purpose vehicle with the sole purpose and mandate to develop and operate the Wotten Waven-Laudat geothermal field.** DGDC is founded under corporate law and is a private company in all respects, despite the GoCD currently being its only shareholder. DGDC will enter into a concession agreement with the GoCD for the use of the geothermal resource; construct and operate SGPP and enter into a power purchase agreement (PPA) with DOMLEC for the sale of geothermal electricity. The GoCD has also issued the Geothermal Resource Development Act (2016), which sets the legal and policy framework governing the use of geothermal resources, providing greater confidence to prospective investors.

12. **Arranging low-cost financing and mobilizing global industry knowledge are critically needed to move the geothermal program forward.** Analyses conducted by the World Bank have shown that access to low-cost financing has the highest impact in terms of the likely reduction of the electricity retail price once SGPP is built. Equally important is to develop and operate SGPP successfully. To this extent, insurance against contingencies, and global industry knowledge and practice are also needed. To address the remaining barriers associated with development of the Wotten Waven-Laudat field, upon request by the GoCD, the World Bank in coordination with other development partners has arranged financing for the ***Dominica Geothermal Risk Mitigation Project*** (the Project).



C. Higher Level Objectives to which the Project Contributes

13. **The proposed Project can critically contribute to help reduce poverty and boost shared prosperity in Dominica as envisaged by the Regional Partnership Strategy (RPS) for the OECS for the period FY15-19 and the Performance and Learning Review of the RPS published in May 2018.** To achieve the twin goals, the RSP has identified three main areas of engagement including: (i) competitiveness; (ii) public sector modernization; and (iii) resilience. By providing access to more reliable and cost-efficient geothermal energy resources, the Project will be instrumental to improving the investment climate, a key outcome of the engagement on competitiveness. Strengthening capacity for public-private partnerships (PPPs) is also an objective of the Bank's engagement on sector modernization, and this is well supported by the Project, which will critically help reduce risks associated with geothermal development and attract a qualified private developer. Finally, the diversification of the country's energy-mix will reduce the vulnerability of Dominica's energy sector and economy to extreme weather events and to volatile fuel prices, in line with the Bank's engagement on resilience. In light of the above, the RPS has identified the development of geothermal resources in Dominica as a priority area for support during the RPS period.

14. **The Project is instrumental to the NRDS's goal to build resilience and sustainability cutting across all economic sectors.** NRDS' approach to growth seeks to respond to climate change in a comprehensive manner and integrates geothermal as an important element for sustainable and inclusive growth. The development of geothermal is instrumental to NRDS' objectives to enhance infrastructure resilience and green the economy as well as to NRDS' ultimate goal to foster more equitable and robust growth. Electricity costs reductions associated with the displacement of diesel generation are explicitly recognized in the NRDS as a mean to raise living conditions for households and increased competitiveness for businesses, ultimately leading to more jobs and growth. The NRDS also highlights the potential of geothermal electricity as tradable commodity. The GoCD's energy sector policy⁸ explicitly calls for the development of Dominica's geothermal potential, both to meet domestic energy needs and to export electricity. Therefore, developing Dominica's geothermal resources is a national priority.

15. **The proposed Project is aligned with the Maximizing Finance for Development approach as mainstreamed by the World Bank.** Although developed as public investment, SGPP is expected to increase prospects for private sector involvement going forward, and the whole project design is geared towards contributing to this goal. SGPP operation will help confirm the capability of the reservoir and its ability to support electricity production over an extended period, which is a pre-condition to further expand the Wotten Waven-Laudat field. To protect the viability of the overall geothermal program, a contingent grant facility will be established to provide insurance against additional resource risks. Once SGPP is fully functioning, the green-field will convert to a far less risky brown-field, one that is better positioned for further expansion. A comprehensive assessment will be needed to evaluate the viability of LGPP and develop a roadmap to move forward, as also envisaged under the project. The improved knowledge about the geothermal field, the proven operational capability of the reservoir, and the identification of a clear roadmap will altogether provide what is necessary to make an informed decision about the approach to proceeding with LGPP and eventually select the right private developer.

⁸ Draft National Energy Policy of the Commonwealth of Dominica, which is the GoCD's policy document for the sector.



II. PROJECT DEVELOPMENT OBJECTIVES

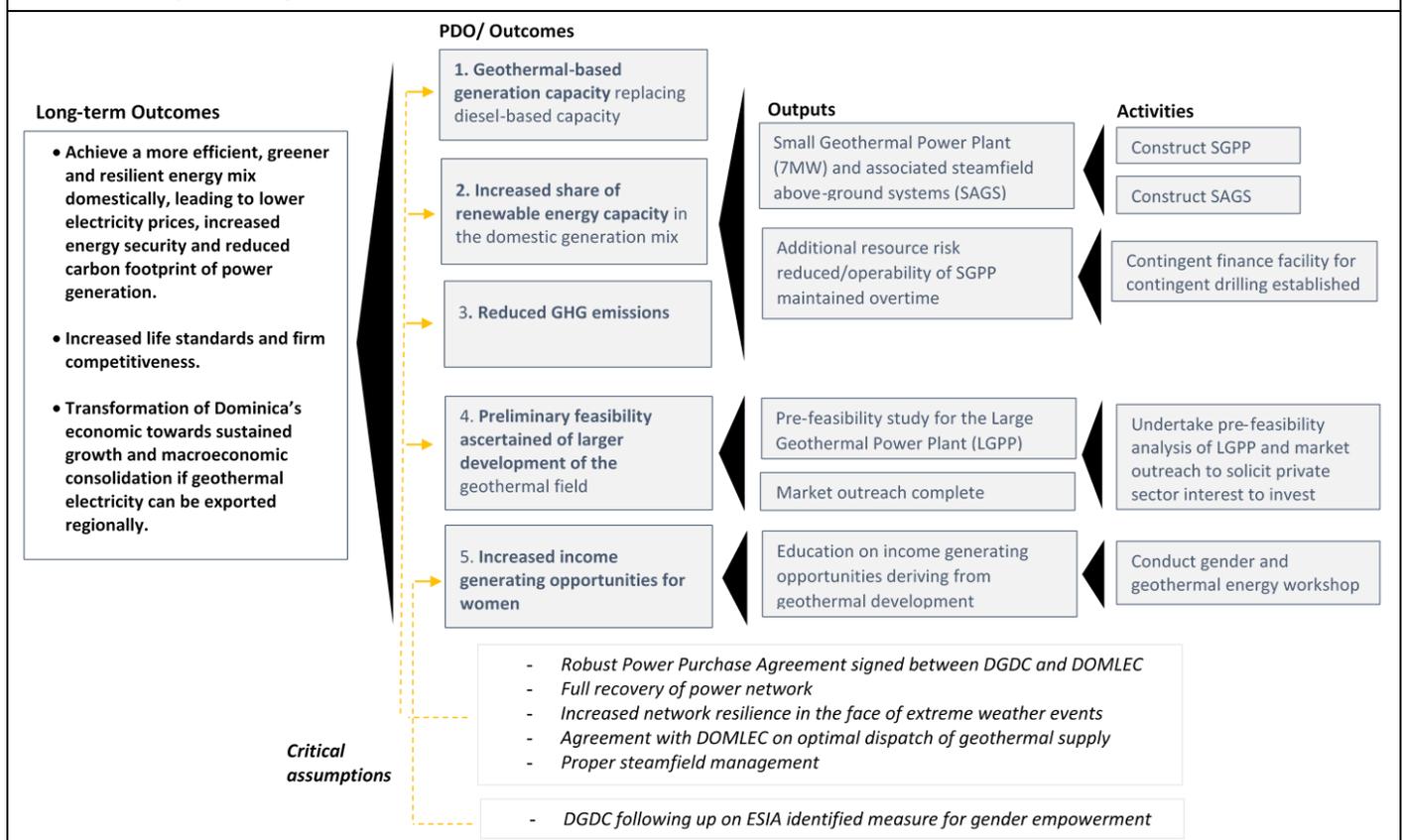
A. PDO

16. The objective of the proposed Project is to help: a) diversify the domestic power generation mix in Dominica by integrating renewable geothermal energy; and b) demonstrate the potential of larger development of the geothermal resource.

B. Project Beneficiaries

17. Direct project beneficiaries include all existing and prospective electricity customers in the country, who will greatly benefit from more resilient and sustainable electricity supply and lower and more stable electricity prices once diesel generation capacity used for baseload needs is displaced with indigenous geothermal capacity. In addition, by demonstrating the potential of a larger operation for regional electricity trade, the proposed Project will help explore new growth opportunities for Dominica. Economic and social benefits deriving from the Project will span across generations and beyond the country's borders if the viability of LGPP is confirmed and Dominica begins exporting geothermal power. Also, the displacement of polluting diesel generation capacity will reduce the carbon footprint of electricity generation in Dominica, with environmental benefits spanning globally as the Project contributes to the global commitment to reduce GHG emissions.

Box 1: Theory of change





C. PDO-Level Results Indicators

18. The primary results arising upon completion of the proposed Project are expected to be:
- (a) Generation capacity of geothermal energy constructed under the Project (MW, as measured by the installed capacity of SGPP);
 - (b) Increased share of renewable energy capacity in the domestic generation mix (percentage);
 - (c) Preliminary feasibility ascertained of larger development of the geothermal field;
 - (d) GHG emissions reduction compared to a business-as-usual baseline (tCO₂e); and
 - (e) Share of women employed in tourism activities facilitated by the project and/or the Government in proximity of the power plant (percentage).

III. PROJECT DESCRIPTION

A. Project Components

19. The proposed Project will comprise of three strategic components (a detailed project description is attached as annex 1):

- (a) **Component 1: Development of Domestic Geothermal Power Generation Capacity (US\$41.5 million)** – This component will entail construction of a 7 MW (nominally) small geothermal power plant (SGPP) and the associated steamfield above-ground systems (SAGS), based on the existing well inventory that has been drilled by the GoCD.
- (b) **Component 2: Contingent Financing in Aid of Additional Drilling (US\$9 million)** – Under this component, grant funds will be set aside to finance the drilling of additional (make-up) production and/or reinjection wells if the productivity of the existing production well declines below an acceptable level and/or the injectivity of the reinjection well does not adequately support power production. Contingencies of this kind could compromise the entire operation of SGPP. The costs associated with contingent drilling would place an undue burden on DGDC, undermining the company's financial viability just when it is beginning to operate on a commercial basis. Addressing unexpected declines in steam productivity early on is also key to maintain the viability of the geothermal field in view of its further expansion. Finally, any additional drilling would provide vital information regarding the steamfield characteristics at Wotten Waven-Laudat, which could help delineate the larger geothermal resource. In order to allow sufficient time for risk mitigation, the contingent grant facility will be in place for seven years and the project duration has been set accordingly. A detailed presentation of the scope and disbursement arrangements for this facility is provided in annex 3.
- (c) **Component 3: Technical Assistance for Advancing LGPP to Development Status and Soliciting Private Sector Investment (US\$0.953 million)** – This component will finance analysis geared towards establishing the viability of expanding the geothermal field and identifying a clear roadmap for developing LGPP. Specifically, the following key activities may be carried out: (i) additional geological surveys and scientific studies to better identify the likely boundaries of the larger geothermal resource at Wotten Waven-Laudat; (ii) feasibility study to confirm the viability of LGPP including defining its



potential scope, need for additional delineation drilling, and its “bankability”; and (iii) development of an investor prospectus and market outreach to solicit private sector interest to invest in LGPP. The exact activities will be selected in a manner to avoid overlapping with analytical work financed by other donors, which may directly or indirectly relate to Dominica’s geothermal development program.

B. Project Cost and Financing

20. The financing plan for the proposed Project, as detailed in table 1, amounts to US\$51.45 million and includes a combination of concessional financing and grants from development partners as well as equity from the GoCD. Adding the value of existing assets that the GOCD has transferred (US\$9 million), overall project costs amount to US\$60.5 million. Financing of component is as follows:

(a) Component 1: The costs associated with the construction and operation of SGPP is estimated at US\$41.5 million, of which US\$32.5 million is the estimated value of the Engineer-Procure-Construct (EPC) contract to be used for civil works and the construction of the geothermal power plant and associated steam gathering system. The estimated EPC contract costs include a 15 percent contingency allowance. Component 1 will be financed by the following sources:

- US\$10.3 million from the GoCD. The GoCD has already provided US\$7 million equity to DGDC to capitalize the company and invest in SGPP and will provide additional US\$3.3 million to cover EPC costs;
- US\$17.2 million credit from IDA;
- US\$10 million grant from the UK’s Department for International Development (DFID);
- US\$2 million grant approved from the Small Island Developing States (SIDS) DOCK Initiative.

The Recipient will have the flexibility to decide which sources of financing to use when payments to be made for the EPC become due. Overall, it is expected that by the end of project implementation each financier contribution will be in line with Table 1 below.

In addition, the GoNZ has provided a parallel in kind-grant in the amount of US\$2 million, which has financed technical advisory services for project preparation provided by Jacobs New Zealand Ltd. (Jacobs) and is covering the costs of DGDC’s Project Manager.

(b) Component 2. The Clean Technology Fund (CTF) has provided a US\$9 million contingent recovery grant that will be set aside under component 2 and released to cover the cost of additional drilling shall the need arise.

(c) Component 3. The technical assistance envisaged under component 3 will be funded through a US\$0.953 million grant provided by CTF.

Table 1: Cost Estimates and Sources of Funding

Project Components	Project cost	IDA	Trust Funds			Parallel Funding	Counterpart Funding
			CTF	DFID	SIDS	NZ	DGDC Equity
Component 1: Development of Domestic Geothermal Power Generation Capacity (SGPP) – (Estimated costs US\$38.2 million)							
<i>Steamfield Development - Wells *</i>	9.0						9.0
Power Plant + SAGS, Civil works	32.5	17.2		10.0	2.0		3.3



Land, Infrastructure, Engineering, Supervision, and Management Costs	9.0					2.0	7.0
Component 2: Contingent Financing in Aid of Additional Drilling– (Estimated costs US\$9 million)							
Contingent Financing in Aid of Additional Drilling	9.0		9.0				
Component 3: Technical Assistance for Advancing LGPP to Development Status and Soliciting Private Sector Investment – (Estimated costs US\$1 million)							
Geoscientific Studies & Evaluation of Inter-Island T-Link, Feasibility and E&S Safeguards, Market Sounding & Engagement with Developer	0.953		0.953				
Total financing	51.453**	17.2	9.953	10.0	2.0	2.0	10.3

*Sunk costs/already invested

The overall cost of the Project, including the value of existing assets already transferred to DGDC, is **US\$60.5 million

C. Lessons Learned and Reflected in the Project Design

21. The unusual features of development and implementation of geothermal projects result into specific challenges, which need to be considered by the host country and development partners. The proposed Project addresses several lessons learned from prior geothermal projects and from interaction with well-reputed geothermal developers.

22. **Importance of proper steamfield management.** By far, the largest component of the cost of geothermal electricity is the capital cost of (i) extracting geothermal steam; and (ii) the above ground facilities, including the steam gathering system and the power plant. For a project to be economically viable, the steamfield must produce its rated capacity of geothermal steam for at least 30 to 40 years. Prior developments have had steam fields whose productivity has largely dropped in 10-20 years, thereby imposing a considerable cost on the developer. Proper steamfield management is critical to the proposed Project. SGPP is expected to supply base load electricity for 30 years, so its failure would inflict great cost on Dominica. In addition, a properly functioning steamfield is critical to de-risking the overall geothermal program and lay the basis for developing LGPP. During project implementation and the associated procurement for design, construction and management of the plant facilities, the evaluation of bids will emphasize proper steamfield management. Furthermore, component 2 has been specifically designed to address any further contingencies associated with the steamfield.

23. **A significant reduction in the retail tariff can be accomplished if the public sector undertakes the high risk, front-end investments.** International experience with geothermal projects clearly shows that the high costs of upstream resource development and the associated uncertainties often adversely impact the bankability of downstream operations. Global experience also shows that when host governments take the upstream risks, they enhance the bankability of downstream development by the private sector. In turn, the Government can recover the upstream costs over time through further expansion of geothermal resources and the economic development of the national economy. Large part of the development impact associated with geothermal projects derives from the fact that they provide reliable and cost-efficient electricity supply, which, in places such as Dominica, can help reduce the retail tariff. Therefore, in effect, a public-private risk sharing approach is well suited to facilitate private sector investments and at the same time achieving the public interest.

24. **Implementing such a complex project in a small island country requires bringing human capacity**



from abroad. The GoCD is keenly aware of the country's small size and limited population. As a result, in consultation with development partners, it has agreed to structure DGDC so that the managerial core will come either from Dominica or the OECS region, and international contractors would provide the technical, construction and operational capacity, with financial support provided in part by the GoNZ and AfD (see annex 4 for a detailed description of implementation arrangements).

IV. IMPLEMENTATION

A. Institutional and Implementation Arrangements

25. DGDC will be the implementing agency for the proposed Project and will develop, own and operate SGPP. A full description of the institutional and implementation arrangements (including the relevant regulations underpinning geothermal development) is provided in annex 4.

26. Funds made available to the Project from the World Bank and other development partners (CTF, DFID, SIDS DOCK) will be channelled to DGDC through the GoCD. Specifically, legal agreements for credits and grants will be entered into between the GoCD and the World Bank. Therefore, the GoCD will enter into a Subsidiary Agreement with DGDC to transfer funds on the same conditions. The company will be responsible for the investments under component 1; the use of the contingent recovery grant set aside under component 2 and for implementing the TA activities envisaged under component 3. All civil works, the geothermal power plant and associated steam gathering system to be constructed under component 1 will be procured through a single EPC contract. The operation and maintenance (O&M) requirements of the Project will be split between the above ground aspects (steamfield, power plant and well pads) and the management of the geothermal resource and wells. At this stage, it is intended that DGDC will contract experienced service providers to operate and maintain above ground facilities and separately for sub-surface O&M.

27. DGDC is governed by a fully independent Board composed of four Directors headed by an Executive Chairman. The company's staff comprises seven professionals including a Project Manager (PM), who has the responsibility to oversee all project activities. The PM was competitively selected by the GoNZ and seconded to DGDC for a minimum period of two years as part of the in-kind support provided to the Project. Two Engineers (with competencies on mechanical and electrical engineering) provide support on engineering aspects. Financial management is entrusted to the Financial Controller (FC), who develops the annual budget and executes the financial transactions of the company. The FC also provides procurement support to the PM, although extensive procurement assistance will be provided by the Owner's Engineer (OE). A dedicated safeguards team, including an Administration and Safeguards Officer, a Community Liaison Officer and a Site and Office Attendant, have been appointed to handle the environmental and social management associated with the Project.

28. DGDC is being assisted by three groups of international specialists with global experience in geothermal development programs. Jacobs, which has provided extensive project preparation support as part of the technical assistance financed by the GoNZ, has been appointed as OE by DGDC, with the responsibility to provide oversight in the construction and operation of SGPP and all other technical aspects associated with the Project. Clean Infra Partners is providing transactional advice and financing



expertise to DGDC, including assistance with the PPA negotiations. Holland&Knight is providing legal services, including the drafting and review of all contracts. All three companies have been contracted by DGDC using *own* funds. In addition, DGDC will benefit from external expertise contracted by AfD and provided to the company to provide support on environmental and social management.

B. Results Monitoring and Evaluation

29. The Results Framework (RF) and Monitoring and Evaluation attached as section VII, identifies outcome indicators (Project Development Objective Indicators) for the Project as a whole, and output indicators (Intermediate Result Indicators) for each project component. Annual target values for the results indicators have been estimated based on the feasibility analysis completed by the GoCD and DGDC with support from international consultants and notably Jacobs. Target values concerning GHG emissions reduced or avoided have been estimated by the project team. The methodology used and a full analysis for GHG emission reductions are presented in annex 3. DGDC will be responsible for collecting and collating information on the project activities and submitting progress reports to the Bank, on an annual basis for PDO indicators and on a semi-annual basis for the intermediate indicators at component level.

C. Sustainability

30. The sustainability of the proposed Project critically hinges upon the viability of SGPP, which depends on three major factors, including: (i) adequate steam capacity available at the wellhead; (ii) DGDC's ability to operate and maintain SGPP properly; and (iii) utilization of the power produced at Wotten Waven-Laudat, through its integration into the grid, increased resilience and overall optimization of Dominica's power system.

31. Resource risks associated with SGPP have been mitigated through the exploration drilling program conducted by the GoCD. Any residual resource risks associated with variations in the reservoir permeability, which may result in unexpected declines of well productivity, or any issues affecting reinjection capacity will be addressed through the insurance mechanism established under component 2. The contingent drilling will allow to immediately restore a volume of steam production in line with plant capacity and protect the viability of SGPP.

32. Adequate attention must be paid to the O&M of the plant and the steamfield. As highlighted above, DGDC plans to contract O&M services. Specialist O&M services will be required for routine major plant overhauls, a work that can only be undertaken by an organization with adequate experience. If no O&M contractor experienced in geothermal equipment is available and/or willing to be hired at a reasonable cost, DGDC may need to build the organizational capacity internally. As far as steamfield management is concerned, the Project aims for a single operator for the entire steamfield to ensure that SGPP requirements are preserved when LGPP begins operation in the future. Ongoing steamfield management must be undertaken by a competent party with experience and knowledge of geothermal operations and management of the subsurface geothermal resource. As such capacity does not exist in Dominica at present, DGDC will develop an O&M strategy, including capacity and training requirements.

33. The recent natural disaster has dramatically shown the vulnerability of Dominica's T&D network; strengthening its resilience in the face of severe weather events is key to the sustainability of the power



sector and of this Project as well. The overall optimization of Dominica's power system to minimize the use of diesel fuel and hence costs to the consumers also rests on the adequacy of the T&D system. Although resilience and optimization are sector issues that go beyond this particular Project and mostly fall under the responsibility of DOMLEC, the Project's ability to fully deliver its benefits may in the future be influenced by distribution and transmission bottlenecks. CDB assistance provided to DOMLEC will help the company incorporate resilience measures in the rebuilding of the T&D network. Also, the study financed by AfD will provide a factual basis to define a long-term strategy for making the power system more resilient. Continued commitment to the resilience agenda by DOMLEC and by the GoCD will be critical going forward. The integration of power produced from SGPP into the grid will require some upgrading of the existing transmission line running from Laudat (the nearest substation to the power plant) to Fond Colé (the main distribution/transmission node in the south of the island). Discussions with DGDC have resulted in a robust proposal as detailed in annex 1.

34. The viability of SGPP will determine sustainability well beyond the proposed Project. As SGPP would be the first geothermal power plant in Dominica and the entire Caribbean Region since the Bouillante plant was commissioned in Guadalupe 30 years ago, risk perception, especially in view of the further development of the Wotten-Waven field is very much shaped by the performance of this plant. Also, a successful SGPP would prove the viability of the geothermal market in the Caribbean region, improving the circumstances of geothermal projects being prepared elsewhere in the region.

D. Role of Partners

35. The proposed Project has provided an ideal platform for development partners supporting geothermal development in Dominica to come together and deploy their respective assistance in complementarity with one another. Concessional finance and grants provided by IDA, DFID, CTF, SIDS DOCK are paramount to lower the financial burden and risks on DGDC. Support from the GoNZ will continue throughout implementation through the PM seconded to DGDC. Development partners share a common understanding of the opportunities and challenges attached to geothermal development and the need for a more resilient power system in Dominica. In the aftermath of Hurricane Maria, a broader group of partners has come together in an unprecedented and coordinated effort to help lift Dominica. As highlighted above, parallel support to the power sector from AFD, the UAE and CDB is critically helping address sector issues that may affect the Project.

V. KEY RISKS

A. Overall Risk Rating

36. The following are the Project's risks rated as *Substantial*. In light of such risks, the overall Project risk is rated as ***Substantial***.

37. **Macroeconomic risk.** The Macroeconomic risk is rated *Substantial* considering the severe effects associated with Hurricane Maria. Latest projections estimate that real GDP will contract by 14.5 percent in 2018 and will take about 5 years to recover to pre-hurricane levels. The fall in output and government revenues, coupled with increased expenditure for reconstruction, will lead to a substantial fiscal



imbalance and risks in terms of public spending capacity, financial sector instability, and constraints affecting reconstruction. In this context, concessional financing by external partners will cover near-term current account deficits. Fiscal imbalances are not expected to impact the Project significantly. The IDA credit is provided under the most concessional terms. Proceeds will be on-lent to DGDC, which is expected to be financially viable once SGPP is operational. Also, among all private sector projects SGPP is expected to provide significant positive benefits if it results in lower electricity tariffs. The reduced reliance on imported fuels and lower energy costs will help improve the balance of payments and increase firm competitiveness, thus contributing to fiscal consolidation. There is a risk that impending emergencies may result into undue government's pressures on DGDC, endangering the company's ability to operate under commercial principles. To mitigate such a risk, the Bank team will remain closely engaged with the GoCD, and notably the Ministry of Finance, to help protect DGDC's viability overtime.

38. **Technical Design of Project or Program.** As highlighted above, any residual resource risks that may affect the operation of the power plant will be mitigated through the contingent drilling funds set-aside under the Project. The technology for a geothermal power plant is pretty standard and does not pose major technical risks, especially for a small-size plant such as SGPP. Nonetheless, the overall technical risk for the Project is assessed as *Substantial* since the larger geothermal resource area is not yet sufficiently delineated to quantify the resource and scope of the LGPP expansion. The assessments to be carried out under component 3 will allow to better ascertain the contours of the larger geothermal resource at Wotten Waven-Laudat and the viability of the LGPP operation. They will also help with proper scoping of LGPP to ensure optimal operation of the field for both domestic and export needs.

39. **Institutional Capacity for Implementation and Sustainability.** This is rated as *Substantial* as the proposed Project is the first geothermal project in Dominica, and DGDC itself is newly established; thus, the company's own expertise to undertake the Project is limited at this time. The preparation support provided by development partners has been critical to take the Project to the current investment-ready state. Continuing support throughout implementation and adequate implementation arrangements are the most critical measures to counter capacity risks. As an international geothermal expert with large project management experience, the PM is expected to provide sound project supervision. Capacity building and knowledge transfer have been part of the services provided by Jacobs during project preparation. Retaining the company as OE will provide continuity and solid oversight of technical aspects. In addition, the recourse to a single EPC contract and multiple O&M contracts constitute an optimal choice to ensure efficient and sustainable project implementation. The arrangements made by Dominica and notably the use of top-notch advisory services, provide a suitable model for countries that are investing in geothermal development for the first time, especially in contexts where a geothermal market is yet to be established. The Bank team will continue to coordinate with the DGDC to ensure that sound business decisions are taken and enforced.

40. **Fiduciary.** This is rated as *Substantial* mostly because of the risks associated with procurement activities under the Project. The procurement of the EPC contract, which is the highest-value contract, absorbing 60 percent of project funds, is a complex process and DGDC does not have previous experience with World Bank-funded projects. The availability of procurement expertise within country is obviously limited. Furthermore, the recovery process is still ongoing and government agencies and the private sector are stretched by the enormous and competing demands associated with the reconstruction. Procurement risks are being mitigated by relying on the support of the OE, who has solid expertise in this field (see annex 4). Also, the Bank team will ensure close support and supervision towards the



achievement of value for money, successful award of contracts and proper contract administration (see annex 5 for details on implementation support).

41. **Environment and Social.** The classification of social risks as *Substantial* is mainly due to legacy issues associated with the acquisition of four parcels of land executed by the GoCD during the geothermal exploration and drilling phase. Since such properties were acquired for uses that are instrumental to the proposed Project, they form part of the project-affected areas and land acquisitions must be executed in compliance with the World Bank's Operational Policy on Involuntary Resettlement (OP 4.12). Upon Bank's suggestion, in 2017 DGDC, on behalf of the GoCD, carried out an audit, which identified several incompliances (notably in terms of land valuation, documentation and grievance redress), and developed an Action Plan to address these shortcomings. The Bank concurred with the results of the Action Plan and closely monitored its implementation. In September 2018, the GoCD authorized and executed compensation at replacement cost for three of the four parcels (for more details see annex 4). The fourth parcel belongs to a private firm and compensation will be settled through an adjustment of tax arrears. The Action Plan and later the payment of outstanding compensations have helped build institutional capacity and better position the GoCD to handle new land acquisitions for the Project. The environmental risks identified for the Project are potential impacts on ecology, as the power plant site is partially within the village boundary of Laudat and within a habitat that has been classified as of 'high' sensitivity, located approximately 500-600 m from the Morne Trois Pitons National Park (MTPNP) World Heritage Site. DGDC has developed a robust ESIA, which manages potential risks following the mitigation hierarchy set under the applicable World Bank Performance Standards as well as the applicable Bank's environmental, health and safety guidelines.

42. **Stakeholder Risk.** As result of the proposed Project, DGDC will become a major supplier of electricity and will need to have a constructive relationship with DOMLEC, which has the monopoly for providing electricity to consumers throughout the island. Ordinarily, forging such a relationship may pose challenges, and this is especially so in Dominica, where DGDC and DOMLEC have conflicting objectives that became clear in the aftermath of Hurricane Maria. As more time has elapsed since Hurricane Maria, the GoCD and DOMLEC have collaborated on restoring the electric system to its pre-storm configuration. The PPA between DGDC and DOMLEC, which is the most important mitigating factor of stakeholder risk, appears to be well advanced. The signature of the PPA and its approval by IRC will bind DOMLEC legally to obligations related to DGDC in relation to the Project. A signed PPA is set as disbursement condition. Despite the encouraging progress with respect to concluding the PPA, the parties need to continue sparing effort to build the constructive relationship needed to fully offset the risks that divergent objectives pose to the proposed Project.

43. **Threat of natural disasters.** Power sector resilience to natural disasters rests with DOMLEC, as single owner and operator of Dominica's power network. The last Annual Report suggests that the company has a relatively healthy balance sheet with resources adequate to manage its system and deliver its services in a normal year. However, it does not have the resources to rebuild a destroyed system. In this regard, the CDB loan provides critical support. However, it will cover the rebuilding of the system to its pre-hurricane conditions. As result, the system will be marginally more resilient than in the past and still not be able to withstand a catastrophic storm or to accommodate major changes in electricity consumption overtime. Technical assistance by CDB and other partners will help define a longer-term strategy for power sector resilience. The Bank will continue close engagement with the GoCD and energy sector stakeholders to help ensure that all parties constructively cooperate around the resilience agenda.



The risks to infrastructure from natural disasters, especially flooding, have been identified as a major risk by the ESIA process. Measures to manage this risk have been incorporated into the management plan and should be considered for final design of the pipelines and other facilities.

44. **Securing a private partner.** The longer-term strategy for scaling-up geothermal in Dominica rests on engaging a qualified private partner. GoCD's failed attempts to enlist a private developer in the past provided two important lessons: (i) resource and market risks were too high; and (ii) because of its small scale, SGPP remained less appealing to developers, while there was greater interest in LGPP, if its viability could be established. Building on these lessons, the proposed Project has been specifically designed so as to de-risk investments in Wotten Waven-Laudat as much as possible before reengaging the market. As a result, chances to secure a partnership with a qualified developer are expected to be higher. If this continues to be a challenge – as future market conditions cannot be predicted with certainty – DGDC would nonetheless be capable to operate SGPP, which is assessed to remain a valuable project.

VI. APPRAISAL SUMMARY

A. Economic and Financial (if applicable) Analysis

Economic Analysis

45. A cost-benefit analysis has been carried out to assess the economic viability of the Project from the point of view of the society at large. A detailed analysis, including an assessment of the Project's development impact, the rationale for public sector financing and the value added of Bank's support is presented in annex 6.

46. A key benefit that can be quantitatively assessed is the reduction in energy costs resulting from the displacement of expensive diesel-based generation with more cost-efficient and greener geothermal-based generation to meet domestic energy needs. Cost savings are expected to be passed through onto customers, leading to lower retail prices. This will earn large economic and social benefits to Dominica's people and firms. Households will experience welfare gains in many aspects, including income opportunities, education, health, and general quality of life, that may arise as consumers can spend less on electricity. Firms will be able to be more competitive and attract business and investments. In addition, the overall expenditure on fuel subsidy will decrease as less diesel fuel is imported and used for electricity generation. Other benefits that can be assessed in quantitative terms are the positive externalities to the global community as the carbon footprint of power generation in Dominica is reduced.

47. The Project is assessed to be highly valuable with a net present value (NPV) of US\$136.4 million and an economy internal rate of return (EIRR) of 38.0 percent, assuming a carbon price of US\$40/ton of CO₂. The economic viability of the Project remains solid even assuming reduced energy cost savings, exhalation in the costs for building SGPP, as well as contingencies that may reduce the operability of SGPP and require additional drilling.

Financial Analysis

48. The financial analysis assesses the viability of the proposed Project from the point of view of the developer (DGDC). This analysis estimates the financial return of SGPP using the concepts of Project



Internal Rate of Return (Project IRR), Equity Internal Rate of Return (Equity IRR) and Debt Service Coverage Ratio (DSCR). Because of the specific circumstances of this Project, the targets of the financial returns will be somewhat different from what is expected for typical private projects. In a normal case, DGDC should try to maximize its return by securing the highest possible price for the electricity produced by SGPP under the PPA with DOMLEC. However, the main goal of the Project is to help reduce and stabilize electricity retail prices in Dominica, which calls for exactly the opposite. Since during the development of SGPP DGDC will be entirely owned by the GoCD, the company can accept a lower return and the GoCD will realize the real return from the Project through a reduction in the retail price of electricity.

49. The analysis shows that the Project is expected to produce an overall return (Project IRR) of 2.7 percent and a return on equity (Equity IRR) of 6.18 percent. The Minimum DSCR is estimated at 1.1X; the Average DSCR at 3.2X. These results suggest that the DGDC will generate enough cash flow from the Project to repay its debt and earn a financial return slightly higher than the GoCD's target. A sensitivity analysis performed to test the viability of the Project in the face of negative variations of key parameters (drop in the well productivity and capital and operating cost overruns) shows that DGDC is likely to remain financially sound throughout project implementation. In sum, the company meets the cash flow standards as envisaged by the World Bank. Rate of returns are lower than what is normally expected for electricity projects, but this is only due to the fact that benefits are transferred to consumers, in line with the public interest attached to this Project. A full financial analysis can be found in annex 6.

B. Technical

50. The Project builds upon actions taken to date by the GoCD to advance preparation of the Wotten Waven-Laudat field. The phased approach utilized by the GoCD – that is, to develop the field in stages – is very much in line with industry practice. For the purposes of developing SGPP, the relevant resource area has been proven by drilling. Three initial wells were drilled as exploration wells, two of which successfully produced steam; these were later followed by dedicated production and reinjection wells. The identified reservoir area is sufficiently proven for the development of SGPP using the existing wells. Geothermal production will be from the existing production well (WW-P1), which has already been tested and found capable of supporting a 7-8 MW power generation facility. The proposed power plant site is very close to WW-P1; it will require the least amount of civil enabling works and will minimize potential land acquisition and resettlement. The power plant technology can be either conventional condensing steam turbine(s) or a binary plant, and the location proposed is sufficiently large to accommodate either technology. The choice between them will be up to vendors when tendering for the plant. Both power plant technologies will require re-injection, and fluids for reinjection will be piped to the existing rejection wells. The conceptual design of the reinjection pipeline has been completed; the detailed design will be part of the EPC contract – as it is common practice. Electricity generated by the power plant will be distributed through mostly existing transmission lines. The use of existing wells for reinjection and of the existing easement for transmission will significantly reduce environmental and social impacts.

51. While resource risk associated with SGPP has been taken to a minimum through the exploration and production drilling program conducted by the GoCD, in a field that is operated for the first time, there are still residual resource risks associated with variations in the reservoir permeability. The producing well may begin to demonstrate a decline in productivity. Furthermore, for the power plant to achieve full rated power output, the reinjection of spent geothermal fluids must occur at the same rate they are produced.



If the projected capacity of the existing production/reinjection wells indicates that there may be declines below the minimum level required for SGPP to operate correctly, the contingent grant facility established under component 2 will be mobilized to finance the drilling of one or more additional wells. Production wells will be drilled from the same well pad as the existing well, thus minimizing any potential additional environmental or social impacts.

52. To further develop the geothermal field, a larger resource area in line with the capacity envisaged for LGPP should be confirmed, which would require more upfront investments in exploration and drilling. The analyses to be funded under component 3 together with improved knowledge regarding the geothermal field characteristics gained from the operation of SGPP, will provide a comprehensive evaluation of several key aspects of LGPP.

53. A more detailed technical assessment is presented in annex 1.

C. Financial Management

54. A Financial Management Assessment (FMA)⁹ for the proposed Project was conducted to determine whether the GoCD, through its implementing agency, DGDC, has acceptable FM arrangements in place to adequately control, manage, account for and report on the use of project funds. The scope of the assessment included: (i) an evaluation of the proposed financial management systems to be used for project monitoring, accounting and reporting; (ii) a review of the propose FM staffing; (iii) discussions of the propose flow of funds; (iv) the internal controls that should be in place; (v) reporting requirements, including the format and content of IFRs and annual financial statements; and (vi) a review of the external audit arrangements.

55. DGDC has adequate financial management arrangements in place that can provide reasonable assurance, accurate and timely information on the use of project funds subject to incorporation of the following mitigation measures:

- (i) DGDC has FM staff with the necessary knowledge of all DGDC finance systems and procedures and are familiar with applicable Bank FM requirements; and
- (ii) Roles and responsibilities between the GoCD and DGDC are set and presented in the Project Operations Manual.

56. Additional FM arrangements are detailed in annex 4.

D. Procurement

57. Procurement under the Project will be conducted in accordance with the World Bank's 'Procurement Regulations for IPF Borrowers' (July 2016, revised in November 2017 and August 2018). The Project is subject to the World Bank's Anti-Corruption Guidelines, dated October 15, 2006, revised in January 2011, and as of July 1, 2016. A Procurement Assessment was carried out to evaluate the adequacy of existing procurement arrangements for project implementation. The assessment identified the following specific procurement risks and challenges: (i) lack of previous experience of the implementing

⁹ In accordance with OP/BP 10.00 and the Financial Management Practice Manual



entity (DGDC) in World Bank-funded projects; (ii) the need of procurement support for complex procurement processes; and (iii) limited number of staff with previous procurement experience.

58. The following actions will be taken to address the procurement capacity challenges (further details on procurement are provided in annex 4):

- (i) Participation of the implementing entity staff in procurement training events delivered by the Bank;
- (ii) Extensive hands on procurement support to be provided by the owner's engineer, related to the bidding process for the geothermal plant;
- (iii) Close support and supervision of the Bank's procurement specialist to the project.
- (iv) Procurement arrangements will be included in the Project Operations Manual.

E. Social (including Safeguards)

59. The Wotten Waven-Laudat geothermal field is located in the southwestern part of Dominica, in the Roseau Valley about 5 to 6 km east of the capital Roseau. The valley lies inland from the coast and before Hurricane Maria was covered by forests with rich vegetation. Mountains surround the valley on three sides. The mountains located farthest to the West belong to the Mornes Trois Pitons National Park (MTPNP) established in 1975 under the National Parks and Protected Areas Act, which in 1997 was declared United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site.

60. DGDC meets the criteria envisaged under Operational Policy 4.03 Performance Standards (PS) for Private Activities for application of the Performance Standards (see section C, annex 4 for details). The company has addressed social risks associated with the Project through the Environmental and Social Impact Assessment (ESIA) process by preparing a Social Impact Assessment (SIA) and a Stakeholder Engagement Plan (SEP – including Grievance Redress Mechanism). The SIA builds upon the review and analysis of information collected under the ESIA's carried out during the exploration and production drilling phase. It also considers social risks through the lens of the pre- and post-Hurricane Maria conditions. Social issues related to environmental receptors are also addressed in the SIA.

61. During project preparation, several public consultation meetings and fifteen focus-group discussions were held between 2016 and 2017. Following the passage of Hurricane Maria in September 2017, further consultations were held with community members to determine if there were vulnerability issues to be considered. A draft Non-Technical Summary (NTS) of the ESIA was discussed at separate meetings in Laudat, Trafalgar and Wotten Waven in July 2018. The document was also disclosed on the DGDC's website. The finalized NTS and Volumes 1 and 2 of the ESIA (Introduction and Environmental Impact Assessment) were disclosed in country on August 10, 2018. The remaining ESIA components and notably the Abbreviated Resettlement Action Plan (ARAP) were disclosed in country on October 18, 2018. The full ESIA was disclosed on the Bank website on October 24, 2018.

62. The main social impacts of the Project are related to direct and indirect employment opportunities and the needed land acquisition. There will be minor impacts in terms of economic displacement to livelihoods, especially as related to the tourism activities around the MTPNP World Heritage Site. Hurricane Maria caused substantial damage to agriculture livelihoods in Dominica, including loss and/or damages to animals, crops, buildings, infrastructure and equipment. Damage to forest resources was also reported, with further impacts on agriculture. As a result, among productive sectors, agriculture was the



one most affected by the disaster, with damages and losses equal to US\$179 million, followed by the tourism sector (US\$91 million) and commerce and micro-businesses (US\$77 million).

63. The GoCD is responsible for land acquisition and resettlement, which will be addressed in line with the requirements of OP 4.12 on involuntary resettlement. With OP 4.12 triggered, the GoCD will be responsible for the implementation of the ARAP prepared under the ESIA, including grievance redress. Land acquired by the GoCD will be leased to DGDC for forty years at concessionary rates. To facilitate DGDC's ability to carry out its oversight of all project-related safeguards, a Memorandum of Understanding will be entered into by the Ministry of Lands and Housing and DGDC for land acquisition matters and ARAP implementation.

64. The ARAP, which sets out land acquisition guidelines and procedures (for negotiation and compensations), has identified thirteen properties that will be acquired for the construction of the power plant and the reinjection pipeline. For the reinjection line, portions of each of six properties will be acquired to define a corridor of up to 10m. This would include three structures, one of which is residential, one intended for residential use and one used for livestock. DGDC will determine the exact land to be acquired for the reinjection line based on technical and financial considerations. Five of the properties in close proximity to the power plant site are expected to be affected by noise, construction and visual impacts and have thus been considered for resettlement. The property belonging to one project-affected-person (PAP) already contains a well pad from the drilling phase and thus DGDC considers acquiring the remainder of the parcel. Twelve PAPs requested cash compensations while one opted for a replacement property. Additional surveys will be carried out to identify a resettlement site for this party.

65. **Economic displacement and vulnerability issues.** Some of the PAPs will suffer economic damage in the form of loss of trees, crops, livestock and some structures on their land. The ARAP includes an assessment of the compensation values for these assets. The DGDC will follow up with the relevant Government Departments to ensure that all planned economic and livelihood restoration support measures and related payments are guaranteed to PAPs. DGDC will also facilitate access of affected persons to existing government programs for livelihood restoration. Prior to Hurricane Maria, the social assessment revealed the presence of a few vulnerable (physically disadvantaged and elderly) persons within the communities adjoining the project sites. Vulnerability conditions have worsened following the passage of Hurricane Maria. DGDC will also follow up with relevant Government departments to ensure that support is provided to vulnerable PAPs through the provision of additional assistance in the form of cash and other social assistance programs such as employment training, counseling in domestic matters and any other assistance that may be requested.

66. **Gender issues and interventions.** Despite significant progress in Dominica in the education and leadership spheres, two main gender challenges persist, including women's access to labor market and gender-based violence (GBV). Female labor force participation is lower compared to male one and women's labor condition has been further exacerbated by Hurricane Maria. The loss of assets and crops posed significant income and food security challenges resulting in women's immediate needs for livelihood recovery interventions. GBV and especially intimate partner violence remain also a critical health and social constraints for the female population. Given this context, the Project will promote economic opportunities for women and stakeholders' awareness on the links between gender and geothermal energy. Specifically, a Community Development Fund (CDF) will be financing a series of



gender-sensitive activities¹⁰. The Project will ensure that at least 60 percent of the people employed for these activities will be women, especially the most in need. In addition, the Project will support a gender and geothermal energy workshop to increase the sectorial knowledge and benefits related to the gender and geothermal energy agenda. Additionally, the Project will create a wide range of economic opportunities for women. During the construction phase, several services will be needed to respond to the daily necessities of workers, including food, laundry, housing and transportation's provision, which are normally provided by women. In addition, as the power plant is likely to become a tourist attraction, more business opportunities will be generated for the local community and especially women, who already work as vendors in the tourism industry.

67. **Labor influx and gender relations.** The Project will involve the influx of approximately 50 foreign workers who will be housed in a workers' camp, during the construction stage. The camp will be located close to the proposed work sites to minimize the impact of traffic on the local communities due to workers travelling daily to and from the site along the narrow Roseau Valley roads. Labor influx could potentially increase the incidence of GBV, unintended pregnancy, and sexually transmitted infections (STIs), including HIV/AIDS, on the local communities. To address these risks, the social, health and safety procurement clauses covering labor recruitment, safety, and HIV/AIDS will be incorporated in all works contracts. In addition, the EPC Contractor will be required to develop a workers' code of conduct to address relations between the workers and the community.

68. **Citizen engagement.** The SEP provides guidance for stakeholder engagement during project implementation; laying the foundation to strengthen and maintain relationships with all stakeholders throughout the project cycle. The DGDC's safeguards team will be primarily responsible for SEP implementation, under the oversight of the DGDC's executive management team. While grievance redress related to land acquisition will be a GoCD's responsibility (exercised by the Division of Lands and Survey), DGDC will be responsible for all other project-related grievance redress including monitoring and evaluation. The company has prepared separate workers' and community grievance redress mechanisms.

F. Environment (including Safeguards)

69. Despite the limited environmental footprint of the Project, since its locations are on the periphery of the MTPNP, the project risk category is assessed to be Category A, on the basis of the screening criteria defined under the World Bank's Operational Policy 4.03. In addition, the Project's direct area of influence could expand to high value biodiversity areas.

70. The ESIA completed by DGDC considers the direct, indirect and cumulative environmental impacts associated with the Project, provides an analysis of alternatives and complies with: (a) the host country legislation; (b) the applicable WB Performance Standards; and (c) the applicable WBG environmental, health and safety guidelines. The key environmental, health and safety impacts and risks associated with the construction of the geothermal power plant are: (i) air emissions, increased noise, dust and solid and hazardous waste generated from construction activities and/or accidental spills in the villages close to the Project and its accesses; (ii) erosion and sedimentation; (iii) increased risks of accidents in access roads;

¹⁰ Activities have been identified during ESIA consultations, although specific activities will be selected during project implementation. A potential activity is the construction of a visitor center at the power plant site to be managed by the community.



and (iv) potential impacts on tourism and habitats in high sensitive areas. The earthworks and stream crossings required for the construction of the rejection pipeline may cause impacts on water quality and ecology. Once SGPP is in operation, the key impacts and risks are: (i) potential for soil and water erosion, runoff, and sedimentation; (ii) increased emissions of potentially hazardous (and malodorous) air pollutants such as hydrogen sulfide (H₂S); and (iii) community and worker exposure to explosions, well blowouts and pipeline failure as well as hazardous working condition for plant personnel.

71. The ESIA contains the Environmental and Social Management Plan (ESMP), a Monitoring Plan, and the Framework Environmental and Social Management System (ESMS) developed for the Project. The Framework ESMS details the environmental and social policy applicable to the Project and is consistent with the requirements of PS 1. It provides the key elements for developing and implementing an overarching ESMS, which will establish a methodological approach to managing environmental and social risks and impacts in a structured way and on a continuous basis. DGDC will be responsible for implementing the ESMS and ensuring compliance with national regulations and project sponsor's requirements over the life of the project. The ESMS will ensure that there are appropriate environmental and social policies and procedures in place and that these are followed consistently.

72. The Climate Change Group of the Bank has assessed 100 percent climate co-benefits for the IDA-financed part of the Project. More details on social and environmental risks and safeguards, as well as on gender aspects are provided in annex 4.

G. World Bank Grievance Redress

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

Results Framework

COUNTRY: Dominica

Dominica Geothermal Risk Mitigation Project

Project Development Objective(s)

The objective of the proposed Project is to help: a) diversify the domestic power generation mix in Dominica by integrating clean, renewable geothermal energy; and b) demonstrate the potential of larger development of the geothermal resource.

Project Development Objective Indicators

Indicator Name	DLI	Baseline	Intermediate Targets						End Target	
			1	2	3	4	5	6		
Generation capacity of geothermal energy constructed under the Project (MW)										
Generation Capacity of Geothermal Energy Constructed Under the Project (Megawatt)		0.00	0.00	0.00	7.00	7.00	7.00	7.00	7.00	7.00
Increased share of renewable energy capacity in the domestic generation mix (percentage)										
Share of Renewable Energy Capacity in the Domestic Generation Mix (Percentage)		24.70	24.70	24.70	51.00	51.00	51.00	51.00	51.00	51.00
Preliminary feasibility of larger development of the geothermal field ascertained										
Preliminary Feasibility of		No	No	No	No	No	Yes	Yes	Yes	Yes



Indicator Name	DLI	Baseline	Intermediate Targets						End Target
			1	2	3	4	5	6	
Larger Development of the Geothermal Field (Yes/No)									
Estimated GHG emissions reduction compared to a business-as-usual baseline (tCO2)									
Estimated GHG Emissions Reduction Compared to A Business-As-Usual Baseline (Tones/year)		0.00	0.00	0.00	19,111.00	38,223.00	38,223.00	38,223.00	38,223.00
Increased income generating opportunities for women									
Share of women employed in tourism activities facilitated by the project and/or by the Government in proximity of the power plant (Percentage)		0.00	0.00	0.00	10.00	20.00	30.00	40.00	60.00

Intermediate Results Indicators by Components

Indicator Name	DLI	Baseline	Intermediate Targets						End Target
			1	2	3	4	5	6	
Small Geothermal Power Plant (SGPP)									
Small Geothermal Power Plant (SGPP) Constructed (Number)		0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00
Steam Above Ground System (SAGS)									



Indicator Name	DLI	Baseline	Intermediate Targets						End Target
			1	2	3	4	5	6	
Steam Above Ground System (SAGS) Constructed (Percentage)		0.00	0.00	25.00	100.00	100.00	100.00	100.00	100.00
Insurance for Contingent Drilling									
Insurance for Contingent Drilling Established (Yes/No)		No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(Pre) feasibility Study for the Large Geothermal Power Plant (LGPP)									
(Pre) feasibility Study for the Large Geothermal Power Plant (LGPP) Completed (Yes/No)		No	No	No	No	Yes	Yes	Yes	Yes
Outreach to Market to Solicit Private Sector Interest to Invest in DGDC									
Outreach to Market to Solicit Private Sector Interest to Invest in DGDC Completed (Yes/No)		No	No	No	No	No	Yes	Yes	Yes
Gender and Geothermal Energy Workshop									
Gender and Geothermal Energy Workshop Conducted (Yes/No)		No	No	Yes	Yes	Yes	Yes	Yes	Yes



Monitoring & Evaluation Plan: PDO Indicators

Indicator Name	Definition/Description	Frequency	Datasource	Methodology for Data Collection	Responsibility for Data Collection
Generation Capacity of Geothermal Energy Constructed Under the Project		Annual	Project progress reports to be compiled by DGDC		DGDC
Share of Renewable Energy Capacity in the Domestic Generation Mix		Annual	Inferred based on project progress reports to be compiled by DGDC		DGDC
Preliminary Feasibility of Larger Development of the Geothermal Field		Annual	Reported by DGDC		DGDC
Estimated GHG Emissions Reduction Compared to A Buisness-As-Usual Baseline		Annual	Project progress reports to be compiled by DGDC		DGDC
Share of women employed in tourism activities facilitated by the project and/or by the Governement in proximity of the power plant	Women employment in activities planned to be financed by the Community Development Fund to be established under the Project.	Annual	Project progress reports to be compiled by DGDC		DGDC



Monitoring & Evaluation Plan: Intermediate Results Indicators

Indicator Name	Definition/Description	Frequency	Datasource	Methodology for Data Collection	Responsibility for Data Collection
Small Geothermal Power Plant (SGPP) Constructed		Annual	Project progress reports to be compiled by DGDC		DGDC
Steam Above Ground System (SAGS) Constructed		Annual	Project progress reports to be compiled by DGDC		DGDC
Insurance for Contingent Drilling Established		Annual	Project progress reports to be compiled by DGDC		DGDC
(Pre) feasibility Study for the Large Geothermal Power Plant (LGPP) Completed		Annual	Project progress reports to be compiled by DGDC		DGDC
Outreach to Market to Solicit Private Sector Interest to Invest in DGDC		Annual	Market outreach		DGDC



Completed			report prepared by DGDC		
Gender and Geothermal Energy Workshop Conducted		Annual	Project progress reports to be compiled by DGDC		DGDC



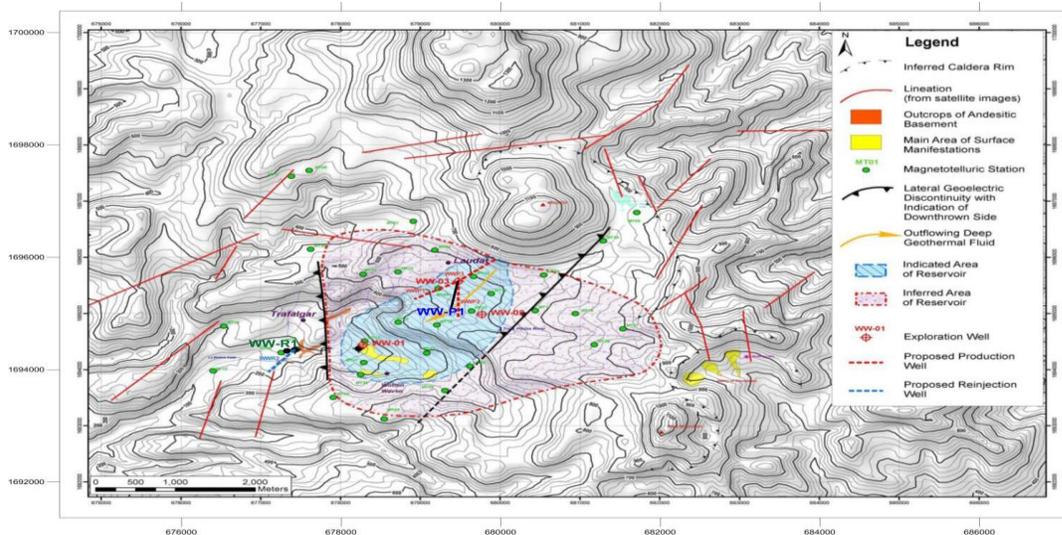
ANNEX 1: DETAILED PROJECT DESCRIPTION

COUNTRY: Dominica
Dominica Geothermal Risk Mitigation Project

1. The development of the Wotten Waven-Laudat geothermal field in the Roseau valley is a key part of the GoCD's strategy to exploit, for the first time, what is preliminarily estimated to be upwards of 500 MW of geothermal power generation potential throughout the island. The proposed Project builds upon actions taken to date by the GoCD to advance preparation of the Wotten Waven-Laudat field and utilizes a phased approach, which is very much in line with industry practice.

2. For the purposes of developing SGPP, the relevant resource area which has been proven by drilling is shown in Figure 1. The temperatures and pressures measured in the existing wells are nearly uniform and the deep permeability of these wells is generally good, all of which supports the hypothetical model of the reservoir. Three initial wells were drilled as exploration wells and two successfully produced steam. These were later followed by dedicated production and reinjection wells which proved the concept of targeting geological structures with directional wells. The resource quality (enthalpy and gas content) is suitable for either condensing steam or binary plant. The nature of the area currently tested by drilling is consistent with it being an outflow from a hotter upflow zone elsewhere, so an assessment of the resource quantity based on the currently drilled area and the anticipated well capacities can be considered conservative, although the location of the higher-temperature upflow zone has not yet been confirmed. Similarly, the success ratio in drilling so far, both for production and reinjection, is typical for a project at this stage of development and can be regarded as positive for the future. Wells drilled and tested so far are considered sufficient for the first stage of the Project, though some more drilling would eventually be prudent to ensure continuity of supply.

Figure 1 – Wotton Waven Geothermal Field



Source: Technical Assistance For Geothermal Power Development, Feasibility Study, HCB Energy, SPA 2013



3. The indicated reservoir area is about 3 km² and is deemed to be sufficiently proven to be used as a basis for the development of SGPP using the existing wells. Two independent resource assessments reached the conclusion that there is a 90 percent probability that the indicated resource is capable of supporting at least 25 MWe for 30 years. A larger area is considered to comprise an inferred resource, that is to say with a lower level of confidence until it is drilled, but with an estimated combined resource capacity of around 50 MW at a 90 percent confidence level. There is considerable potential for a yet larger resource. Although there is a low risk that recharge by low temperature or acid fluids could prematurely reduce the output of the wells, the overall resource risk for SGPP is considered to be very low.

4. The proposed Project will comprise three strategic components:

5. **Component 1: Development of Domestic Geothermal Power Generation Capacity (Estimated cost US\$41.5 million).** This component will entail construction of a 2 x 3.5 MW power plant and the associated SAGS, based on the existing well inventory that has been drilled by the GoCD. Existing wells will be used for reinjection, which, together with the use of the existing transmission easement, will significantly reduce the environmental and social impacts associated with the Project. Geothermal production will be from existing well WW-P1 (see Figure 1). This well has already been tested and is estimated to be capable of supporting a 7 to 8 MW power generation facility. Production fluids will be separated into steam and brine, utilizing a separator on the well pad. Steam and, depending on the generation technology selected (condensing steam turbine or binary plant), brine will then be piped to a power plant, to be located approximately 100 m north of the well pad, this pipeline providing sufficient distance for scrubbing of the steam to remove any carried-over brine and associated silica before introducing the steam into the power plant. The separated brine will be reinjected via wells WW-R1 and WW-01 (see Figure 1).

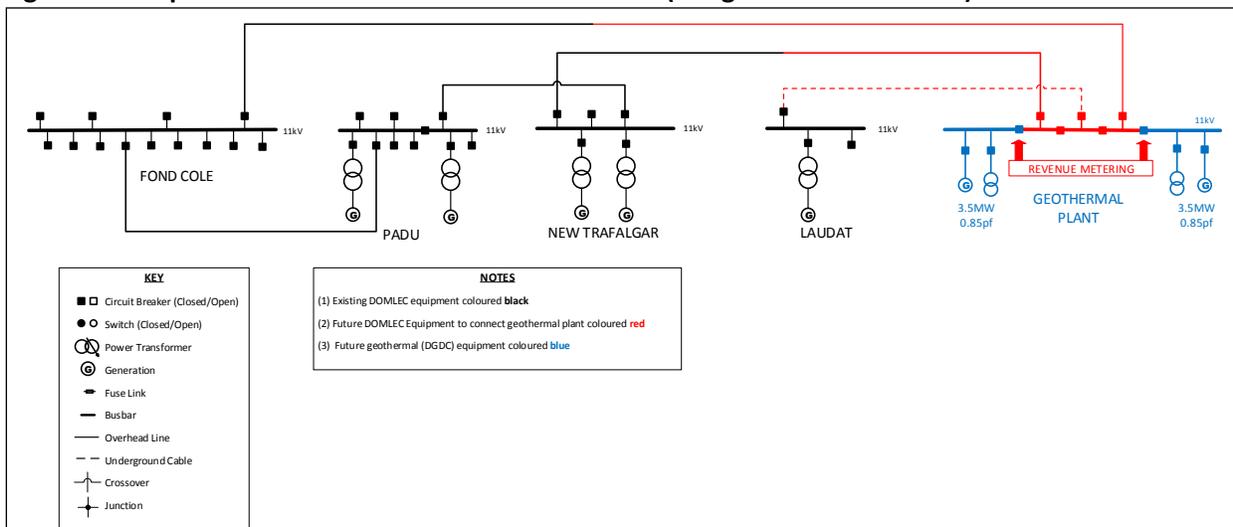
6. The location of the power plant has been identified based on the outputs of a topographical survey (LIDAR and terrestrial survey), which indicated that such location would require the least amount of civil works as well as minimize potential land acquisition. The land is gently sloping but can be benched appropriately for the installation of the power plant. The power plant technology can be either conventional condensing steam turbine(s) or a binary plant, and the identified location is sufficiently large to accommodate either technology. Both technologies are suitable for the proposed development and the choice between them will be up to vendors when tendering for the plant. The final selection will then depend largely on the tendered price, but consideration will be given also to overall 2-phase fluid consumption to provide a stated output (and hence energy conversion efficiency), plus any differences in associated environmental impacts of the plant offerings. Both power plant technologies need to remove and discharge non-condensable gases, comprising mostly carbon dioxide (CO₂) with some hydrogen sulphide (H₂S). The usual method of disposal is to release the gas into the cooling tower plume (more effective with wet cooling towers, but still achievable with air cooled condensers), where it will be carried upwards and will disperse over a wider area to result in ground level concentrations which are within standard continuous (24 hour) exposure limits. Dispersion modelling will be undertaken during the design phase to ensure that dilution of the discharged gases is appropriate.

7. Both power plant technologies will require re-injection, and fluids for reinjection will be piped to wells WW-R1 and WW-01 (see Figure 1). A potential pipeline route from the production well pad and the power plant area has been identified, which is essentially a corridor, and the conceptual design of the pipeline has been completed. The detailed design will be part of the EPC contract.



8. The interface between SGPP and DOMLEC’s transmission system (and the point of sale of electricity) is defined in an interconnection agreement included in the PPA. The output from Laudat hydropower station (right next to the geothermal site) will be taken via underground cable to SGPP, where a switchboard will marshal the 11 kV output from both plants and return the combined power to Laudat substation via double circuit underground cables. These will be rated for 33 kV, which will allow the option in the future to install a step-up transformer at SGPP and dispatch all or part of the power at the higher, 33 kV, voltage. At Laudat, the output will be connected to the existing overhead line running to New Trafalgar hydro station and from there via Padu hydro plant to Fond Colé. DOMLEC is also proposing to disconnect an additional existing transmission line which runs from New Trafalgar directly to Fond Colé and extend this up to Laudat, hence providing a second circuit connecting Laudat and the geothermal plant to Fond Colé. The existing portions of this second line was destroyed by Hurricane Maria and in rebuilding it, DOMLEC intends to extend it to Laudat and install upgraded insulators to permit subsequent operation at 33 kV rather than the current 11 kV. The provisions made at the geothermal power plant and on the restored second line will allow the entire valley system down to Fond Colé to be upgraded to operate at 33 kV, thus reducing transmission losses from what will become the major power source for the south of the island. The proposed interconnection system is shown in Figure 2.

Figure 2 – Proposed Network Connection for the SGPP (as agreed with DOMLEC)



9. There is a potential dispatch problem because of the restricted transmission capacity from Fond Colé to Sugar Loaf (the main distribution/transmission node in the north of the island). Currently, overnight demand in the south may not be sufficient to absorb all the available capacity; and, because of the transmission bottleneck, the running of diesel at Sugar Loaf may still be required to meet projected load growth in the north. This issue will be alleviated by the installation of a transmission grade battery storage system at Fond Colé, for which Dominica has received funding from the United Arab Emirates (UAE)-Caribbean Renewable Energy Fund. The system will obviate the need for diesel-based spinning reserve capacity, whilst also providing peak lopping during high demand periods and increased overnight load to recharge the battery. Overall, it will allow more consistent use of the baseload hydro and geothermal capacity.

10. The use of existing wells for reinjection and of the existing easement for transmission will



significantly reduce the environmental and social impacts associated with the Project.

11. Component 2: Contingent Financing in Aid of Additional Drilling (Estimated cost US\$9 million).

Under this component, grant funds will be set aside to finance the drilling of additional (make-up) production and/or reinjection wells if the productivity of the existing production well declines below an acceptable level and/or the injectivity of the reinjection well does not adequately support power production. When production starts from a geothermal well, the production fluid is drawn from within a volume of rock around the production liner of the well. Fluid that is withdrawn will be replaced from resources further from the well. However, the water pressure in the vicinity of the well must be reduced to induce flow from elsewhere. The permeability of the surrounding rock and its associated structures will determine how much pressure draw-down is required to maintain flow into the vicinity of the well. In practice, the producing well will begin to demonstrate a decline in productivity, with the rate of decline being a function of the reservoir properties. Decline rates are typically in the range of 2-5 percent per annum, but it is not possible to predict this decline rate with certainty prior to the start of operations. Furthermore, for the power plant to achieve full rated power output, the reinjection of spent geothermal fluids must occur at the same rate they are produced. Well testing indicates this should be achievable in the two existing wells, however long-term tests at the exact conditions of plant operation have not been undertaken (as this is not practical). As such there is a residual risk that the injection capacity of wells may reduce over time (primarily due to scaling) and hence limit plant output.

12. If there are indications of premature loss of well productivity, or issues with injection capacity, grant financing under component 2 will be utilized for contingent drilling ahead of the production decline reaching a level that would compromise the SGPP operation. The projected capacity of the wells can be assessed by monitoring the well head pressure needed to maintain required production or injection capacity and also by periodic measurement of production well output using tracer flow testing (injection flow, being of water only, not mixed steam and water, can be monitored more easily by normal instrumentation). The projection must be made sufficiently into the future to allow time for a rig to be contracted and mobilized and drilling to be undertaken before the production or and injection capacity actually fall below the required level. The additional production well(s) will be drilled from the same well pad as the existing well, but directionally away from the existing wells, thus minimizing any potential additional environmental or social impacts. As SGPP production will be sourced from only a small portion of the reservoir area that has already been defined by geoscientific surveys and proven by drilling, the contingent drilling will be targeted in a different direction so as to access a new productive volume within the already identified reservoir. The opportunity may also be taken, while the rig is mobilized, to conduct a work-over (internal cleaning-out of scale) on the wells if required.

13. In addition to restoring the operational capacity of the steamfield and SGPP, the additional drilling would reduce resource risks associated with LGPP. Addressing unexpected declines in steam productivity early on is key to maintain the viability of the geothermal field in view of its further expansion. Also, any additional drilling would provide vital information regarding the steamfield characteristics at Wotten Waven-Laudat, which would help delineate the larger geothermal resource and inform the design and scope of LGPP. Overall, the contingent grant finance option is critical to minimizing resource-related risks. In its absence, the impact on SGPP operation and the uncertainty concerning resource capacity could halt further operation and possibly expansion of the geothermal field.

14. Component 3: Technical Assistance for Advancing LGPP to Development Status and Soliciting



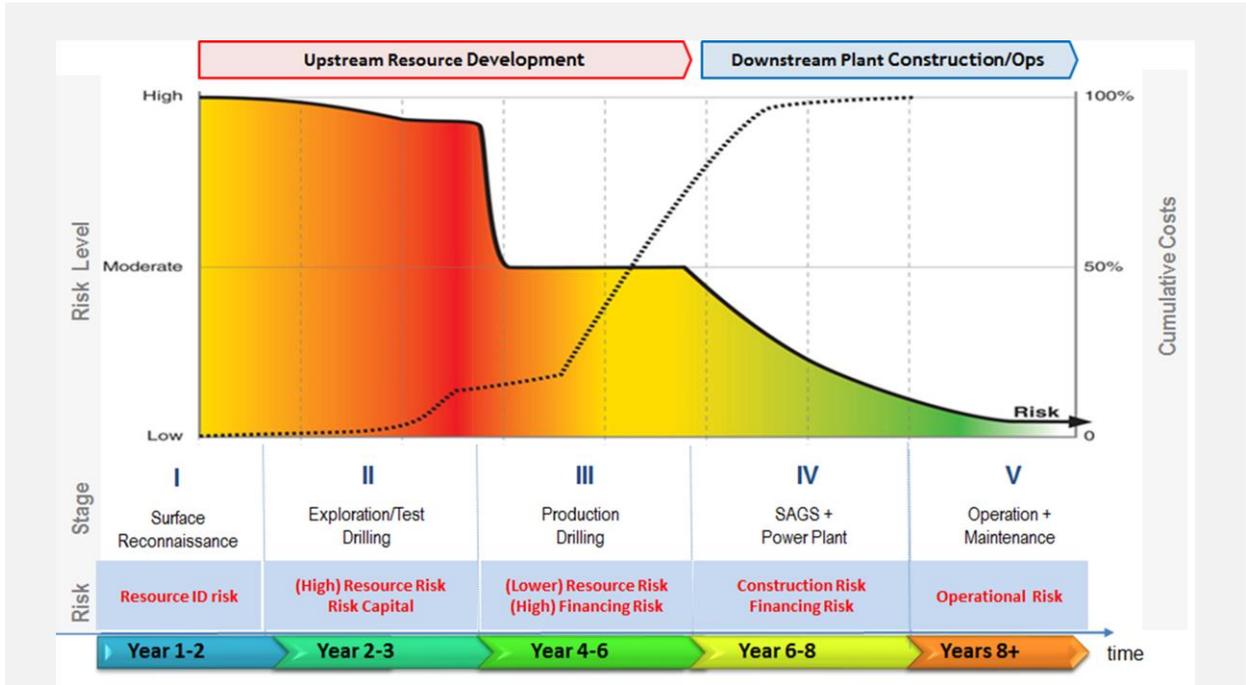
Private Sector Investment (Estimated cost US\$0.953 million). Making an informed decision on expanding the geothermal field and identifying a clear roadmap for developing LGPP will require a comprehensive set of analyses. The exact number and scope of the analyses to be accommodated under this component will be flexibly defined taking into account parallel work financed by other donors, and notably AfD and CCI, which may directly or indirectly relate to Dominica’s geothermal development program. Activities may include: (i) additional geological and geophysical surveys to better identify the likely boundaries of the larger geothermal resource at Wotten Waven-Laudat; (ii) feasibility study to confirm the viability of LGPP including defining its potential scope, need for additional delineation drilling, and its “bankability”; and (iii) preparation of an investor prospectus and market outreach to solicit private sector interest to invest in LGPP.

15. These assessments, together with improved knowledge regarding the geothermal field characteristics gained from the operation of SGPP, will provide a comprehensive evaluation of several key aspects of LGPP. This will allow to select the right approach to proceeding with the larger operation; it will also provide critical information to potential developers, thereby enhancing their confidence in investing in the field. With these studies in hand and investor interest peaked, the GoCD would be in a better position to fully engage the market and identify and select a qualified private partner with the expertise needed to take on the next, larger, and more complex investments in the Wotten Waven-Laudat field.



ANNEX 2: MULTI-STAGE GEOTHERMAL DEVELOPMENT CYCLE – ILLUSTRATION OF RISKS AND COSTS

COUNTRY: Dominica
Dominica Geothermal Risk Mitigation Project



SOURCE: Adapted from the Geothermal Handbook: Planning and Financing Power Generation, ESMAP, The World Bank, 2012

Geothermal is developed through a multi-stage process in which there is considerable risk in the early stages (I and II in particular), primarily because of the uncertainty regarding the availability of a viable steam resource with which to generate electricity. Only after exploration drilling can an investment grade decision be made on whether to proceed with additional investments for subsequent stages. Mobilizing risk capital to fund exploration drilling can be a significant challenge, especially for the private sector, which is a major barrier to geothermal development. Once the geothermal resources are confirmed, risks are considerably reduced and a project’s bankability can be determined. However, unlike with conventional power projects, developers have to raise additional equity in order to develop the remainder of the steamfield with further drilling (Stage III), which lenders typically do not cover. As a result, geothermal developments can experience considerable delays achieving financial closure despite the reduced resource risk, thus creating another significant barrier, especially for private sector participation.

When the steamfield is fully developed, then the overall risks are typically sufficiently reduced to the point at which lenders may extend loans to finance the above-ground components of the project (Stage IV). However, geothermal projects typically have high upfront costs, which can lead to higher financing risks for which lender can seek compensation, further challenging the development. Once the plant is commissioned, managing the steam supply as planned during operations (Stage V) is important, in order to not risk cost increases from having to drill additional wells.



ANNEX 3: CLEAN TECHNOLOGY FUND

COUNTRY: Dominica
Dominica Geothermal Risk Mitigation Project

Indicator	Results attributable to CTF support	Results expected from Small Geothermal Power Project:	Scale-up phase (implementation of Large Geothermal Power Project):
Geothermal electricity generation capacity enabled [MW electrical]	7	7	40-100
Annual electricity generated from geothermal [GWh] ¹	51.2	51.2	316-790
Potential for GHG emissions reduced or avoided			
-Tons of CO ₂ avoided per year [tCO ₂ eq/year]	38,223	38,223	179,577-448,942
-Tons of CO ₂ avoided over lifetime of the Project [tCO ₂ eq]	936,463 Over 25 years	936,463 Over 25 years	4,489,417-11,223,544 Over 25 years
Cost effectiveness			
- CTF cost effectiveness [US\$CTF/t CO avoided over lifetime of the Project]	10.5	10.5	n/a
- Total project cost effectiveness [US\$ Total Project/t CO ₂ avoided over lifetime of the Project]	53.9	53.9	n/a
Other co-benefits (potentially expanding regionally)	<ul style="list-style-type: none"> • More affordable energy access • Improved energy security • Environmental co-benefits • Health co-benefits • Electricity export revenues • Employment opportunities 		

¹ The calculation is based on a availability factor of 96% for geothermal power plant and a load factor starting at 72%. The calculation assumes a 3% annual increase in load factor based on GDP growth projection.



A. Country and Sector Context

Country Context

1. **Given its limited growth opportunities, it is paramount for Dominica to increase the competitiveness of traditional economic sectors and seize new ones with transformational potential such as geothermal.** Growth in Dominica has been stagnant for years and prospects for the future are not brighter. Although tourism is a key industry, because of the rugged terrain and lack of sandy beaches, Dominica has struggled to attract large volumes of traditional stay-over tourists on the par of other destinations in the Caribbean Region. The contribution of agriculture has declined from 30 percent of GDP in the early 1990s, to the present 15 percent, following the loss of preferential access to the European Union market and the global financial crisis. Vulnerability to natural disasters further exacerbates the problem, as recently demonstrated by the devastating effects of Hurricane Maria. While progressively recovering from the disaster, the country must focus on increasing productivity in traditional economic sectors as well as seizing new ones. This first and foremost requires addressing the inadequacy and high costs of infrastructure services, especially electricity. Overly expensive electricity supply drives up the cost of doing business and is a major drag on productivity and competitiveness for Dominica's firms. Lower electricity costs would enable a shift to more energy-intensive, higher added-value businesses, such as agro-processing. They would also allow Dominica to better compete price-wise with other Caribbean touristic destinations, as tourism picks up again. A key growth opportunity is associated with developing geothermal energy for exports to neighboring countries; electricity produced domestically could bring large revenues to Dominica and significantly boost its GDP growth.

2. **Building resilience and green growth are key priorities for Dominica's, and both entail a more diversified and greener energy mix.** Fiscal losses arising from natural disasters and the ongoing challenges of climate change threaten to set back hard-earned development gains and restrain economic growth. Following Hurricane Maria, the Government of the Commonwealth of Dominica (GoCD) has adopted the National Resilient Development Strategy (NRDS), which sets Dominica's mission and pathway towards becoming "*the first climate-resilient country in the world*". Dominica is also receptive to contributing to climate change mitigation. Despite its carbon footprint being very small, the country has committed to a Nationally Determined Contribution that established economy-wide greenhouse gas (GHG) emission reduction targets. Diversifying the energy mix is a key element of the GoCD's strategies for climate change adaptation and mitigation, and this can be better achieved by leveraging the country's large indigenous geothermal energy resources. In the context of an island country exposed to extreme weather events, such as Dominica, geothermal energy provides a more resilient alternative baseload capacity than hydropower, as demonstrated by the damages caused by Hurricane Maria to hydropower assets. Geothermal is also largely more cost-efficient and greener than diesel-based capacity, which accounts for a predominant part of Dominica's energy mix.

Sector Context

3. **Dominica has a small power system that relies heavily on diesel to produce electricity.** Prior to the hurricane, Dominica's installed generation capacity totaled 26.7 megawatt (MW), of which more than 20 MW were diesel-based, encompassing five power stations, mostly in an aging condition. The residual 6.6 MW derived from three small cascading run-of-the-river hydro plants. Baseload needs were approximately 12 MW and were accommodated using hydropower generation and diesel-based



generation for the remaining part. Peak load was around 17 MW. The power system is operated by a single, vertically integrated private concessionaire, Dominica Electricity Service Limited (DOMLEC). DOMLEC owns two of the five diesel plants and all three hydroelectric power stations. Previously, its license was exclusive; but, since the approval of the Electricity Supply Act (ESA) in 2006, the Independent Regulatory Commission (IRC) – the regulator – may license other generators. DOMLEC served 36,467 customers, most of which residential, accounting for 98 percent of the island’s population. 50 percent of sales was from the household sector; the rest was predominantly commercial consumption and only a small share (around 10 percent) industrial.

4. **Dominica’s power system suffered widespread devastation due to Hurricane Maria and recovery is ongoing.** Electricity service completely ceased following the disaster because of the widespread and severe damages to the transmission and distribution (T&D) system. At least 75 percent of the network was damaged or destroyed; damages to generation sites varied from moderate to severe (to hydropower assets). Recovery of the national power system has progressed steadily, although at a slower pace than expected as the magnitude of the challenge clearly exceeds DOMLEC’s human, financing and logistic capacity. The Caribbean Development Bank (CDB) recently approved a US\$15.804 million loan and a US\$0.211 million grant to DOMLEC, which is allowing the company to acquire much needed equipment, manpower and technical capacity to hasten power system rehabilitation. It is expected that load will be restored to pre-hurricane level in a year time, as customers are reconnected, and businesses return to operate. Afterwards, demand is predicted to increase steadily as the economy picks up again and plans to develop tourism activities, especially in the north of the island, are resumed.

5. **Going forward, lowering and stabilizing electricity costs is the most impending priority for Dominica’s power sector.** Because of the reliance on imported diesel, the average retail price of electricity in Dominica, at US\$33 per kWh as of December 2016, is among the highest in the world. Fuel costs are passed-through to customers through a fuel surcharge, which accounts for large part of the tariff applied by DOMLEC². In addition, customers are exposed to the volatility of international oil prices, which makes it difficult for Dominica’s people and businesses to predict their electricity costs. The ramifications of high and rising oil prices run through the economy. As the cost of manufacturing and services increase, the country is challenged to maintain its competitiveness and attractiveness to investment. Households are also severely hit by rising electricity prices and have no other choice than curtailing consumption or bearing a heavier monthly expense. In addition, increased costs of diesel imports create a severe negative impact on the country’s balance of trade.

6. **Geothermal resources can be a ‘game changer’ for Dominica.** Geothermal energy is a unique renewable resource, one that can provide reliable and cost-efficient baseload capacity in an environmentally sustainable manner. As an underground resource, geothermal steam cannot be lost due to weather events and the above-ground infrastructure can be built with enhanced resilient features. In Dominica, switching baseload generation from diesel to geothermal could lower wholesale electricity costs in Dominica significantly. The share of renewables into the energy mix would more than double and greenhouse gas (GHG) emissions would be reduced. As an indigenous resource, geothermal also offers a

² Fuel importers and retailers operate under fixed pricing schemes determined by the Ministry of Trade, Energy and Employment, which ensure that local retail prices reflect price changes in the international marketplace. In addition to the fuel surcharge, the retail tariff also comprises an energy charge per kWh of electricity consumed and a service charge per kVA of installed capacity (for commercial, industrial and hotel customers only).



natural hedge against the price volatility of imported fuels. Furthermore, the volume of geothermal resources, largely exceeding domestic needs, provides a transformational growth opportunity for the country, if larger capacity is built for electricity export purposes. Electricity could become Dominica's new, most profitable export commodity. Guadeloupe and Martinique – both French territories – have shown interest in importing electricity. Overall, developing geothermal capacity is instrumental to building resilience in the face of climate change and external shocks and can realistically transform Dominica's economy.

7. **The GoCD seeks to attract private participation to take geothermal development forward.** Green-field sites like Wotten Waven-Laudat pose inherent risks, primarily related to the uncertainty regarding subterranean resource availability and the limited information on the steamfield characteristics that determine the viability of a future power generation facility. The GoCD has taken the lead and borne the initial and riskier exploratory investments with the clear objective to attract a qualified private developer to partner with and develop the Wotten Waven-Laudat field. Such investments have considerably reduced the resource risks associated with SGPP. Nonetheless, it is only natural that the incipient stage of the geothermal market and the lack of a track record of deals in the Caribbean region still create a perception of a high-risk environment among prospective private investors. In Dominica, the problem is compounded by the very small size of the domestic market and the limited human capacity available to the sector. Following two failed attempts to enlist a private partner and pressed by the urgent need to displace diesel generation to reduce electricity costs in the country, the GoCD has resolved to proceed and develop SGPP with public funding. Even if commercial capital was mobilized, owing to the perceived risks, the cost of financing would likely be high. The higher risk premium would raise the cost of electricity produced at Wotten Waven-Laudat, which directly conflicts with GoCD's primary goal to reduce and stabilize electricity prices in the country. Going forward, only the private sector can develop LGPP and achieve the scale at which Dominica expects to expand its geothermal capacity. Nonetheless, prospects for LGPP are inextricably linked to SGPP. A SGPP that is successfully developed and operated will confirm the viability of expanding the Wotten Waven-Laudat field. Therefore, in addition to accommodating a national goal, SGPP is instrumental to the GoCD's strategy to de-risk the next, larger, and more complex geothermal investments and ultimately attract a suitable private developer for LGPP.

8. **The GoCD has established the Dominica Geothermal Development Company (DGDC), a special purpose vehicle with the sole purpose and mandate to develop and operate the Wotten Waven-Laudat geothermal field.** DGDC is founded under corporate law and is a private company in all respects, despite the GoCD currently being its only shareholder. DGDC will enter into a concession agreement with the GoCD for the use of the geothermal resource; construct and operate SGPP and enter into a PPA with DOMLEC for the sale of geothermal electricity. As a private entity, DGDC provides an ideal conduit to open up the geothermal sector to private sector participation. The GoCD has also issued the Geothermal Resource Development Act (2016), which sets the legal and policy framework governing the use of geothermal resources, providing greater confidence to prospective investors.

9. **Arranging low-cost financing, mobilizing global industry knowledge, and enhancing investor confidence are critically needed to move the geothermal program forward.** In order to maximize the benefits associated with SGPP, and notably reduce electricity costs as much as possible, it is critical that GoCD is able to mobilize an adequate amount of low cost financing, in the form of concessional loans and grant funds, for the development of SGPP. Analyses conducted by the World Bank have shown that access to low-cost financing has the highest impact on the likely end-price of electricity once geothermal capacity



displaces diesel-based generation. Equally important is to develop and operate SGPP successfully and ensure proper steamfield management, so as to further decrease risks associated with the geothermal program and enhance investor confidence. To this extent, insurance against contingencies, and global industry knowledge and practice are also needed. The development community can critically help in all these areas. To address the remaining barriers associated with the development of the Wotten Waven-Laudat field, upon request by the GoCD, the World Bank in coordination with other development partners has designed the Dominica Geothermal Risk Mitigation Project (the Project).

B. Brief Description of the Project

10. The objective of the proposed Project is to help: a) diversify the domestic power generation mix in Dominica by integrating renewable geothermal energy; and b) demonstrate the potential of larger development of the geothermal resource.

11. The Project is instrumental to GoCD's strategy to develop geothermal energy for domestic needs and at the same time de-risk the geothermal program incrementally to a level that would allow attracting a qualified private developer to undertake the larger and more complex investments at the Wotten Waven-Laudat field. Such strategy includes: (i) developing the 7 MW SGPP for the domestic market, which, in addition to diversifying the local generation mix, will transform what is now a geothermal green-field into a less risky brown-field development; (ii) protecting the operability of SGPP in the face of residual risks; (iii) evaluating the viability of a larger plant on the same reservoir (LGPP) for export purposes and identifying a clear roadmap for moving forward; and (iv) with the benefit of a functioning SGPP and a clear roadmap in hand, taking the necessary actions for identifying and selecting a qualified private partner.

12. The project scope is articulated in the following three components:

- Component 1: **Development of Domestic Geothermal Power Generation Capacity** (estimated costs US\$41.5 million);
- Component 2: **Contingent Financing in Aid of Additional Drilling** (estimated costs US\$9 million);
- Component 3: **Technical Assistance for Advancing LGPP to Development Status and Soliciting Private Sector Investment** (estimated costs US\$0.953 million)

13. The Project will be implemented by DGDC and will be financed through a combination of equity from the GoCD, concessional finance and grants from development partners. Specifically, the GoCD has transferred the existing geothermal wells and other assets to DGDC as well as provided owner equity to capitalize the company and invest in SGPP. The financing envelope will include a credit from the International Development Association (IDA); grants from the UK's Department for International Development (DFID) and the Small Island Developing States (SIDS) DOCK Initiative; and the support from the Clean Technology Fund (CTF). The Government of New Zealand (GoNZ) will extend an in-kind grant to DGDC to support project implementation (see section B of the main text for more details on the project financial plan).

C. Rationale, Scope and Structure of CTF financing

Rationale for and Scope of CTF Support



14. The GoCD requested US\$10 million of CTF financing including a US\$9 million contingent recovery grant and a US\$1 million grant³. Dominica was identified as one of the priority beneficiaries of the second tranche of the Utility-Scale Dedicated Private Sector Program (DPSP) approved by the CTF Sub-Committee in October 2013. CTF support to this Project is consistent with the objectives outlined in the DPSP and notably that of sustaining geothermal development with private sector participation by addressing resource risk in the early stages of geothermal development.

15. **CTF support is critical to lower the risks associated with the geothermal program, attract private participation and ultimately enable the transformational potential attached to geothermal development.** Specifically, such support will contribute to: (i) mitigate effectively the residual risks associated with SGPP; (ii) address issues of resource risks in relation to LGPP; and (iii) help confirm the viability of LGPP. The availability of contingent grant finance will be critical to help secure the lowest price for electricity produced at Wotten Waven-Laudat in line with Dominica's needs. The risks still attached to SGPP may cause unforeseen costs that, if passed through to customers, would prevent a major reduction of electricity prices. Also, risks associated with the geothermal investments would continue to deter private sector interest. In particular, LGPP would remain a highly uncertain complex operation in what would still be a nascent market. Overall, CTF financing will be a key enabler of the transformational impact associated with geothermal development, including better life standards; more competitiveness for Dominica firms; a greener energy mix that better meets climate adaptation and mitigation needs; and eventually greater economic opportunities resulting from electricity trade, which may reshape Dominica's growth prospects.

16. CTF support will be allocated to the following key activities:

17. **Component 2: Contingent Financing in Aid of Additional Drilling (US\$9 million from CTF).** In case the productivity of the existing single production well declines to or below an acceptable level and/or the injectivity of the reinjection well does not adequately support power production, funding under this component will be mobilized to finance the drilling of 1-2 make-up production or injections wells. In the absence of contingent grant finance, the costs associated with contingent drilling would place an undue burden on DGDC, undermining the company's financial viability just when it is beginning to operate on a commercial basis⁴. If passed through, such costs would lead to an increase of the geothermal tariff, which would undermine the benefits that SGPP is supposed to provide to Dominica's people and firms. Having an SGPP that operates on a steady and sustainable basis is key to reduce concerns among prospective developers regarding the viability of the more complex, much larger operation. In addition, addressing unexpected declines in steam productivity early on is key to reduce resource risks associated

³ Funding approved by the CTF has been deducted by the fee charged to cover project preparation and supervision costs incurred by the World Bank. As a result, the net grant amount allocated to component 3 of the Project is US\$953,000.

⁴ A recent example of such a situation was at the San Jacinto-Tizate geothermal field in Nicaragua, where rapid pressure declines within a six-month period led to a 2/3 capacity loss in some wells. This required immediate cash injection into the operation to assess the field conditions and drill additional wells to maintain operational capacity. To date a total of 7 make-up wells have been drilled, causing unforeseen costs close to 15-20 percent of initial investments. Dominica's stretched public finances would have difficulty covering a similar contingency. A recent example of such a situation was at the San Jacinto-Tizate geothermal field in Nicaragua, where rapid pressure declines within a six-month period led to a 2/3 capacity loss in some wells. This required immediate cash injection into the operation to assess the field conditions and drill additional wells to maintain operational capacity. To date a total of 7 make-up wells have been drilled, causing unforeseen costs close to 15-20 percent of initial investments. Dominica's stretched public finances would have difficulty covering a similar contingency.



with LGPP. For a project like LGPP to be economically viable, the steamfield must produce at its rated capacity of geothermal fluid for 30-40 years. Any additional drilling would provide vital information regarding the steamfield characteristics at Wotten Waven-Laudat, which could help delineate the larger geothermal resource and inform the design and scope of LGPP.

18. **Component 3: Technical Assistance for Advancing LGPP to Development Status and Soliciting Private Sector Investment (US\$0.953 million from CTF).** This sub-component will finance a set of technical assistance (TA) activities for advancing development of LGPP. Once SGPP is up and running, there will be better prospects for further expanding the geothermal field; having a clear roadmap in place will be critical to seize this opportunity. A set of analyses should be undertaken to assess fully LGPP's viability along all key dimensions (technical aspects, environmental and social sustainability, market prospects, etc.). Specifically, the following key steps will be required: (i) undertake additional geological surveys and scientific studies to improve the identified, likely boundaries of the larger geothermal resource at Wotten Waven-Laudat; (ii) carry out a feasibility study to confirm the viability of LGPP, including defining its potential scope, the need for additional delineation drilling, and its "bankability"; and (iii) develop an investor prospectus and market outreach to solicit private sector interest to invest in LGPP. The exact number and scope of the analyses to be accommodated under this component will be flexibly defined taking into account parallel work financed by other donors. Feasibility assessments and critical feedback from the market, combined with the improved knowledge regarding the field characteristics gained from the SGPP operation, will provide all the elements needed to make an informed decision about the approach to be used in proceeding with LGPP. On the other hand, all these actions will provide the critical information that developers normally seek in order to evaluate an investment opportunity such as LGPP and eventual share the sizable investments needed for its development.

Proposed Structure of CTF Financing

19. The following arrangements for CTF financing have been designed based on the nature of the activities being supported:

- **Contingent Financing in Aid of Additional Drilling:** A contingent recovery grant will be set aside and mobilized in the event that the drilling of additional wells is required. DGDC will monitor the reservoir and the well head pressure to identify any declines. Variations in the reservoir permeability may lead to faster than anticipated decline of steam production. Similarly, for the power plant to achieve full rated power output, the reinjection of spent geothermal fluids must occur at the same rate they are produced. Well testing indicates this should be achievable in the two existing wells, however long-term tests at the exact conditions of plant operation have not been undertaken (as this is not practical). As such there is a residual risk that the injection capacity of wells may limit plant output and require additional drilling.

DGDC could request the release of the contingent recovery grant if reservoir monitoring and modelling indicate that the production capacity and/or the reinjection capacity may decline below their respective minimum levels defined as follows:

- Minimum level of production guaranteed when physical parameters reach the following values: (i) mass flow two-phase fluids >90 kg/s; (ii) enthalpy two-phase fluids >1,060 kJ/kg; (iii) operating pressure at wellhead = 6.0 bar.
- Minimum reinjection capacity for each reinjection well defined as: (i) WW-03 - 53 kg/s-bar (assumed operating point of 40 DegC for condensate); (ii) WW-01 - 11.4 kg/s-bar (assumed



operating point of 160 DegC for brine); and (iii) WW-R1 - 2.5 kg/s-bar (assumed operating point of 160 DegC for brine).

The Bank will verify the validity of the request for releasing grant funds for contingent drilling before these can be disbursed. In order to provide adequate risk mitigation, the duration of the project, and therefore of the period allowed for accessing contingent finance, shall this be required, is 7 years.

- **Technical Assistance for Advancing LGPP development:** Evaluating LGPP feasibility and engaging high caliber international developers are non-negligible tasks that require top-notch and sophisticated expertise. To allow DGDC to mobilize the best expertise available globally, the CTF funds are provided to the company as a grant. A grant for technical assistance would enhance the value added of the overall CTF support. It would be the last key piece to ensure that the de-risking strategy bears the intended results and that a qualified private developer is found. This proposal is fully consistent with the scope of the CTF's private sector window, which specifically envisages that technical assistance and advisory services needed to prepare projects and reach adequate knowledge of the market are funded through grants.

D. Assessment of Proposed Project with CTF Investment Criteria

1. Potential for GHG Emissions Savings

20. Given the absence of combustion in the geothermal development process, technically there is no technology-driven carbon CO₂ emissions associated with geothermal generation. In reality, direct emissions do exist and are linked to the geology of the underground reservoir and the chemical composition of fluids. However, these are generally significantly smaller than emissions of thermal-power plants. In Dominica, the geothermal fluid conditions are typical for high temperature geothermal reservoirs.

21. By displacing high polluting diesel-based generation with clean, renewable geothermal sources, the proposed Project will result in a significant net reduction of CO₂ emissions. GHG emission savings have been estimated by assessing and comparing emissions under two scenarios: (i) a 'baseline scenario', which entails a business-as-usual situation, namely that DOMLEC continues to produce the same amount of electricity from diesel-based generation; and (ii) a 'project scenario', which entails that 51.2 GWh of electricity will be generated from geothermal instead of diesel every year (see annex 6 for details on the technical parameters of the geothermal power plant resulting in this output). Emissions associated with the SGPP power plant are calculated assuming a net emission factor of 0.109 t CO₂/MWh, as estimated based on production well test results. Emissions associated with the baseline scenario are calculated using an emission factor of 0.856 t CO₂/MWh, as estimated based on the performance of the existing diesel generators. This analysis shows that the Project will earn GHG emission savings in the range of 38,223 tons of CO₂ per year or a total of 936,463 tons of CO₂ over a 25-year lifetime.

22. **Scope for avoided annual GHG emissions through scale-up.** As highlighted earlier, the proposed Project is geared towards de-risking to the extent possible investments in geothermal development at Wotten Waven-Laudat, eventually leading to the implementation of LGPP. If LGPP is implemented, GHG emission savings would increase exponentially, with benefits spanning well beyond Dominica's borders. The electricity supply that is made available for exports would allow importers to displace more polluting domestic generation capacity. In particular, power exported to the neighboring islands of Guadeloupe



and/or Martinique would likely displace HFO-based generation in those islands. The net emission reduction theoretically associated with LGPP, assuming a geothermal generation capacity in the range of 40-100 MW and an emission factor of 0.677 t CO₂/MWh for HFO in Guadeloupe and Martinique, is estimated in the amount 0.18-0.45 million tons per year or 4.5 -11.2 million tons over a Project's lifetime of 25 years.

2. Cost-Effectiveness

23. The cost-effectiveness ratio of CTF financing is 10.5. This is calculated as the ratio of CTF financing (US\$10 million) and tons of CO₂ emissions avoided over the lifetime of the Project. Total project cost effectiveness (calculated as the ratio of total Project cost and ton of CO₂eq reduced/avoided) is estimated as 53.9.

3. Demonstration Potential at Scale

24. As first geothermal development in the Caribbean region in 30 years, the proposed Project will contribute to shape the geothermal market in Dominica and demonstrate a successful path forward for the other OECS countries that are pursuing geothermal development. Within Dominica, technical assistance provided by development partners has helped establish practices that are fully in line with industry and international standards. Such assistance will continue throughout project implementation and endow DGDC with the needed technical, operational and commercial expertise.

25. Having in place a well-functioning geothermal power plant that meets industry standards is a necessary condition to attract the interest of world class geothermal developers. But the demonstration potential associated with a successful SGPP is much wider. Lessons learnt from the institutional and operational set up of SGPP can inform design and implementation of other geothermal projects in the region. As more projects come on line, practices throughout the geothermal development chain will improve through learning by doing and the high-risk perception that is naturally associated with nascent markets will progressively decrease. Knowledge and experience built through the Project will also add to the global expertise on geothermal development.

26. The CTF contingent recovery grant effectively provides a pilot insurance mechanism that can be replicated across OECS countries and help them seize financing from development partners, commercial lending and private equity sponsors. In addition, technical assistance also financed through CTF will support analysis and a much-needed market engagement exercise – two key activities to establish a roadmap for further development of geothermal resources. Overall, this multifaceted CTF support can help sustain long term changes in the regional geothermal market by facilitating the entrance of new and diverse players.

4. Development Impact

27. CTF support will help Dominica seize and maximize the transformational potential associated with geothermal development in several ways, with effects spanning well beyond the domestic power sector and the country's borders.

28. CTF contingent grant finance will help secure the lowest price for electricity produced at Wotten Waven-Laudat and therefore critically contribute to stabilizing electricity prices in Dominica. The availability of grant funding, as provided by CTF, would reduce the hardship faced by DGDC in case an unanticipated decline in well productivity requires immediate additional drilling. Basic analysis carried out



during project preparation indicated that the geothermal tariff agreed with DOMLEC may need to increase by 10-20 percent if drilling costs of US\$4.5-9 million are incurred and passed through. Furthermore, the successful operation of SGPP, combined with extensive analysis financed in part through the CTF grant, will improve prospects for further developing the geothermal field. Any additional drilling would also help reduce resource risks associated with LGPP. The development of LGPP with private participation would turn Dominica into a regional energy hub exporting geothermal power to its neighbors.

29. The development of significant geothermal capacity, which is widely accepted as one of the cleanest forms of power generation with small land footprint and low air emissions, will put Dominica on a much greener growth path. SGPP alone will drastically change the country's energy mix, taking the share of renewable energy from 25 to 51 percent. In addition to curtailing CO₂ emissions, the shift to geothermal will also reduce emissions of sulfur dioxide (SO₂), nitrogen oxide (NO_x), and total suspended particulates (TSP), with large positive impacts on people's health and living conditions. Any adverse impacts associated with geothermal power plants commonly refer to manageable site-specific issues (e.g. securing a project's land or right-of-way, disturbance of protected/sacred sites), which under the proposed Project will be addressed through thorough feasibility studies and impact assessments. Old issues such as subsidence and risk of hydrothermal eruption are now addressed through the normal practice of fluid reinjection.

30. The proposed Project will produce positive externalities spanning well beyond Dominica's borders. Over-reliance on expensive fuel oil is a common challenge across the OECS and all countries in the region bear the consequences of high electricity prices and vulnerability to oil price and supply shocks. A successful SGPP would boost investors' confidence and prove the viability of the geothermal market in the Caribbean region, improving the circumstances of geothermal projects being prepared elsewhere in the region. The development of significant geothermal capacity would ease the region's reliance on expensive imported fuel. Electricity exports would also enable efficiency gains associated with the integration of the region's power systems, as opposed to the current situation of energy markets that are small and isolated.

31. Those living in the Project area stand to gain from job and business opportunities that will arise as a result of the proposed Project. Local workers will be likely employed in the construction works and potential drilling activities associated with SGPP. Local businesses will seize the opportunities of contracts for ancillary works, including development of access roads, preparation of well pads etc., which in turn will translate into more jobs locally. There are also long-term prospects for local villagers to work in the facilities on an on-going basis.

5. Implementation Potential

32. Geothermal development is a foundation of Dominica's national development strategy and a key priority to the GoCD. The Growth and Social Protection Strategy 2014-2018 (GSPS 2014-2018) highlights three main objectives for the energy sector, including: (i) containing energy costs; (ii) encouraging energy conservation; and (iii) diversifying energy sources and reducing reliance on fossil fuels. The development of geothermal energy is seen as the natural solution to achieve such objectives and ultimately support Dominica's quest for competitiveness, growth and long-term sustainability.

33. The significant progress made in terms of power sector legislation and regulation achieved in recent years, as detailed in annex 4, has established a sound environment for geothermal development, as well as addressed some of the key requirements to strengthen the investment climate and ultimately



encourage private sector participation. Furthermore, DGDC has been endowed with the critical structure needed to ensure robust decision making and project implementation. Detailed institutional and implementation arrangements, including external support throughout project implementation are detailed in annex 4. The GoCD has also mobilized unprecedented financing from various development partners, including CTF, as detailed in the financing plan provided in section B of the main text.

6. Additional Costs and Risk Premium

34. The proposed CTF support is tailored to help Dominica overcome the resource and market risks that are intrinsic to geothermal projects, especially when the industry is at a nascent stage, and that imply a higher risk premium for such projects. The GoCD has played a crucial role in the development of the Wotten Woven-Laudat field through its prior mandate to undertake extensive surface exploration and drilling. The combination of large upfront capital requirements, high uncertainty, and the time needed to complete resource validation discourage commercial investors and pose an insurmountable financial hurdle for geothermal projects. For these reasons, the use of public funding or some sort of cost-sharing mechanisms between public and private partners have proven critical to complete resource validation everywhere in the world and Dominica is no exception. While resource risk associated with SGPP has been taken to a minimum through the exploration and production drilling program conducted by the GoCD, in a field that is operated for the first time like Wotten Waven-Laudat, there are still residual resource risks associated with variations in the reservoir permeability leading to unexpected declines of well productivity.

35. The proposed contingent grant finance will provide insurance against such risks, which is critical to the Project for two reasons. First, it would ease the potential financial burden on DGDC, avoiding that the financial standing of the company is undermined right at the beginning of its commercial operation. Second, an SGPP that is up and running would send a powerful signal to the market that the Wotten Waven-Laudat field has a proven capability and is the right location for investments in geothermal generation capacity. In addition, as also highlighted above, the additional drilling would maintain the steam productivity as well as provide vital information on field characteristics, which altogether contribute to reduce resource risks associated to LGPP.

36. Resource validation over a larger area at Wotten Waven-Laudat must be conducted to confirm the full availability of a commercial grade resource in line with the capacity envisaged for LGPP. The CTF grant for technical assistance and parallel donor's sponsored technical assistance will support critical analysis that is needed to better identify the resource area; assess the feasibility of the associated transmission infrastructure and notably the undersea links to Guadalupe and/or Martinique; and test the interest of the geothermal development community in investing in LGPP. Feasibility analysis and market sounding, together with the operation of SGPP, will shed light on several key aspects of LGPP. On this basis, DGDC will be better positioned to engage the market.

7. Financial Sustainability

37. Once the energy potential of a given geothermal field has been confirmed with the required level of certainty, geothermal has a risk profile more similar to many other renewable power generation technologies, with relatively high upfront costs and comparatively low costs of operation and maintenance. This well applies to SGPP. As the preliminary exploratory and production drilling program has confirmed sufficient steam capacity at the well-head to proceed with the Project, the financial risks associated with SGPP have become manageable. Once commissioned, the profile of returns on



investment is expected to be similar to that of other base-load power generation sources, with the exception of the contingencies associated with the variability of production well output or reinjection capacity. The proposed CTF contingent recovery grant will help protect the revenues of the DGDC should these contingencies materialize, maintaining the financial viability of the Project. As result of CTF support, SGPP will be more on a par, in terms of financial sustainability, with more conventional power generation projects.

8. Effective Utilization of Concessional Finance

38. As emphasized upfront, arranging for low-cost financing is critical to move forward the geothermal development program in Dominica. The recourse to concessional finance and grants for the proposed Project makes eminent financial and economic sense. On the one hand it will allow DGDC to secure an adequate return on investments in the face of high risks. On the other hand, concessional funding, grants and CTF support in particular, by lowering the cost of financing and providing insurance against unforeseen risks, will allow to secure lower electricity prices. Furthermore, CTF funds will enable DGDC to seize opportunities to attract a private partner.

39. International experiences, including ongoing CTF support to geothermal development elsewhere in the world, have amply demonstrated the need to provide assistance for resource validation under the most concessional terms. In fact, experiences clearly show that an increased focus on resource assessments leverages larger investments in geothermal energy than downstream one-off investments in power plants. This points to the need for a larger critical mass of well-targeted concessional funding. CTF grant and concessional finance deployed for technical assistance fit within this same support strategy. The market sounding and engagement process that will be part of technical assistance will raise knowledge of the geothermal field and the market capacity, which are key objectives identified under the Utility-Scale DPSP of the CTF. Given the criticality of acquiring adequate information and knowledge, the Utility-Scale DPSP contemplates the use of grant resources for these tasks.

9. Mitigation of Market Distortions

40. The use of CTF funds will help address the market distortions that are typical of geothermal development in its early stages, eventually resulting in a large risk-return imbalance that discourages private sector participation. By supporting the effective implementation of SGPP and providing technical assistance for advancing preparation of LGPP, CTF resources will place the GoCD in the best possible position to attract a qualified private developer and support a transformational expansion of geothermal capacity in Dominica. Therefore, CTF funds will not displace but rather “crowd in” the private sector.

41. Financing for SGPP from various sources, including several development partners has been already assembled. Going forward, CTF funds may well help catalyze more multilateral and bilateral financing as well as commercial financing for advancing LGPP. This is likely to be the case if the knowledge gained through SGPP and the analyses conducted with CTF support will provide enough confidence to go ahead with exploration drilling and eventually development of the larger resource area.

10. Risks

42. The following are the key risks that may specifically affect the implementation of CTF support:

43. **Institutional Capacity for Implementation and Sustainability.** This is rated as *Substantial* as the proposed Project is the first geothermal project in Dominica, and DGDC itself is newly established; thus,



the company's own expertise to undertake the Project is limited at this time. The preparation support provided by development partners has been critical to take the Project to the current investment-ready state. Continuing support throughout implementation and adequate implementation arrangements are the most critical measures to counter capacity risks. As an international geothermal expert with large project management experience, the PM is expected to provide sound project supervision. Capacity building and knowledge transfer have been part of the services provided by Jacobs during project preparation. Retaining the company as OE will provide continuity and solid oversight of technical aspects. In addition, the recourse to a single EPC contract and multiple O&M contracts constitute an optimal choice to ensure efficient and sustainable project implementation. The arrangements made by Dominica and notably the use of top-notch advisory services, provide a suitable model for countries that are investing in geothermal development for the first time, especially in contexts where a geothermal market is yet to be established. The Bank team will continue to coordinate with the DGDC to ensure that sound business decisions are taken and enforced.

44. **Fiduciary.** This is rated as *Substantial* mostly because of the risks associated with procurement activities under the Project. The procurement of the EPC contract, which is the highest-value contract, absorbing 60 percent of project funds, is a complex process and DGDC does not have previous experience with World Bank-funded projects. The availability of procurement expertise within country is obviously limited. Furthermore, the recovery process is still ongoing and government agencies and the private sector are stretched by the enormous and competing demands associated with the reconstruction. Procurement risks are being mitigated by relying on the support of the OE, who has solid expertise in this field (see annex 4). Also, the Bank team will ensure close support and supervision towards the achievement of value for money, successful award of contracts and proper contract administration (see annex 5 for details on implementation support).

45. **Stakeholder Risk.** As result of the proposed Project, DGDC will become a major supplier of electricity and will need to have a constructive relationship with DOMLEC, which has the monopoly for providing electricity to consumers throughout the island. Ordinarily, forging such a relationship may pose challenges, and this is especially so in Dominica, where DGDC and DOMLEC have conflicting objectives that became clear in the aftermath of Hurricane Maria. As more time has elapsed since Hurricane Maria, the GoCD and DOMLEC have collaborated on restoring the electric system to its pre-storm configuration. The PPA between DGDC and DOMLEC, which is the most important mitigating factor of stakeholder risk, appears to be well advanced. The signature of the PPA and its approval by IRC will bind DOMLEC legally to obligations related to DGDC in relation to the Project. A signed PPA is set as disbursement condition. Despite the encouraging progress with respect to concluding the PPA, the parties need to continue sparing effort to build the constructive relationship needed to fully offset the risks that divergent objectives pose to the proposed Project.

46. **Securing a private partner.** The longer-term strategy for scaling-up geothermal in Dominica rests on engaging a qualified private partner. GoCD's failed attempts to enlist a private developer in the past provided two important lessons: (i) resource and market risks were too high; and (ii) because of its small scale, SGPP remained less appealing to developers, while there was greater interest in LGPP, if its viability could be established. Building on these lessons, the proposed Project has been specifically designed so as to de-risk investments in Wotten Waven-Laudat as much as possible before reengaging the market. As a result, chances to secure a partnership with a qualified developer are expected to be higher. If this



continues to be a challenge – as future market conditions cannot be predicted with certainty – DGDC would nonetheless be capable to operate SGPP, which is assessed to remain a valuable project.

47. **Safeguards Risks.** The classification of social risks as *Substantial* is mainly due to land acquisition issues that DGDC has inherited from the exploratory phase of geothermal development.



ANNEX 4: IMPLEMENTATION ARRANGEMENTS

COUNTRY: Dominica
Dominica Geothermal Risk Mitigation Project

A. Project Institutional and Implementation Arrangements

Institutional and Legal framework

1. DGDC will be the implementing agency for the proposed Project. The company was established by the GoCD with the sole purpose and mandate to develop and operate the Wotten Waven-Laudat geothermal field. DGDC is organized under the Companies Act of Dominica 1994 as a Limited Liability Company. In line with its mandate, the company will develop, own and operate SGPP. The GoCD's role is as shareholder, equity provider and lender to the company, alongside undertaking standard Government functions. It is contemplated that DGDC will serve as a special business vehicle to attract a qualified private developer for the larger, more complex investments at the Wotten Waven-Laudat.

2. In recent years, Dominica has made significant progress in terms of power sector legislation and regulation. The Electricity Supply Act (ESA) approved in 2006 removed the exclusivity granted to DOMLEC in the generation segment, opening it to new entrants. DOMLEC, as any other private company, is regulated by the Independent Regulatory Commission (IRC). The ESA also envisages the obligation for DOMLEC to purchase power (including geothermal power) that is more cost-efficient than own generation, as a mean to decrease the end-price charged to electricity customers. The IRC has the statutory powers (and duties) to enforce such a provision. The IRC shall also approve and monitor PPAs between DOMLEC as off-taker and independent power producers. Another key step has been the issuance of the Geothermal Resource Development Act (Geothermal Law) approved by the Cabinet in 2016, which governs geothermal development throughout the value chain.

3. DGDC will enter into a Geothermal Resources Concession Agreement (Concession Agreement) with the GoCD, acquiring the exclusive right to conduct reconnaissance, exploration and drilling activities as well as to exploit the geothermal resource for generation and sale of electricity both domestically and abroad. DGDC will enter into a power purchase agreement (PPA) with DOMLEC for the off-take of geothermal electricity produced at SGPP. The negotiation of the PPA between DGDC and DOMLEC is well advanced and signature is expected before approval of the proposed Project.

4. As part of the technical assistance and advisory services provided to the GoCD and lately to DGDC on an ongoing basis along the past few years, the World Bank has had the chance to advice on some of these regulations. Among the other things, the Bank provided advice on the Geothermal Law, which was geared towards strengthening clarity on: (i) the definition of the geothermal resource and its ownership; (ii) procedures to allocate the right to use the resource; (iii) land and statutory rights; and (iv) any overlapping and/or contradiction with pre-existing regulation, especially concerning the transaction between the developer and the off-taker. The Bank has also reviewed and comment on drafts of the Concession Agreement and PPA, as well as advised on the organization of DGDC competencies and functions.



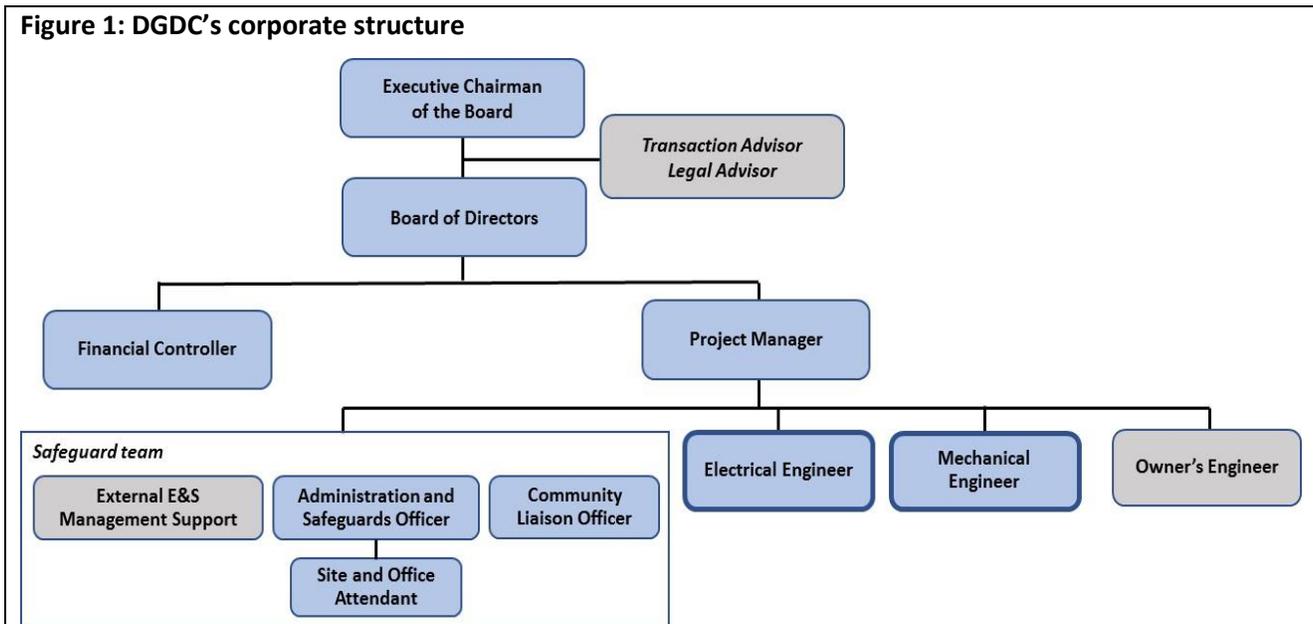
Implementation Arrangements

5. DGDC will be sole implementing agency of the Project. Funds made available from the World Bank and other development partners (CTF, DFID, SIDS DOCK) will be channelled to DGDC through the GoCD. Specifically, legal agreements for credits and grants will be entered into between the GoCD and the World Bank. Therefore, the GoCD will enter into a Subsidiary Agreement with DGDC to transfer funds on the same conditions.

6. The company will be responsible for the investments under component 1 of the Project; the use of the contingent recovery grant set aside under component 2 and for implementing the TA activities envisaged under component 3. DGDC will execute all proposed project investments, including construction, testing, commissioning and operation, and will own all infrastructure financed under the Project. All civil works, the geothermal power plant and associated steam gathering system to be constructed under component 1 will be procured through a single EPC contract. Specifically, the scope of work of the EPC will consist of engineering design, procurement, construction, commissioning, and operations/maintenance support period. The O&M requirements of the Project will be split between the above ground aspects (steamfield, power plant and well pads) and the management of the geothermal resource and wells. An O&M contractor will be appointed to operate and maintain above ground facilities. Sub-surface O&M will be separately contracted by DGDC as this will allow for ongoing management of the entire geothermal resource such that future exploration for the LGPP is not hindered.

7. DGDC will operate autonomously on a commercial basis. The company is governed by a fully independent Board composed of four Directors, all private sector professionals, and headed by an Executive Chairman, who has decision making powers (fig.1). The Board exercises company oversight to ensure it meets shareholder expectations; it has responsibility for approving contract award and signing contracts with providers.

Figure 1: DGDC's corporate structure





8. Day-to-day management is entrusted to a management team within DGDC. The responsibility for overseeing all project activities is entrusted to a Project Manager (PM). The PM is an international professional with extensive experience in the geothermal sector, who was competitively selected by the GoNZ and seconded to DGDC for a minimum period of two years as part of the in-kind support provided to the Project. Staff includes members with responsibility for procurement, technical, financial, safeguards and administrative functions. Financial management is entrusted to the Financial Controller (FC), who develops the annual budget and executes the financial transactions of the company. The FC also provides procurement support to the PM, although extensive procurement assistance will be provided by external experts (see next paragraph). Two Engineers (with competencies on mechanical and electrical engineering) provide support on engineering aspects. A dedicated safeguard team has been appointed to handle the environmental and social management associated with the Project. This includes: (i) an Administration and Safeguards Officer responsible for office management and administration of stakeholder engagement systems; (ii) a Community Liaison Officer, who is the first point of contact for community queries and to share information with community members; and (iii) a Site and Office Attendant, who monitors sites for maintenance purposes, provides local guiding services to visitors and undertakes office activities as required. Safeguards responsibility is shared with the GoCD, which is responsible for land acquisitions, resettlement and related grievance (see section C for details on the applicable policies and arrangements).

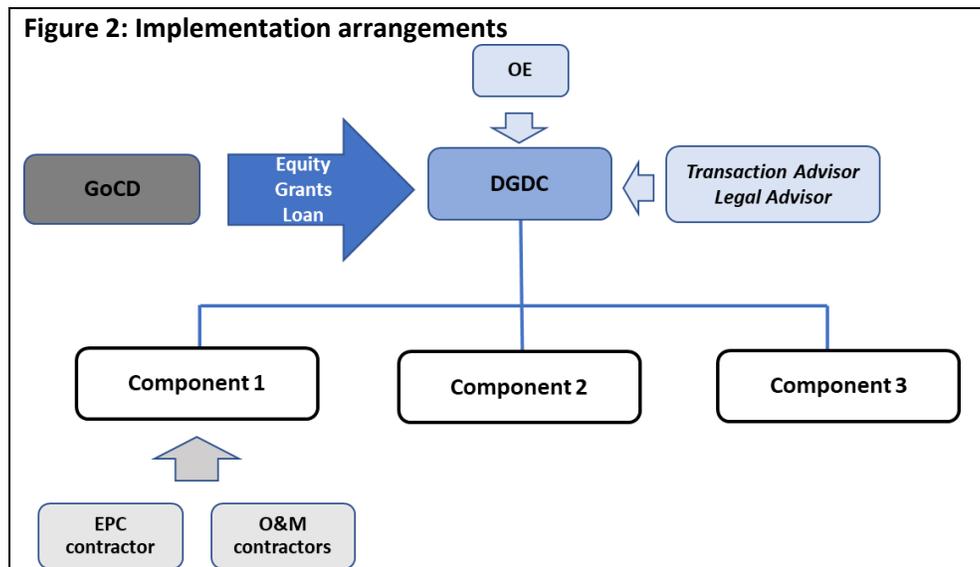
9. For some key functions, DGDC is being assisted by international specialists with global experience in geothermal development programs, all contracted by the company using *own* funds. Functions and the associated support arrangements are as follows:

- **Owner's Engineer.** DGDC recently appointed Jacobs as Owner's Engineer (OE), with the responsibility to provide oversight in the construction and operation of SGPP and all other technical aspects associated with the Project. Specifically, as OE, Jacobs will: (i) manage tendering activities to select the EPC contractor; (ii) supervise the EPC contractor from selection to project commissioning; and (iii) provide technical advice to the PM. In 2013, Jacobs was competitively selected by the GoNZ and appointed to provide technical advisory services for site development and project preparation to the GoCD and to DGDC once established. Jacobs' role has been pivotal in preparing the Project. As the contract with the GoNZ came to an end, DGDC determined to appoint Jacobs as OE via an open book process. Retaining as OE a firm who has supported preparation and technical design of a project is a common practice as such firm is best placed to supervise works carried out under the project. This is the case of Dominica as well, where Jacobs has unique experience of the geothermal field and the Project, besides having all the specific capabilities required for the OE role. Jacobs will also provide support to the DGDC to establish, implement and maintain the ESMS.
- **Transaction Advisor:** Initially financed by the Clinton Climate Initiative, Clean Infra Partners has been retained by DGDC as a business advisor to: (i) conduct negotiations of the PPA with DOMLEC; (ii) undertake financial analysis; and (iii) support development of DGDC's financing plan and business plan. Clean Infra Partners has been integral to the geothermal development for several years and it is expected that its services will be completed before the Project's Effectiveness Date.
- **Legal Advisor:** Similar to Clean Infra Partners, Holland & Knight has been retained as legal counsel to DGDC with services to include preparation and review of the Concession Agreement, PPA, EPC



Contract, O&M contracts and legal and financing agreements with development partners. These services too will be completed before the Project's Effectiveness Date.

- **Additional safeguard support:** AfD recently approved a US\$2 million grant to DGDC, which, among the other things will finance support for environmental and asocial management under the Project. External expertise will be contracted by AfD and seconded to DGDC.



B. Financial Management, Disbursement and Procurement

Financial Management (FM)

10. **Organization and staffing.** DGDC is an ongoing, for profit entity that is expected to be sustainably viable for the life of this Project and beyond. The company is wholly-owned by the GoCD but it is anticipated that GoCD will eventually sell shares of DGDC or additional shares to individuals or commercial entities. Given that DGDC is newly established, it will be important that roles and lines of reporting between the company and the GoCD are clarified going forward. The finance functions of DGDC will be handled solely by one qualified professional, the Financial Controller. The FC has the education level (including BA (Hons)- Accounting and Finance with Accounting Systems; MSc - Banking and Finance; and being a CPA), experience (12 years) and knowledge to adequately perform these functions.

11. **Budgeting, Accounting and Reporting.** DGDC will utilize International Financial Reporting Standards (IFRS) Accrual Basis accounting principles. The company is endowed with an appropriate Accounting Software System (Quickbooks) to record accounting transactions, which provides for separate, self-balancing sets of accounts in accordance with generally accepted accounting principles and procedures. The budget cycle should include planning and implementation of all project activities, which are to be reflected in the company's annual budget. All project budgeting and accounting transactions will run through the company's accounting system. This should function as the DGDC's budgetary and accounting tool, used to record the Project's expenditures and to make relevant payments in accordance with the annual budget. It will be the basis for the preparation of IFRs and any other required project

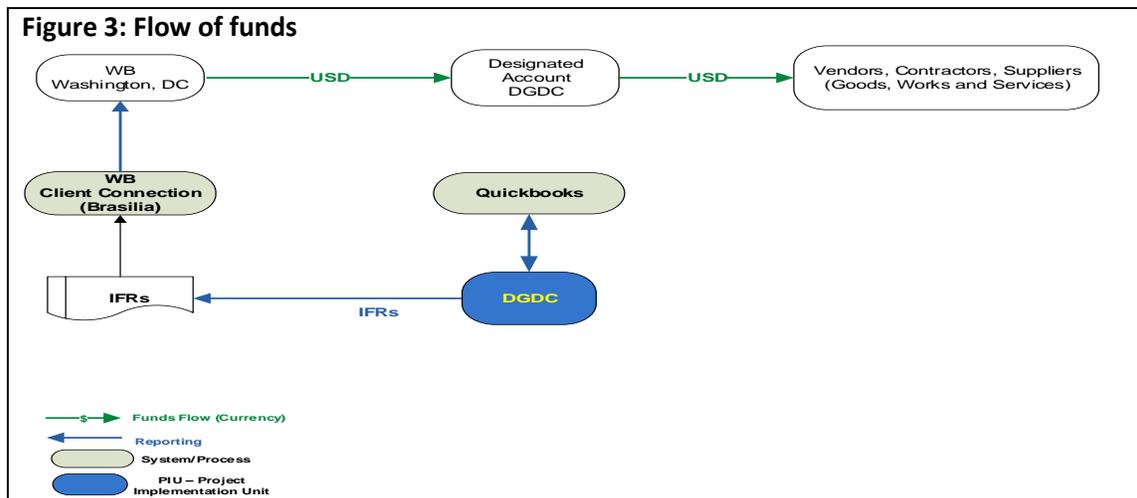


financial statements, as well as for monitoring physical progress and contract management. All payments will follow the commitment, verification and payment routine. All project costs are to be recorded according to the established Chart of Accounts. The use of the DGDC's integrated financial management system (Quickbooks), will also facilitate the consolidation of information on project transactions.

12. **Internal Controls.** DGDC will have an adequate system of internal accounting controls to provide management with reasonable assurance as to the safeguarding of assets against losses from unauthorized use or disposition, and the reliability of financial records for preparing financial statements and maintaining accountability of assets. The internal control structure includes a series of checks-and-balances required for the appropriate recording and authorization of transactions and ensures that access to assets is limited to authorized personnel. Each transaction should be divided into component tasks completed by different staff members to increase the likelihood of detecting unintentional errors and prevent misappropriation. DGDC's integrated financial management system, used for recording transactions under the Project, should have inbuilt controls in place that help to ensure that transactions are properly authorized and that payments are made only for due circumstances (i.e. where goods or service are confirmed as delivered), as described in the Project's Operations Manual.

13. **Funds Flow, Accounting and Disbursement Arrangements.** Following the general practice of the current Bank's portfolio, the following disbursement methods may be used to withdraw funds from the IDA credit and the grants: (a) reimbursement, (b) advance, and (c) direct payment. Under the advance method, a designated account (DA) will be opened by DGDC at the Bank of Dominica under the name of the Project. Given the specific nature of the contingent grant facility established under component 2 of the Project, it is envisaged that a separated DA will be open for the related funds. Funds deposited into the DAs as advances would follow World Bank disbursement policies and procedures, as stipulated in the Financing Agreement, the Grant Agreement and in the Disbursement Letter (DL). Following current practices, advances made to the DAs would be documented through the use of interim unaudited financial reports (IFRs) and supporting documents defined in the DL. The ceiling for advances to be made into the DAs are also defined in the DL. Documentation of eligible expenditures paid out of the DA are expected to be on a bi-annual basis, following the instructions included in the DL.

14. The following description indicates the flow of funds mechanisms to be used for the Project.





15. **Financial Reporting.** Though DGDC will be accounting using IFRS accrual basis, they will adjust the total balance to cash basis for reporting to the World Bank. DGDC will ensure the timely production of cash basis interim unaudited financial monitoring reports (IFRs) to be submitted within 45 days after the end of each reporting period (bi-annually). These IFRs will be produced from the QuickBooks system and will consolidate the project's financial expenditure data for all components. The format and content of the IFRs have been agreed with the DGDC.

16. **External Auditing.** Annual project financial statements will be audited by an external auditor in accordance with acceptable auditing standards. The external audit will be conducted under Terms of Reference acceptable to the Bank. Auditors will be required to issue an opinion on consolidated project's financial statements, covering all sources of funding. Auditors will also be required to issue a Management Letter, where relevant internal control weaknesses will be identified, which will contribute to the strengthening of the control environment. The audit report and the Management Letter will be submitted to the Bank no later than within six months after DGDC's fiscal year end.

17. **Supervision Plan.** The scope of project supervision will entail assessment of the implementation of FM arrangements and FM performance; identification of corrective actions, if necessary; and monitoring of the FM risk. It will be determined based on the project risk and will include: (a) review of IFRs; (b) review of the audit report and follow-up on any issues raised by auditors in the management letter, as appropriate; (c) participation in project supervision; and (d) updating of the financial management rating in the Implementation Status Report (ISR).

Procurement

18. Procurement under the Project will be conducted in accordance with the *World Bank's 'Procurement Regulations for IPF Borrowers'* (July 2016, revised November 2017). The Project is subject to the *World Bank's Anticorruption Guidelines*, dated October 15, 2006, revised in January 2011, and as of July 1, 2016.

19. **Procurement Assessment.** DGDC is a new entity; as such, it has not implemented procurement procedures or World Bank-funded projects before. A Procurement Assessment was carried out to evaluate the adequacy of the procurement experience and capacity of its current staff, related to the implementation of the proposed Project. The assessment found that the PM has vast experience in procurement procedures following World Bank Procurement Guidelines, from previous projects where he participated. The FC, who will support procurement functions, does not have any knowledge or experience regarding local or international procurement. However, both staff members participated in the World Bank procurement training held in Santo Domingo, Dominican Republic in May 2018.

20. **Proposed Procurement Arrangements.** DGDC's procurement responsibilities include planning, seeking and evaluating bids, and awarding and managing contracts. The procurement function will be led by the PM, who, as highlighted above, has vast knowledge of World Bank procurement requirements and specifically in the contracting of EPC service providers for geothermal power projects, having been the Project Manager/Procurement Team Lead for several similar projects. The PM will be supported by the DGDC's FC. Although the FC has no prior procurement experience, his professional and education background (mainly accounting) will provide a useful foundation upon which to develop the needed capability. It is envisaged that the FC, under the guidance of the PM and with assistance of the Owner's



Engineer will take over the day-to-day or routine procurement tasks, with the PM focusing on key and important aspects.

21. DGDC will be supported throughout implementation of component 1 of the Project by the OE (Jacobs). Their services are broad, but in relation to procurement, they specifically include:

- (i) Preparing the tender package for geothermal plant contractor;
- (ii) Leading and managing the tendering process and providing the technical lead on bid evaluation;
- (iii) Review of contractor supplied designs;
- (iv) Supervision of contractor manufacture, procurement, construction, installation and commissioning;
- (v) Support to the legal advisor in their preparation of legal documents;
- (vi) Support to business advisor in budgeting, cost estimation, cost control and the arranging of finance.

22. The OE team providing procurement support throughout the project cycle comprises a core management team supported by six lead technical specialists who will advise on their particular disciplines.

23. Procurement of works and services for components 2 and 3 will be managed by DGDC with support from technical consultants and through interaction with the World Bank as necessary under the terms of the Loan Agreement. All activities under these components will be financed by the Project and as such shall be procured in line with the Bank's Procurement Regulations.

24. **Procurement Plan and PPSD.** As per Procurement Regulations paragraph 4.3, DGDC has prepared a high-level, simplified Project Procurement Strategy for Development (PPSD) that is consistent with the World Bank's Core Procurement Principles. The PPSD details the initial Procurement Plan, acceptable to the Bank.

25. **Procurement under the Project.** Under Component 1, a Contractor for the Geothermal Plant will be selected under Open International Market Approach and Request for Bids. Under Component 2 a Contractor for the drilling of wells will be selected, if needed, under Open International Market Approach and Request for Bids. Under Component 3, one or more consultant firms will be engaged to provide technical assistance, with the actual scope to be defined by DGDC. These firm(s) will be selected through an Open International Market Approach and the use of Quality- and Cost-Based Selection procedures.

26. **Procurement risk management.** Procurement risks identified by the assessment will be mitigated by ensuring that the following actions are implemented:

- (i) Participation of the implementing entity staff in procurement training events delivered by the Bank.
- (ii) Extensive hands on procurement support to be provided by the OE, related to the bidding process for the geothermal plant.
- (iii) Close support and supervision of the Bank's Procurement Specialist to the Project.
- (iv) Procurement arrangements will be included in the Project Operations Manual.

27. The Bank's Procurement Specialist assigned to this project will monitor the procurement risk during implementation and will support, train, and guide the client's procurement team assigned to the Project. The procurement performance will be monitored during implementation supervision, and additional measures may be recommended if deemed necessary.



C. Environmental and Social (including safeguards)

28. The Project risk category is Category A on the basis of the screening criteria defined under the World Bank's Operational Policy 4.03. The development of geothermal resources for power generation is normally beneficial as it may displace more polluting and harmful fossil-based alternatives for baseload power generation, contributing to protect the environment locally and to reduce global GHG emissions. This is the case of this Project. In addition, a small geothermal power plant such as SGPP has a limited environmental footprint. Nonetheless, the A categorization is recommended based on the project locations, which are on the periphery of the MTPNP, a UNESCO World Heritage Site. In addition, the Project's direct area of influence could expand to high value biodiversity areas.

29. As implementing agency of the Project, DGDC will be responsible for safeguards implementation. The company meets the criteria to be defined as a *private entity* as set in paragraph 3 of the Operational Policy 4.03 Performance Standards for Private Activities (OP 4.03). Specifically, although publicly owned, DGDC: (a) carries out a business purpose, which is that of constructing and operating SGPP, and does so on commercial basis; (b) will make profits through the sale of geothermal electricity to DOMLEC and therefore will be financially autonomous; and (c) has an independent Board and a competitively selected Project Manager, which make the company managerially autonomous from the GoCD. In light of its private entity nature, the Bank has approved that Performance Standards (PSs) be applied to the DGDC.

30. DGDC has assessed the environmental and social impacts and risks associated with component 1 of the Project through the Environmental and Social Impact Assessment (ESIA) process consistent with World Bank's requirements. This was developed with technical support by Jacobs, whose services were paid by the GoNZ. The ESIA includes criteria to assess the significance of the adverse impacts, as well as national applicable laws and regulations.

31. Under OP 4.03, Performance Standards for Private Sector Activities, the applicable PSs for the project are:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts
- PS2: Labor and Working Conditions
- PS3: Resource Efficiency and Pollution Prevention
- PS4: Community Health, Safety and Security
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- PS8: Cultural Heritage

32. The World Bank's Performance Standard 7 on Indigenous Peoples is not applicable to the Project as there are no indigenous people in the project area. Performance Standard 5 on Land Acquisition and Involuntary Resettlement is also not applicable because the GoCD, and not DGDC, will carry out land acquisition. This responsibility falls under the Division of Lands and Survey of the Ministry of Lands, Housing, Settlements and Water Resource Management (Ministry of Lands and Housing). Thus, involuntary resettlement will be addressed in line with the requirements of the World Bank's Operational Policy on Involuntary Resettlement (OP 4.12).

74. With OP 4.12 triggered, the GoCD will be responsible for the implementation of the Abbreviated Resettlement Action Plan (ARAP) prepared under the ESIA, including grievance redress. The GoCD has



delegated authority to DGDC to act on its behalf with respect to safeguards implementation. To facilitate DGDC's ability to carry out its oversight of all project-related safeguards, a Memorandum of Understanding will be entered into by the Ministry of Lands and Housing and DGDC for land acquisition matters and ARAP implementation.

33. Under the ESIA, DGDC has prepared a Social Impact Assessment (SIA). The SIA builds upon the review and analysis of information collected under Environmental and Impact Assessments (ESIAs) carried out between 2009 and 2015⁵, and considers social risks through the lens of the pre- and post-Hurricane Maria conditions. Social issues related to environmental receptors are also addressed in the SIA.

34. The ESIA contains the Environmental and Social Management Plan (ESMP), a Monitoring Plan, a Stakeholder Engagement Plan (SEP), and a Grievance Mechanism. It also includes the Framework Environmental and Social Management System (ESMS) developed for the Project in consistency with the requirements of PS 1. The Framework ESMS provides the key elements for developing and implementing an overarching ESMS, which will establish a methodological approach to managing environmental and social risks and impacts in a structured way and on a continuous basis. DGDC will be responsible for implementing the ESMS and ensuring compliance with national regulations and project sponsor's requirements over the life of the Project. The ESMS will ensure that there are appropriate environmental and social policies and procedures in place and that these are followed consistently. The ESIA, along with the various plans and measures, will ensure that the Project complies with: (a) the host country legislation; (b) the applicable WB Performance Standards; and (c) the applicable WBG environmental, health and safety guidelines.

35. **Social impacts.** The main social impacts of the Project are related to direct and indirect employment opportunities and the land acquisition for the geothermal power plant and the reinjection pipeline route. There will be minor impacts in terms of economic displacement to livelihoods, especially as related to the tourism activities around the MTPNP World Heritage Site.

36. Land acquisition and resettlement issues have been approached by first dealing with the legacies of the compulsory acquisition by the GoCD of four parcels of land in 2013 during the exploration and drilling phase. Since such properties were acquired for uses that are instrumental to the proposed Project, they form part of the project-affected areas and land acquisitions must be executed in compliance with OP 4.12. Upon Bank's suggestion and as part of ESIA preparation for the Project, in 2017 DGDC carried out a "Land Acquisition Review", which detected several incompliances with the requirements of OP 4.12, notably in terms of land valuation, documentation and grievance redress. Therefore, DGDC developed an Action Plan to address these shortcomings, which the Bank concurred with and whose implementation it closely monitored. In September 2018, the GoCD authorized and executed compensation at replacement cost for three of the four parcels. Such compensation includes market value plus 10.5 percent transaction and taxation costs. In addition, a 6 percent interest fee accruing since the time the land was acquired (as per the national legislation) was paid to landowners. Affected landowners were made eligible to receive

⁵ Environmental and Impact Assessments (EIAs) were carried out in 2009 and 2011 in relation to the exploration and production drilling program conducted by the GoCD; the Situational/Gap Analysis prepared by the World Bank in 2013; and a social, physical and biological baseline survey carried out between 2013 and 2015 under a subsequent ESIA Baseline Study (2015), which addressed some of the gaps that had been identified by the World Bank analysis in relation to the ESIAs.



the equivalent value of waived taxes and transaction fees whether or not they decide to buy land elsewhere. The fourth parcel belongs to a private firm, the Rain Forest Aerial Tram Facility Limited (RFATL), which leased 1.0 acre of its 37.187-acre property to the GoCD in 2011. The RFATL is currently in liquidation and the company – and later the liquidator – expressed interest for the GoCD to buy the whole property. The parties have agreed that the GoCD will pay the outstanding lease fees and buy the parcel based on a recalculation of the property valuation post-Hurricane Maria. Since RFATL owes large tax duties to the GoCD, the compensation will be settled through an adjustment of RFATL's tax arrears.

37. The ARAP has identified thirteen properties that will be acquired for the construction of the power plant and the reinjection pipeline. For the reinjection line, portions of each of six properties will be acquired to define a corridor of up to 10m. This would include three structures, one of which is residential, one intended for residential use and one used for livestock. DGDC will determine the exact land to be acquired for the reinjection line based on technical and financial considerations. Five of the properties in close proximity to the power plant site are expected to be affected by noise, construction and visual impacts and have thus been considered for resettlement. The property belonging to one project-affected-person (PAP) already contains a well pad from the drilling phase and thus DGDC considers acquiring the remainder of the parcel. Twelve PAPs requested cash compensations while one opted for a replacement property. Additional surveys will be carried out to identify a resettlement site for this party.

38. Grievance redress related to land acquisition will be addressed by the Ministry of Lands and Housing (Department of Lands and Surveys) and any complaints submitted to DGDC will be directed to the Ministry. DGDC will coordinate with the Ministry to ensure that complaints are taken care of and will collate the outcomes of the related grievances for reporting purposes. DGDC will be responsible for all other project-related grievance redress including monitoring and evaluation. The company has prepared separate workers' and community grievance redress mechanisms.

39. Prior to Hurricane Maria, the social assessment revealed the presence of a few vulnerable (physically disadvantaged and elderly) persons within the communities adjoining the project sites. Vulnerability conditions have worsened following the passage of Hurricane Maria. 75 percent of the housing stock in the country was moderately to highly damaged or destroyed. The project area was no exception and many PAPs lost at least the roof of their house. Despite the naturally difficult social and economic circumstances in the post-disaster context, community members were reluctant to discuss the economic implications of their losses during the field surveys.

40. In addition to land acquisition, the ARAP addresses the needs of vulnerable people and women in terms of compensation pertaining to and reflecting their full activities. Women and vulnerable people were encouraged to actively participate in all Project-related resettlement consultations and negotiations and several focus group meetings were targeted at women. All compensation due to female-headed households will be given to only the female family head. ARAP monitoring and evaluation will pay special attention to the impact of resettlement on women and other vulnerable people. DGDC will liaise with relevant Government departments to provide additional assistance to vulnerable PAPs in the form of cash and, upon request, employment training, counseling in domestic matters and any other assistance that may be requested.

41. **Gender issues.** Despite significant progress in Dominica in the education and leadership spheres, two main gender challenges still persist, including women's access to labor market and gender-based



violence (GBV). Female labor force participation is lower compared to male one (respectively 59 and 70 percent), and female unemployment is higher, especially among people living in poverty (33.8 percent for poor females vs. 20 percent for poor males)⁶. Women also tend to work in the informal market in micro-enterprises and subsistence farming, as well as in the governmental and commercial services sector. Women's time availability is also a major obstacle to their economic development. More than half of women's time is primarily dedicated to domestic work, including care activities and household chores and women spend on average double of time in unpaid care work compared to men. The PDNA conducted in the aftermath of Hurricane Maria detected that women's labor condition has been further exacerbated by the disaster. The loss of assets and crops posed significant income and food security challenges resulting in women's immediate needs for livelihood recovery interventions. GBV and especially intimate partner violence remain also a critical health and social constraints for the female population who represents 89 percent of GBV survivors. Post-traumatic stress disorders currently affect the majority of the population, especially the male population who is already showing unhealthy coping mechanisms, such as drug and alcohol abuses.

42. **Gender sensitive interventions.** Given this context, the Project will promote women's access to economic opportunities linked to the project, stakeholders' awareness on the links between gender and geothermal energy agenda, and activities to reduce risks of GBV and sexually transmitted infections (STIs) for women. A Community Development Fund (CDF) will finance activities promoting economic opportunities for women⁷. The project will ensure that at least 60 percent of the people employed for these activities will be women, especially the most in need. In view of the potential future expansion of the geothermal energy sector in Dominica, specific attention will be devoted to increase the sectorial knowledge and benefits related to the gender and geothermal energy agenda. To that end, a gender and geothermal energy workshop will be designed and conducted. Participants to the workshop will include personnel from DGDC; the Ministry of Trade, Energy and Employment; DOMLEC; the Bureau of Gender Affairs; local NGOs and representatives from communities and municipalities near the Project's area of influence.

43. The Project is also expected to provide direct and indirect working opportunities to local communities. With regards to direct working opportunities, approximately 40 short-term employers and 60-80 workers will be needed during construction and for operation of the power plant. Given their higher expertise in this area, local men will benefit more from direct working opportunities compared to women. The ESIA estimated also that approximately 20-30 indirect jobs should be generated by the Project. During the construction phase, several services will be needed to respond to the daily necessities of workers, including food, laundry, housing and transportation's provision. As result, local women, who are the most active in these sub-sectors, will have access to working and income opportunities. In addition, as the power plant is likely to become a tourist attraction, more business opportunities will be generated for the local community and especially women, who already work as vendors in the tourism industry.

44. **Labor influx and gender relations.** The Project will involve the influx of approximately 50 foreign

⁶ Commonwealth of Dominica. (2014, April). Commonwealth of Dominica's national review report on the Beijing +20 Review. https://www.cepal.org/mujer/noticias/paginas/3/51823/Dominica_Review_Beijing_20.pdf

⁷ The ESIA consultations have already identified gender-sensitive activities to be carried out under CDF, prioritizing the construction of a visitor center at the power plant site to be managed by the community. Although specific activities will be selected during project implementation, the Fund will devote specific attention to strengthen business-generating opportunities for local women, such as the provision of technical and financial support for the creation and management of the visitor center.



workers who will be housed in a workers' camp during the construction stage. The camp will be located close to the proposed work sites to minimize the impact of traffic on the local communities due to workers travelling daily to and from the site along the narrow Roseau Valley roads. Labor influx could potentially increase the incidence of GBV, unintended pregnancy, and sexually transmitted infections (STIs), including HIV/AIDS, on the local communities. To address these risks, the social, health and safety procurement clauses covering labor recruitment, safety, and HIV/AIDS will be incorporated in all works contracts. This will require the selected EPC contractor (and eventual sub-contractors) to: (i) conduct awareness raising campaigns and implement mitigation measures among workers and local residents for prevention of GBV and HIV/AIDS transmission; (ii) conduct periodic workers health surveillance; and (iii) apply worker policy and codes of conduct on child protection and GBV.

45. **Citizen engagement.** As part of project preparation, DGDC held several consultation sessions. Three public meetings were held between December 2016 and August 2017; a total of fifteen focus group meetings – involving groups of 5-15 people – were held as part of the ESIA baseline data collection. Together, all these consultations provided the opportunity to interested communities and for representatives of local hotels and resorts, handicraft vendors, hot springs businesses, and unemployed parties in the area to express their concerns on the Project. Following Hurricane Maria, DGDC conducted five supplementary focus group meetings in March 2018 to identify the Hurricane's impacts on the communities and to understand how the social baseline had changed.

46. The main concerns expressed by the communities were related to: noise levels during construction; community benefits; routing of the reinjection lines through the villages; leaks from reinjection pipes; and land acquisition. The Project has selected the reinjection pipeline route in a way to minimize land acquisitions and resettlements, as detailed in the ESIA. Other risks raised by the communities will be addressed by: implementing noise suppression measures during construction; providing community benefit options as detailed in the ESIA; developing an emergency response and disaster management plan; and duly implementing the ARAP in accordance to World Bank requirements. A full summary of consultation comments and how they are addressed in the ESIA is presented in the Social Impact Assessment.

47. DGDC presented the Non-Technical Summary (NTS) of ESIA findings to the interested communities in the Roseau valley at three public meetings held in the first week of July 2018 in Laudat, Wotten Waven and Trafalgar. Community members were given the opportunity to express concerns and ask questions about the Project and ESIA findings. Concerns generally included community health and safety issues, natural hazards, employment and construction impacts. The draft NTS was also disclosed on the DGDC's website in June 2018.⁸

48. The Stakeholder Engagement Plan prepared under the ESIA provides guidance for stakeholder engagement during project implementation; laying the foundation to strengthen and maintain relationships with all stakeholders throughout the project cycle. The DGDC's safeguards team will be primarily responsible for SEP implementation, under the oversight of the DGDC's executive management team. DGDC has established clear procedures for public communications regarding the Project. Communication with the press is a designated responsibility of DGDC's Board. Social media accounts (Twitter and Facebook) have been also set up to provide continuous updates on the project.

⁸ <https://www.geodominica.dm/#download>



49. **Environmental and EHS impacts.** The key environmental, health and safety impacts and risks associated with the construction of the geothermal power plant are: (i) air emissions, increased noise, dust and solid and hazardous waste generated from construction activities and/or accidental spills in the villages close to the Project and its accesses; (ii) erosion and sedimentation; (iii) increased risks of accidents in access roads; and (iv) potential impacts on tourism and habitats in high sensitive areas. The earthworks and stream crossings required for the construction of the rejection pipeline may cause impacts on water quality and ecology. Once SGPP is in operation, the key impacts and risks are: (i) potential for soil and water erosion, runoff, and sedimentation; (ii) increased emissions of potentially hazardous (and malodorous) air pollutants such as hydrogen sulfide (H₂S); and (iii) community and worker exposure to explosions, well blowouts and pipeline failure as well as hazardous working condition for plant personnel.

50. **Implementation arrangements.** As project implementing agency, DGDC is ultimately responsible for the management and supervision of all project activities, including safeguards. The framework ESMP summarizes DGDC's commitments to address, mitigate and monitor risks and impacts identified as part of the ESIA, through avoidance, minimization and compensation/offset that will be applied to the construction and operation of SGPP and the associated reinjection pipeline and wells. DGDC's structure to implement the ESMS relies on the PM, and a dedicated safeguard team, who will be responsible for safeguards implementation, including stakeholder engagement and grievance redress issues. As detailed above, DGDC's safeguard team includes: (i) an Administration and Safeguards Officer; (ii) a Community Liaison Officer; and (iii) a Site and Office Attendant. DGDC's human resources policies and procedures will provide a description of functions/positions and requirements. Throughout project preparation, while supporting ESIA development, Jacobs has provided capacity building on safeguards to DGDC. The PM has in-depth, applied experience related to all aspects of geothermal development, including safeguards compliance. Additional support for environmental and social management will be provided by the external expert who will be contracted by AfD and provided to DGDC.

51. Management of environmental and social risks and impacts during construction of SGPP will primarily be the responsibility of the EPC contractor through the EPC contract. DGDC's PM and the EPC Contractor's Site Manager will ensure good practices on site during construction. Staff will be trained in environmental and social management, auditing and monitoring procedures as per the framework that has been outlined in the Framework ESMS. DGDC will be responsible for reviewing, approving and supervising implementation of the detailed plans and procedures, consistent with the framework ESMP, that will be developed and implemented by the EPC contractor. DGDC will ensure that the construction management plans are in place before construction begins. As indicated in the ESIA, the ESMP will consist of a set of plans and procedures, which include, but are not limited to: Occupational Health and Safety Management, Traffic Management, Subsidence Risk Management, Soil and Erosion Management, Pest and Weed Management, Waste Management, Biodiversity Restoration, Emergency Preparedness and Response Plan, Grievance Mechanism, Stakeholder Engagement Plan, Chance Find Procedure, and Worker's Code of Conduct (with a section on Cultural Heritage).

52. The DGDC Administration and Safeguards Officer will coordinate the creation and implementation of CDF, including its gender-sensitive activities. The gender and geothermal energy workshop will be designed, conducted and financed by the World Bank's LAC Gender and Energy (LAC-EG) Program. The LAC-EG Program will also provide ad-hoc technical and advisory assistance in the selection and implementation of the interventions to be developed under CDF.



53. During construction and operation of SGPP there will be ongoing monitoring of environmental and social aspects, reviews of compliance with the ESMS and an evaluation of the effectiveness of the ESMS. All relevant project environmental and social aspects will be captured in the Aspect Registers. Routine auditing will be carried out, following established procedures, to determine the Project's level of compliance with the ESMP, country regulations, Bank's requirements, and to evaluate the effectiveness of the ESMS. Where needed, changes will be made to the ESMS documentation to ensure that it remains relevant. These activities will help determine whether controls are working or need to be improved. In addition, they will help identify any new environmental and social issues. As a minimum, these reviews should be undertaken every six months during construction and annually for the operation phase. During operations, responsibility for monitoring is on the O&M contractor, whose performance will be monitored in turn by DGDC.

D. Monitoring and Evaluation

54. The Project will use the indicators defined in the Results Framework and Monitoring (RF), attached as annex 1, to track progress on implementation and the level of achievement of its intended objectives. Indicators include outcome indicators (Project Development Objective Indicators) for the Project as a whole, and output indicators (Intermediate Result Indicators) for each project component. Annual target values for the results indicators have been estimated based on the feasibility analysis completed by the GoCD and DGDC with support from international consultants and notably Jacobs. Target values concerning GHG emissions reduced or avoided have been estimated by the project team. The methodology used and a full analysis for GHG emission reductions are presented in annex 3.

55. DGDC will be responsible for collecting and collating information on the project activities and submitting progress reports to the Bank, on an annual basis for PDO indicators and on a semi-annual basis for the intermediate indicators at component level. Specifically, progress related to component 1, and notably to the construction of SGPP and associated infrastructure, will be monitored by the OE. Indicators concerning component 2 relate to the establishment of the contingent grant facility. A critical action is the verification of the conditions that would allow the release of funds from this facility. This can be monitored by the Bank team directly, since the Bank needs to conduct the verification. Progress on technical assistance activities envisaged under component 3 will be monitored directly by DGDC Project Manager, who is personally responsible for procurement functions. Further arrangements for monitoring and detailed reporting arrangements will be detailed in the Project Operational Manual to be prepared by DGDC and approved by the Bank.



ANNEX 5: IMPLEMENTATION SUPPORT PLAN

COUNTRY: Dominica
Dominica Geothermal Risk Mitigation Project

A. Strategy and Approach for Implementation Support

1. The strategy for project implementation support (IS) by the World Bank reflects the nature of the project and its risk profile. The strategy aims at making IS to the implementing agency more efficient while remaining focused on implementation of the risk mitigation measures identified in the SORT. The strategy is also an indicative and flexible instrument that will be revisited during project implementation and as part of the ISR reviews and will be adjusted based on emerging project challenges and field conditions.
2. **Overall Project Implementation.** Project supervision will review the progress in the implementation of each component and support the following critical areas: (i) technical implementation support to ensure the project is being carried out in an effective and integrated manner; (ii) fiduciary capacity support to ensure that the project/program funds are used to achieve value for money as well as that there is adequate capacity and internal control systems and overall governance; and (iii) management of environmental and social factors in the project area of influence. Dedicated attention will be paid to the procurement and execution of the EPC contract, which is the largest contract to be awarded under the Project, accounting for 60 percent of project funds. The Bank team will also coordinate closely with the GoCD, energy sector stakeholders and notably DOMLEC, and other development partners, to monitor progress towards full recovery and increased resilience of the national power system. Finally, it will engage with the GoCD and potential private investors to help ensure that the development status of LGPP is advanced through adequate analysis and market engagement.
3. The long engagement in supporting geothermal development in Dominica has earned the Bank the reputation of a trustworthy partner delivering top quality advisory services. The relations between the GoCD and the Bank are well established, also as result of the effective and integrated post-disaster assistance provided by the Bank. The Bank team will leverage on these good results and continue pursuing close dialogue and mutual collaboration with the GoCD. Team members will ensure timely, efficient, and effective implementation support to DGDC and carry out formal implementation support missions and field visits at least two times a year.
4. **Technical Support.** The supervision mission will review the progress in the implementation of each component, and follow-up closely on the contingencies potentially affecting SGPP operations that could require additional drilling and therefore trigger Component 2 of the Project. The geothermal energy expert on the World Bank team will provide the required assistance, advice, and guidance to DGDC on various technical aspects of geothermal operations. He will review technical specifications of bidding documents for the project and bidding evaluations reports, especially for the EPC contract, and provide advice as needed. This expert will also conduct site visits with the supervision mission and DGDC to verify physical implementation progress and ensure proper guidance, especially if additional drilling is required during implementation.



5. **Fiduciary Support.** The supervision missions will ascertain whether the procurement and FM provisions of the Project Legal Agreements and Operations Manual are being followed. The FM Specialist will review the: (i) project accounting and internal control systems; (ii) budgeting and financial planning arrangements; (iii) IFRs; (iv) audit reports, including financial statements, and remedial actions recommended in the auditor’s Management Letter; and (v) disbursement management and financial flows. Supervision of procurement will be carried out primarily through prior review supplemented by supervision missions at least twice a year. Procurement supervision will be closer during the first 12 months of project implementation, which is when the EPC contract is expected to be awarded. The missions will also discuss progress in the implementation of the Procurement Plan.

6. **Environment/Social Support.** World Bank specialists in environmental and social risk mitigation (safeguards) will be responsible for supervising the DGDC’s compliance with World Bank Group safeguards policies and performance standards and the implementation of the ESIA and other safeguard instruments prepared for the Project. They will conduct supervision missions and site visits to the field twice a year during the duration of the project, review deliverables prepared, provide technical assistance, and conduct trainings to support capacity-building in DGDC, as needed, including on gender-related aspects.

B. Implementation Support Plan and Resource Requirements

7. The overall implementation support plan for the project and resource requirements are described in Table 1 and Table 2 below.

Table 1: Resources Required by Time Frame

Time	Focus	Skills needed	Resource estimate (staff weeks)
First 12 months	Project management	TTL, energy specialist	20
	Specialized geothermal technical support	Geothermal energy expert	8
	Power engineering and operational advisory support	Senior energy advisor	3
	Procurement implementation support	Procurement specialist	6
	Financial management implementation support	Financial management specialist	4
	Environmental implementation support	Environmental specialist	4
	Social implementation support	Social specialist	4
12 months - project end date	Project management	TTL, energy specialist	20
	Specialized geothermal technical support	Geothermal energy expert	4
	Power engineering and operational advisory support	Senior energy advisor	3
	Procurement implementation support	Procurement specialist	4
	Financial management implementation support	Financial management specialist	4
	Environmental implementation support	Environmental specialist	4



	Social implementation support	Social specialist	4
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Table 2: Skills Mix Required

Skills needed	Number of staff weeks	Number of trips per year
TTL	15	2
Energy specialist	5	2
Geothermal energy expert	8	2
Power engineer advisor	3	2
Procurement specialist	4	2
Financial management specialist	4	2
Environmental safeguard specialist	4	2
Social safeguard specialist	4	2



ANNEX 6: ECONOMIC AND FINANCIAL ANALYSIS

COUNTRY: Dominica

Dominica Geothermal Risk Mitigation Project

I. FINANCIAL ANALYSIS

A. General Methodology

1. The financial analysis for the proposed Project focuses on assessing benefits and costs associated with the construction of SGPP. The analysis is meant to establish the viability of this investment from the point of view of the developer (DGDC). In this specific case the concept of financial viability is slightly different from its traditional connotation. Normally, a private developer would seek to maximize its return; that is, maximizing revenues given the level of risk and the costs incurred. Following this logic, it would be in the interest of a privately-owned developer to secure the highest possible price for the electricity produced by SGPP under the PPA with DOMLEC. However, the main goal of the Project – to help reduce and stabilize electricity retail prices in Dominica – calls for exactly the opposite. A cheaper electricity supply made available to DOMLEC should result in a substantially reduced tariff charged to end-consumers.

2. The displacement of expensive diesel-based baseload generation with more cost-efficient geothermal-based generation is motivated by a compelling public interest. Because of this public interest, the GoCD has undertaken the risks and investments associated with developing the geothermal field and has formed and provided capital to DGDC for the purpose of investing in SGPP. DGDC has been established as a private entity and must operate using commercial principles and fiduciary systems. Therefore, during the project construction phase and with regard to the operation of SGPP, the objective will be to keep DGDC solvent while minimizing to the degree possible the retail tariff. Since during the development of SGPP DGDC will be entirely owned by the GoCD, the company can accept a lower financial return and the GoCD will realize the real return from the Project through a reduction in the retail price of electricity. In addition, SGPP will validate the use of geothermal electricity in Dominica and effectively convert what now seems to be a green-field opportunity into a brown-field project. Therefore, SGPP will pave the way for the larger and more complex investments at the Wotten Waven field, eventually leading to the construction of LGPP and electricity exports to neighboring islands. As Dominica has neither the resources nor the technical expertise to accomplish that later expansion all by itself, it will seek a private developer, who may become a co-investor in DGDC and/or develop LGPP as a separate project. In any event, the GoCD is set to gain from private investment in the Wotten Waven field and from significant royalties from the use of the geothermal resource.

3. This analysis assesses the financial return of SGPP using the concepts of Project Internal Rate of Return (Project IRR), Equity Internal Rate of Return (Equity IRR) and Debt Service Coverage Ratio (DSCR). These financial ratios are commonly used to determine the financial viability of projects; however, because of the specific circumstances of this Project, the target of the financial return will be somewhat different from what is expected for typical private projects. Risks associated with geothermal investments vary throughout the multi-stage geothermal development cycle and so does the financial return that a developer should seek. In the case of the proposed Project, the early stages of resource exploration, which



are by definition the riskiest, have been completed and the resource capacity needed for operating SGPP has been fully confirmed. As a result, the Project now presents a risk profile similar to other power generation projects, and, if it were to be developed by a private entity, it would have been reasonable to assume a target Project IRR of about 8 percent and an Equity IRR of about 12 percent. In light of the national goal of lowering the retail tariff, GoCD is aiming for a much lower Equity IRR of about 5 percent, and consequently a lower Project IRR.

4. Positive Equity and Project IRRs, although low, would signal that the Project can earn to DGDC enough revenues to exceed investment and other costs associated with SGPP over the lifetime of the power plant and therefore remain viable. Confirming Project's viability is the key goal of the financial analysis. Currently, DGDC and DOMLEC are negotiating the PPA and the wholesale tariff – that is, the price of geothermal electricity sold by DGDC to DOMLEC – being discussed is US\$7.4 cents/kWh, which is used to assess project revenues. Investments are financed with funding made available from the GoCD. Not only will GoCD provide DGDC with its initial equity, it will also on-lend to the company the proceeds of the IDA credit on concessional terms. Therefore, another criterion to determine the solvency of the Project is to confirm DGDC's ability to service its debt, by assessing its DSCR over time. Specifically, the analysis compares the year-by-year DSCR of DGDC with the typically required level for other Bank-financed electricity projects, namely a minimum DSCR of 1.3X and an average DSCR of 1.5X.

5. In addition, the analysis assesses how profitable the Project would be if DGDC could charge a higher tariff. The difference between the financial return actually being targeted and the return that could be realized under normal circumstances – that is, with DGDC charging a higher price for geothermal electricity – provides a suitable proxy of the benefits accruing to end-consumers.

6. The analysis assesses the Project's viability under a base case scenario and later under a number of circumstances that may affect the Project. Various technical, financial, and economic assumptions and parameters are utilized for the base case scenario analysis, as presented thereafter. They mainly serve to estimate the costs associated with the Project, which form the basis for calculating cash flows. Much of the information is derived from feasibility analysis completed for the Project, DGDC financial model, the PPA and commonly accepted industry practices and standards.

B. Key Assumptions and Parameters

7. **Upstream steamfield development.** The exploration and production drilling program previously conducted by the GoCD has confirmed that there is sufficient steam capacity at the wellhead to support the development of a 7MW geothermal plant (~6.4MW net). The plant may use either a steam condensing or binary technology (both options are suitable); the optimum plant design will be up to contractors when bidding for plant construction.

8. **Geothermal power plant and steam gathering system development.**

- (a) Project costs: Based on current estimates, the total cost of the power plant and the associated steam gathering system will be US\$41.5 million. This includes physical and price contingencies in the amount of 15 percent of EPC contract cost for SGPP construction. In addition, existing assets valued at US\$9 million, were transferred by the GoCD to DGDC as part of its equity contribution. Therefore, the total project cost can be estimated at US\$50.5 million.



- (b) Years of Construction: 2 Years
- (c) Years of Operation (lifecycle): 25 Years
- (d) Net Capacity Factor: 72%¹⁹
- (e) Grid Connection Loss: 1%

9. **Operation and maintenance (O&M) cost estimates²⁰.**

- (a) Fixed O&M Cost: US\$1.3 million
- (b) Variable O&M Cost: US\$3/MWh net delivered
- (c) Workover Frequency: 5 years
- (d) Insurance: 0.6% of plant cost

10. **Capacity payment and energy fee.**

- (a) The tariff for geothermal electricity (wholesale tariff) as set in the PPA between DGDC and DOMLEC consists of a capacity charge and an energy charge. The capacity charge, which is given by the agreed capacity fee (Capacity Rate) multiplied by the net deliverable capacity, accounts for 95 percent of the tariff. The energy charge – equal to the agreed energy fee (Energy Rate) multiplied by the net energy delivered – accounts for the remaining 5 percent.
- (b) Wholesale tariff: US\$0.0740/KWh
- (c) Monthly Capacity Payment: US\$312,151 a month²¹
- (d) Energy Rate: US\$0.0037/KWh

11. **Project investment schedule.** The following schedule (table 1) summarizes the investment costs broken down over the several years that make up the investment period. In reality, the investment period started in 2015, when the GoCD invested US\$9 million to conduct the exploration and production drilling program. This was financed through a loan from AfD, which is being repaid in 10 equal semi-annual installments. As highlighted earlier, the associated assets have been transferred to DGDC; in the financial model, this in-kind equity of U\$9 million from the GoCD is reflected as being injected in 2018.

Year	2019	2020	2021	Total
Existing Well	9.0			9.0
Power Plant & SAGS		21.9	10.6	32.5
Land & Infrastructure/Engineering	6.0	2.0	1.0	9.0
Total	15.0	23.9	11.6	50.5

12. **Financing sources.** Sources of financing and allocations to specific cost components are as follows:

- (a) *Equity from DGDC:* Total equity is estimated at US\$19.3 million, allocated as follows:
 - Existing Well: US\$9 million
 - Land & Infrastructure/Engineering: US\$7 million

¹⁹ Results from a 96% Plant Availability Factor and a 75% Load Factor. The analysis assumes that load factor increases 3% each year based on GDP growth projection, starting from the year of commissioning.

²⁰ O&M cost is escalated by inflation rate. It is noted that such cost is calculated conservatively compared to the market standard.

²¹ Monthly capacity payment is escalated by inflation rate.



- Power Plant & SAGS: US\$3.3 million

(b) *World Bank financial assistance:* The World Bank will extend to the GoCD an IDA credit in the amount of US\$17.2 million, which will be on-lent to DGDC with the same IDA terms, including: (i) 0.75 percent interest and no commitment fee; and (ii) after a 10-year grace period, the repayment will be the equal installment semi-annually for 15 years.

(c) *Clean Technology Fund:* Contingent recovery grant from CTF in the amount of US\$9 million will be extended to DGDC for contingent drilling shall the need arise. Since disbursements are on a grant basis, CTF funding is not included in the financial model.

(d) *Grants:* Grants have been provided from various sources, including:

- DFID: US\$10 million
- Government of New Zealand: US\$2 million (in-kind grant)
- Small Island Developing States: US\$2 million.

13. **Financing schedule.** Table 2 summarizes the expected disbursement schedule (values in US\$ million) for the various sources of funds:

Year		2019	2020	2021	Total
Equity		13.0	4.1	2.2	19.3
Loan	IDA		7.8	9.4	17.2
Grant	DFID		10.0		10.0
	NZ	2.0			2.0
	SIDS		2.0		2.0
Total		15.0	23.9	11.6	50.5

C. Results of the Financial Evaluation

14. **Financial viability.** Based on the assumptions above, the analysis shows that the Project is expected to produce an overall return (Project IRR) of 2.7 percent and a return on equity (Equity IRR) of 6.18 percent. The Minimum DSCR is estimated at 1.1X; the Average DSCR at 3.2X. These results suggest that the DGDC will generate enough cash flow from the Project to repay its debt and earn a financial return slightly higher than the GoCD's target.

Wholesale Tariff	7.4 cents/kWh
Equity IRR	6.18%
Project IRR	2.7%
Minimum DSCR	1.1X
Average DSCR	3.2X

15. Table 4 provides a summary of the financial cash flows for the first 8 years of project



implementation.

Table 4: Summary Financial Cashflow Statement (USD'000)

	2019	2020	2021	2022	2023	2024	2025	2026
Inflows								
Revenue	-	-	1,993	4,022	4,072	4,122	4,173	4,227
Loan	-	7,800	9,400	-	-	-	-	-
Grant	2,000	12,000	-	-	-	-	-	-
Total Inflows	2,000	19,800	11,393	4,022	4,072	4,122	4,173	4,227
Outflows								
Investment	15,000	23,965	11,580	-	-	-	-	-
O&M	-	-	742	1,511	1,546	1,582	1,619	1,657
Insurance	-	-	89	180	184	187	191	195
CTF Insurance Cost	-	205	10	10	10	10	10	10
DGDC Expenses	-	-	78	159	162	166	169	172
Debt Repayment	-	-	-	-	-	-	-	-
Taxes	-	-	-	-	-	-	-	-
Total Outflows	15,000	24,170	12,499	1,860	1,902	1,945	1,989	2,034
Equity Cashflow	(13,000)	(4,370)	(1,106)	2,162	2,170	2,177	2,184	2,193

16. **Financial internal rate of return and benefits to consumers.** Normally, the computation of a project's financial rate of return is based entirely on information — actual or projected — that passes through a company's financial statements. Therefore, benefits relate to revenues and profitability, and not to other notional benefits to consumers. In this instance, however, the project entity is owned by the government (albeit being operated as a private company) with the explicit objective of lowering its own revenues so as to reduce end-user electricity tariffs as much as possible. In that sense, revenues that DGDC foregoes can be considered as virtual dividends that electricity consumers collect at the point of sale. These benefits do not need to be collected by DGDC and refunded to consumers through other mechanisms. Cases A and B below consider different ways of quantifying this virtual dividend in computing DGDC's rate of return.

17. **Case A: DGDC charging a wholesale tariff that would leave the average retail price of electricity at its current level.** The latest available average retail price of electricity in Dominica was around US\$33 cents/kWh (as of end of December 2016). The tariff includes a fixed component (estimated at US\$23 cents/kWh as of end of December 2016) and a variable fuel surcharge (estimated at US\$10 cents/kWh as of end of December 2016). The latter reflects fuel costs associated with diesel-based generation. Using the same simulations developed for the economic analysis, which details how the fuel surcharge is calculated (see paragraph 38), at today's international oil prices, the cost of diesel supply, including fuel costs only, would be around US\$16.5 cents/kWh. The full cost faced by DOMLEC to generate electricity from diesel would be better estimated using the concept of levelized cost²², which reflects also upfront investments in diesel generation at today's value. In the absence of full details on the status and value of diesel generation assets owned by DOMLEC, the fuel cost as estimated above provides an alternative, although it is a lower bound of the costs incurred by DOMLEC. As long as the wholesale tariff for geothermal electricity charged by DGDC is below this level, DOMLEC has an incentive to substitute diesel-based generation with geothermal electricity and the retail price charged to consumers could be reduced.

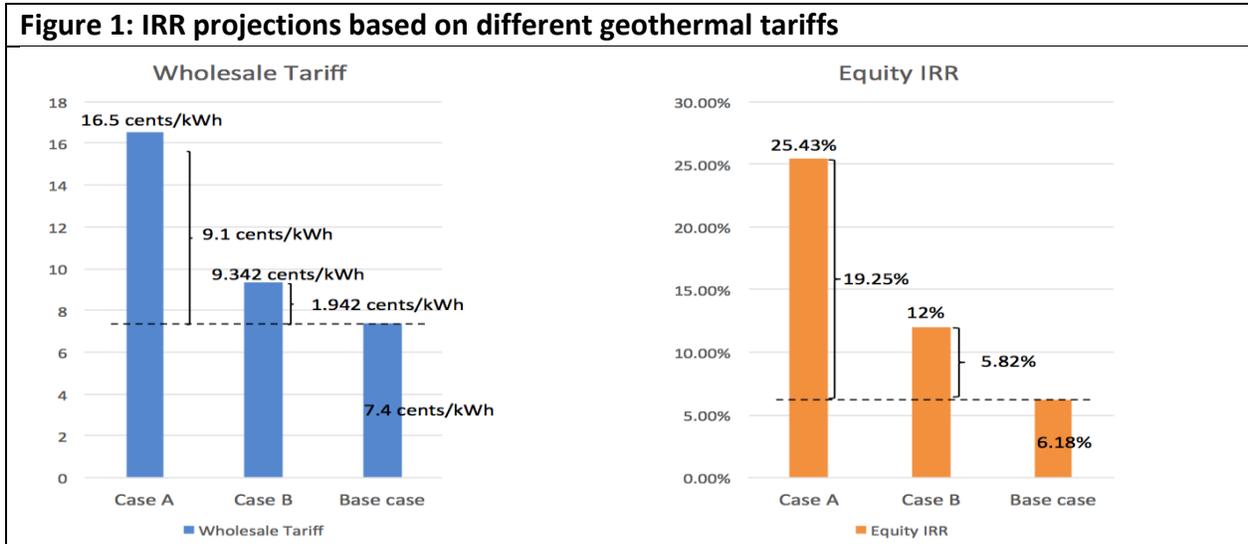
²² Namely the average total cost associated with building and operating a power-generating asset over its lifecycle.



Therefore, US\$16.5 cents/kWh²³ is the maximum price that DGDC could charge to DGDC for geothermal electricity. With a wholesale tariff set exactly at this level, it would be indifferent for DOMLEC to purchase geothermal electricity or continue using diesel-based generation electricity; prices in the country would not change and consumers would not receive any benefits. A wholesale tariff of US\$16.5 cents/kWh would raise the Equity IRR to 25.43 percent. The difference between this and the Equity IRR estimated in the base case scenario (19.25 percent) provides a clear measure of the financial benefits transferred to consumers as result of a lower wholesale tariff.

18. **Case B: DGDC seeking a 12 percent of Equity IRR.** In this second case it is assumed that DGDC is allowed to earn a 12 percent Equity IRR, in line with the target that a private investor would likely seek. This would require DGDC to charge US\$9.342 cents/kWh for geothermal electricity. By keeping the wholesale tariff at US\$7.4 cents/kWh, DGDC is basically transferring 5.82 percent Equity IRR to electricity consumers. Results under both cases are summarized in table 5 and figure 1 below.

Wholesale tariff	Project IRR	Equity IRR
7.4 cents/kWh	2.7%	6.18%
:		
9.342 cents/kWh (Case B)	6.3%	12.00%
10 cents/kWh	7.3%	13.56%
:	:	:
16.5 cents/kWh (Case A)	25.43%	15.8%



D. Sensitivity Analysis

²³ It should be noted that this value used for the cost of diesel-based electricity supply is an historical one and does NOT reflect increases in the international oil prices. These have been significant since the end of December 2016 and are predicted to continue. The economic analysis presents in details fuel price predictions over the lifetime of the Project. As a result, the geothermal tariff that would make indifferent the choice between geothermal- and diesel-based supply should be much higher.



19. A sensitivity analysis has been performed to test the viability of the Project in the face of negative variations of key parameters, such as a drop in the well productivity, capital and operating cost overruns. Any of these changes may lower IRRs below the targets set by the GoCD or DSCR below the level that is typical for Bank-financed power projects. Shall this be the case, the Project would not necessarily face an instance of default but for sure DGDC would be compelled to better control costs and contingencies. The scenarios of the sensitivity analysis are illustrated below.

20. **Decline in well productivity.** Contingent grant finance from CTF provides an insurance against additional resources risks that may arise once operation of the Wotten Waven field begins. In case the productivity of the existing production well declines below an acceptable level and/or the injectivity of the reinjection well does not adequately support power production, funds would be disbursed to finance the drilling of additional (make-up) production and/or reinjection wells. Given the grant nature of this funds, DGDC would not incur capital costs for the additional drilling. O&M costs associate with the additional well(s) would also be marginal. A contingency of this kind may still affect the financial return of the Project as electricity production is reduced at least for a short period. The magnitude of the revenue shortfall would depend on the size of the steam decline and the time needed to complete the contingent drilling and restore productivity. The whole process, from assessing the decline, to completing the procedures for disbursing CTF funds, and finally to drilling, may take up to 2 years. The GoCD has confirmed its commitment to provide cash support to DGDC shall this be needed until the contingent drilling is completed and production is restored.

21. **Construction costs overruns.** Construction costs may escalate above the 15 percent envisaged for physical and price contingencies that has been accounted for in the overall project costs. In this case, the GoCD would be required to increase equity. The table below presents the impacts on the financial ratios of the Project in the face of costs overruns up to 15 percent. In the worst case, the Equity and the Project IRRs would drop to 4.04 percent and 1.8 percent respectively.

Table 6: Results of sensitivity analysis – increased construction costs

	Percentage Change in SGPP Construction Costs						
	+15%	+10%	+5%	0%	-5%	-10%	-15%
Equity IRR	4.04%	4.7%	5.41%	6.18%	7.02%	7.93%	8.94%
Project IRR	1.8%	2.1%	2.4%	2.7%	3%	3.3%	3.7%
Minimum DSCR	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Average DSCR	3.03	3.09	3.14	3.2	3.25	3.31	3.37

22. **O&M costs increased.** A favorable distinction of geothermal power plants is that recurrent O&M costs are significantly lower than those normally associated with thermal power plants as there are no fuel costs. O&M costs are mainly related to depreciation and to operation and maintenance of the turbines; as such they are not expected to vary significantly. A 10 percent increase is assumed as maximum for the sensitivity analysis, which would make the Equity and Project IRRs to decline to 4.89 percent and 2 percent respectively, as presented in the table below. It should be noted that O&M costs assumed for the Project are higher compared to market standards; the effect of any increase is likely to be less severe than what has been estimated here.



Table 7: Results of sensitivity analysis – increased O&M costs					
	Percentage Change in O&M Costs				
	+10%	+5%	0%	-5%	-10%
Equity IRR	4.89%	5.56%	6.18%	6.75%	7.29%
Project IRR	2%	2.4%	2.7%	3%	3.3%
Minimum DSCR	1.01	1.05	1.1	1.15	1.2
Average DSCR	2.94	3.07	3.2	3.32	3.44

23. In conclusion, DGDC is likely to remain financially sound throughout project implementation. The company meets the cash flow standards as envisaged by the Bank. Rate of returns are lower than what is normally expected for electricity projects, but this is only due to the fact that benefits are transferred to consumers, in line with the public interest attached to this Project.

II. ECONOMIC ANALYSIS

A. Project Development Impact

24. The primary economic benefits deriving from the Project, and in particular, from the construction of SGPP, will consist of the savings in power generation as geothermal displaces diesel-based capacity to meet baseload energy needs in Dominica. Supply of more reliable and cost-efficient geothermal electricity will reduce Dominica’s reliance on imported fossil fuels and help stabilize electricity costs. As savings are passed through onto customers, lower electricity prices will make Dominica’s firms more competitive and people less burdened with electricity-related expenditure. The use of indigenous energy resources will reduce Dominica’s dependence on international commodity markets and therefore boost energy security in the country. Also, the development of significant geothermal capacity will drastically change the country’s energy mix, making it greener and more sustainable. The 7 MW of geothermal capacity developed through SGPP alone will take the share of renewable energy from 25 percent to 51 percent. Although Dominica’s emissions footprint is already small, the shift to geothermal energy will reduce CO₂ emissions and contribute to meeting Dominica’s NDCs under the Paris Climate Agreement.

25. The proposed Project will also help Dominica to make an informed decision regarding the further expansion of the geothermal field and the development of LGPP for electricity exports. If the risks associated with LGPP can be systematically reduced – which is a main objective of this Project – to the point that a private developer is secured and LGPP implemented, benefits would be wide and large. Geothermal energy would become a key tradable commodity for Dominica, with the potential to generate considerable export revenues. Benefits would span to the regional level as geothermal power is exported to neighbor islands that, as Dominica, are currently forced to rely on expensive and polluting fossil fuels.

B. Rationale for Public Sector Provision/Financing

26. Government engagement in the Project is justified by the transformational impact of geothermal development in the country and the strategy pursued by the GoCD is appropriate given the inherent risks of geothermal projects in general and the market circumstances in Dominica, especially in the post-



hurricane context.

27. To date, the high risks that are intrinsic to a geothermal project, especially when the industry is at a nascent stage, compounded by the small-scale of Dominica's domestic market and country risks, have discouraged commercial investors, as demonstrated by the GoCD's failed attempts to find a suitable private developer. In 2010, the GoCD issued an international tender to develop the Wotten Waven-Laudat field and, although negotiations were entertained with several qualified developers, it was unable to close a deal. It became apparent that resource and market risks were too high, which moved the GoCD to directly undertake the preliminary exploration and production drilling using grants and concessional borrowing. Nonetheless, SGPP remained less appealing to developers because of its small scale, while there was greater interest in LGPP, if its viability could be established to a greater degree. On the other hand, those developers who showed some interest in SGPP did not necessarily have the capacity to develop the more complex and costly LGPP. Faced with excessive electricity prices and recognizing that SGPP was the only available alternative to reduce and stabilize electricity costs, the GoCD decided to seek the least expensive available funds to invest in the project. As the preliminary exploratory and production drilling program yielded favorable results, the financial risks related to SGPP became manageable.

28. While the GoCD is playing a central role, the scaling-up of geothermal development in Dominica rests on engaging a qualified private partner. Going forward, the GoCD is focused on systematically de-risking the geothermal program before reengaging the market, so as to increase chances to find a viable private partner.

C. Value Added of Bank's Support

29. The World Bank can provide strategic added value in supporting Dominica's geothermal development program, given its global technical experience in the field, its convening capacity and the ability to mobilize low-cost financing. Access to concessional financing is particularly paramount to Dominica. As highlighted by the financial analysis, the combination of grant funds and concessional financing from partners such as DFID, CTF, SIDS DOCK, and the GoNZ, which the World Bank has helped to arrange, is vital to meeting Dominica's development goals.

30. World Bank's experience in the geothermal field includes some of the largest geothermal expansions globally, such as in Indonesia and Kenya, as well as specific attempts at geothermal risk mitigation in Ethiopia, Turkey and Djibouti. Technical assistance provided on an ongoing basis has critically contributed to the current advanced state of investment readiness of Dominica's geothermal program. The Situational/Gap Analysis helped establish benchmarks for the development of Wotten Waven-Laudat field in line with industry and international standards and provided a roadmap that has guided subsequent work carried out by the GoCD. The Analysis covered key areas such as resource assessment, integration of geothermal into the domestic power system, project financing, legal and regulatory aspects, and environmental and social safeguards. World Bank's regional experience has also helped to contextualize its assistance and to create cross-country synergies through engagements in Nicaragua, Chile, and the OECS island of Saint Lucia.

31. Using its global convening capacity, the World Bank has coordinated and worked closely with a number of development partners, taking advantage of their respective expertise. The Situational/Gap



Analysis and associated activities were carried out in coordination with the AfD and the EU, which were supporting the initial investments in drilling and steamfield development. Subsequently, the GoNZ, with which the World Bank is also collaborating in Indonesia, has provided assistance for the upgrading of project feasibility analysis, the preparation of safeguard analysis and project technical design. The World Bank also continues to create opportunities for Dominica (as well as other client countries) to participate in the Global Geothermal Development Plan (GGDP) and the GeoLAC Geothermal Congress, both major industry forums, so the country can gain experience from and contribute to the global dialogue on a range of geothermal development issues.

D. Methodology

32. While the financial analysis has assessed the viability of the proposed Project from the point of view of the developer (DGDC), the economic analysis aggregates and compares benefits and costs from the point of view of the society at large to determine whether the Project improves the overall level of economic welfare.

33. The benefits deriving from the Project are of different kinds, some more quantifiable than others. The analysis is restricted to the project activities that generate benefits for which an economic value can be clearly identified and measured; that is, the construction of SGPP. Other benefits – such as the better-informed decision that the GoCD will be able to make regarding LGPP as result of the TA provided under component 3 – are also very important and should not be neglected. Assuming that LGPP is assessed to be feasible, with a clear roadmap in hand, the GoCD and DGDC will be able to select the best project configuration and the most suitable private developer. Efficiency gains in the form of reduced public spending, higher project sustainability (i.e. safeguard risks minimized and adequately addressed), optimal use of the geothermal resource, etc. will span to the society at large. If electricity produced from LGPP is exported, benefits will also reach neighboring countries. However, such benefits are difficult to quantify, especially considering that LGPP remains theoretical at this stage.

34. Therefore, the economic evaluation focuses on component 1 of the Project. A key benefit that can be quantitatively assessed is the lower cost of electricity supply resulting from displacing diesel-based generation with geothermal-based generation to meet domestic energy needs. Such savings are expected to result into a reduction of the average electricity price charged to end-consumers, earning large economic and social benefits to Dominica's people and firms. The most commonly measured gain is the incremental consumer surplus (CS), which in this case consists of the avoided electricity cost incurred by a consumer on a monthly basis as tariffs are reduced. In reality, households will experience welfare gains in many aspects, including income opportunities, education, health, and general quality of life, that may arise as consumers can spend less on electricity. Also, firms will be able to be more competitive and attract business and investments. In the absence of reliable indicators to measure this multiplier effect on the society and the economy, the analysis only considers cost savings, and therefore provides a conservative estimate of benefits. In addition, a decreasing use of diesel for electricity production will reduce government expenditures on fuel subsidies, liberating resources that can be allocated to alternative investments on public goods.

35. Other benefits that can be assessed in quantitative terms are the positive externalities associated with switching from diesel-based to geothermal-based energy; that is, benefits originating by the



reduction of GHG emissions in Dominica.

36. Project costs comprise all costs associated with the construction and operation of SGPP and above ground infrastructure, including investments and operation and maintenance costs. Investments costs include the value of existing assets transferred from the GoCD to DGDC. Detailed information on costs and disbursement assumptions can be found in the financial analysis (see previous section). Both benefits and costs are estimated in economic terms at constant 2017 prices. The analysis is built over a period of twenty-five years, in line with the lifetime of a geothermal power plant, and uses a discount rate of 10%. Benefits are assumed to become effective the year following completion of investments (2020).

E. Economic Evaluation

Electricity tariff reduction

37. As highlighted in the financial analysis, in Dominica the retail energy tariff has two components: (i) a fix component, which reflects fixed costs incurred by DOMLEC and therefore is a function of the assets owned by the utility; and (ii) a variable fuel surcharge, which reflects the cost of diesel fuel used for electricity production. Specifically, the fuel surcharge is calculated using the following formula:

$$(a) \text{ Fuel Surcharge} = (\text{Fuel Used} \times \text{Price of Diesel}) / \text{Total Energy Produced}$$

with:

$$(b) \text{ Price of Diesel} = \text{Average Price of Diesel}^* \times 0.975^{**} - \text{Base Price}^{**}$$

* International oil prices

**0.975 coefficient and the Base Price altogether reflecting the fuel subsidy allowed by the GoCD

38. Both the fuel surcharge and the fixed component are likely to be reduced as result of the Project. However, while the fuel surcharge reduction is immediate and can be easily measured, the reduction of the fix component will depend, among the other things, on DOMLEC's choices concerning retirement of diesel assets that are no longer operated. As such choices cannot be predicted at this time, the analysis only considers diesel fuel costs avoided by DOMLEC as the utility start purchasing geothermal electricity from DGDC. As a result, the impact of the Project on the retail tariff – and therefore the economic benefits – are potentially higher than what is being estimated here. As it can be seen, the price of diesel is subsidized (part (b) of the formula above), and the overall spending on fuel subsidy will also decrease as result of the Project.

39. The analysis compares a “without project” scenario, where the energy mix remains unchanged, with a “with project” scenario, where the variable component of the tariff and the overall fuel subsidy expenditure are reduced overtime as geothermal generation enters into the energy mix. Specifically, in the “with project” scenario, the geothermal electricity produced under the Project reduces supply from diesel generation. In this case, the fuel surcharge includes two components: (i) the geothermal tariff negotiated under the PPA (assumed to be US\$7.4 cents/kWh, much lower of the unit diesel fuel cost), applied to the amount of electricity that DGDC sells to DOMLEC on a yearly basis; and (ii) the charge reflecting diesel fuel costs passed through onto customers. Such a charge decreases overtime as less fuel is imported and so does the overall spending on fuel subsidies. In the “without project” scenario, the fuel



surcharge is as represented above and fluctuates as international oil prices change. Subsidies also change accordingly.

40. The starting price of diesel (as of May 2018) is derived from the statistics of the U.S. Energy Information Administration - EIA (International Petroleum and Other Liquids Supply price). In the analysis, this price is assumed to increase by 20 percent in 2020; by an additional 20 percent in 2025; and by an additional 10 percent in 2030. This can be considered a conservative approach; forecasts made by other agencies predict much higher oil prices overtime. EIA itself reports higher trends (as used for sensitivity analysis). Also, the Organization for Economic Cooperation and Development (OECD) forecasts that the price of Brent oil could reach as high as USD\$270/barrel by 2020. This is based on skyrocketing demand from China and other emerging markets and prices this high seem unlikely now that shale oil has become available. Nonetheless, oil prices are generally expected to increase above what is being assumed here.

41. It is assumed that electricity demand will return to pre-hurricane levels in 2020 and from then on increase by a 2.5 percent annually. This predicted load growth is pretty conservative, as economic recovery and new tourism development in the North of the island are expected to increase energy needs significantly in the medium term. Nonetheless, power system recovery is ongoing and DOMLEC estimates that all customers will be reconnected in one-year time. There are uncertainties concerning demand in the immediate future as many residents have left the country and it is not clear whether and when they will return. In addition, it will take a while until the economy can fully recover and the speed and extent of the recovery critically depends on the capacity of the GoCD to complete reconstruction and of the private sector to access investments funding. To account for this uncertainty, similarly to the financial analysis, the economic evaluation assumes an initial load factor of SGPP of 75 percent, increasing gradually over the life of the Project.

42. **Results.** Based on the assumptions and the methodology described above, the Project is assessed to generate a **net present value (NPV) of US\$8.5 million** and an **economic internal rate of return (EIRR) of 12.6 percent** (table 8). Such results do not take into account positive environmental externalities (as discussed in the next section). Overall benefits resulting from the Project have a NPV of US\$72.5 million. Savings accruing to electricity consumers over the life of the Project as retail prices are reduced have a NPV of US\$51.1 million, and reduced spending on subsidy of US\$21.5 million. These are significant results, which attest the large benefits accruing to Dominica.

Table 8: Economic analysis results – Cost savings only		
	NPV	EIRR
Total Net Benefits (benefits minus costs)	US\$8.5 mil.	12.6%
Benefits to electricity consumers (reduced retail prices)	<i>US\$51.1</i>	
Reduced subsidies	<i>US\$21.5</i>	
Total benefits to Dominica	<i>US\$72.6</i>	

43. **Sensitivity analysis.** The EIRR and NPV estimated above do not take into account for contingencies that may raise the EPC cost. Shall this increase by 15 percent, as predicted in the financial analysis, the NPV would be US\$5.1 million and the EIRR 11.5 percent.

44. Sensitivity analysis has been conducted to account for different diesel cost trends, since benefits



are larger (or smaller) as diesel fuel prices increase (or decrease). Specifically, two scenarios have been considered (table 9): (1) cost of diesel remaining unchanged at the 2018 level; (2) cost of diesel raised by 32 percent by 2020; by an additional 22 percent by 2025; and by an additional 8 percent by 2030. Scenario 2 reflects oil price trends as predicted by EIA.

	2020	2025	2030
<i>Base case</i>	20%	20%	10%
Scenario 1	2018 price	2018 price	2018 price
Scenario 2	32%	22%	8%

45. Under scenario 1, which is only theoretical as international fuel prices are bound to increase, the EIRR would fall below the hurdle rate of 10 percent and the NPV would become negative (table 10). Under scenario 2, the EIRR would reach 15.1 percent and the NPV US\$18.05 million.

	NPV	EIRR
<i>Base case</i>	US\$8.5 mil.	12.6%
Scenario 1	(US\$15.7 mil.)	2.7%
Scenario 2	US\$18.05	15.1%

46. Additional sensitivity analysis has been conducted to test the viability of the Project in the face of contingencies that may affect the operability of SGPP and require additional drilling. This would cause the activation of the contingency finance facility established under component 2. While funds would be disbursed to DGDC as a grant and therefore are not considered in the financial analysis, they do represent a cost contingency from the point of view of the economic analysis. It is assumed that disbursements would be made in equal installments of US\$3 million each (for a total of US\$9 million) early on as SGPP is commissioned, namely on the third, fourth and fifth year of its operation. In this case, the NPV and the EIRR are estimated to drop to US\$3.9 million and 11.1 percent respectively and the Project would still remain viable.

Global Externalities

47. The second component of the economic analysis focuses on the global benefits deriving from CO₂ emissions reductions (as estimated in detail in annex 3). Specifically, the displacement of 7 MW of diesel-based generation capacity with geothermal-based capacity has been projected to earn emission savings in the range of 38,223 tons of CO₂ per year or a total of tons of CO₂ over 25-year project lifetime. The associated economic benefits are calculated using the shadow price of carbon, as estimated by the World Bank²⁴. Specifically, the analysis considers a shadow price ranging from US\$40 to US\$80/tons of CO₂ in light of the uncertainty surrounding the carbon value that is consistent with the Paris Agreement. This is due to the unpredictability of future socioeconomic and technological trends, which impact the price attributable to carbon. Also, the shadow price varies significantly depending on the country context. The NPV of economic benefits associated with CO₂ emissions reduction along a 25-year period and using a discount rate of 10 percent is in the range of US\$159-318 million.

²⁴ World Bank, 2017. Guidance Note on Shadow Price of Carbon in Economic Analysis.



48. **Summary.** Table 11 consolidates net benefits under each component of the economic analysis. Overall, in the base case scenario the Project is assessed to have a NPV of US\$136.4 million and an EIRR of 38.0 percent, assuming a carbon price of US\$40 tons of CO₂. NPV and EIRR increase to US\$267.6 million and 58.9% respectively if a carbon price of US\$80/tons is assumed. The Project remains firmly viable even if the international price of diesel will not change overtime, which would reduce the cost savings associated with the use of geothermal electricity.

Table 11: Summary of economic analysis

	<i>Base case</i>		Scenario 1		Scenario 2	
Carbon price = US\$40/tons CO ₂	NPV (US\$ ml.)	136.4	NPV (US\$ ml.)	112.2	NPV (US\$ ml.)	145.9
	EIRR (%)	38.0	EIRR (%)	34.7	EIRR (%)	39.6
Carbon price = US\$80/tons CO ₂	NPV (US\$ ml.)	267.5	NPV (US\$ ml.)	243.3	NPV (US\$ ml.)	277.0
	EIRR (%)	58.9	EIRR (%)	56.4	EIRR (%)	60.2