GUYANA UTILITY SCALE SOLAR PHOTOVOLTAIC PROGRAM (GUYSOL)

- Project Concept Note

ABSTRACT

Key Engineering Specifications and Project Implementation details for the Essequibo Coast, Berbice, and Linden Solar PV Projects

Engineering Services Division, GPL

TABLE OF CONTENTS

1 Rationale 3
1.1 Background 3
1.1.1 GPL and LECI 4
1.2 Motivation: Opportunity/Problem Statement 4
1.3 Approach 5
2 Program Objective and Description 6
2.1 Objective 6
2.2 Program Components 6
2.3 Description of Projects 6
2.3.1 Linden PV Project 6
2.3.2 Essequibo Coast PV Project 7
2.3.3 Berbice PV Project 8
2.4 Verifiable Performance Indicators 9
2.5 Outputs and Outcomes 9
2.5.1 Project Outputs 9
2.5.2 Project Outcomes 9
3 Financial Information 10
4 Annex I – Project Sites 12
4.1 Site Acquisition Methodology 12
4.2 Final Project Sites 15
4.2.1 Linden Locations 15
4.2.2 Berbice Locations 24
4.2.3 Essequibo Coast Locations 33
5 ANNEX II - Project Implementation SchedulE 39

LIST OF FIGURES

Figure 2.1 - RE Share for Linden Project 7
Figure 2.2 - Projected Savings for Linden Project 7
Figure 2.3 - Linden Average Generation Mix 2022 7
Figure 2.4 - Linden Average Generation Mix 2023 7
Figure 2.5 - RE Share for Essequibo Coast Project 8
Figure 2.6 - Projected Savings for Essequibo Coast Project 8
Figure 2.7 - Essequibo Coast Average Generation Mix 2022 8
Figure 2.8 - Essequibo Coast Average Generation Mix 2023 8
Figure 2.9 - DBIS Average Generation Mix 2023 8
Figure 4.1 - GHI across Guyana 12
Figure 4.2 - Location in Retrieve, Region 10 (25 acres) 15
Figure 4.3 – Photo of Retrieve Site 16
Figure 4.4 - Proposed interconnection of the Retrieve Farm 17
Figure 4.5 - Location in Block 37, Region 10 (35 acres) 18
Figure 4.6 - Photo of Block 37 Site 19
Figure 4.7 - Proposed interconnection of the Block 37 Farm 20

Figure 4.8 - Location in Dacoura, Region 10 (10 acres) 21
Figure 4.9 - Photo of Dacoura Site 22
Figure 4.10 - Proposed interconnection of the Dacoura Farm 23
Figure 4.11 – Location in Pln. Prospect, East Canje Berbice, Region 6 (50 acres) 24
Figure 4.12 - Picture of Prospect Site 25
Figure 4.13 - Proposed interconnection of the Prospect Farm 26
Figure 4.14 - Location in Hampshire, Corentyne, Berbice, Region 6 (15 acres) 27
Figure 4.15 - Picture of Hampshire Site 28
Figure 4.16 - Proposed interconnection of the Hampshire Farm 29
Figure 4.17 - Location in Onverwagt, West Coast Berbice, Region 5 (30 acres) 30
Figure 4.18 - Picture of Trafalgar Site 31
Figure 4.19 - Proposed interconnection of the Trafalgar Farm 32
Figure 4.20 - Location in Lima Sands, Essequibo, Region 2 (10 acres) 33
Figure 4.21 - Picture of Lima Sands Site 34
Figure 4.22 - Proposed interconnection of the Lima Sands Farm 35
Figure 4.23 - Location in Onderneeming, Essequibo, Region 2 (15 acres) 36
Figure 4.24 - Picture of Onderneeming Site 37
Figure 4.25 - Proposed interconnection of the Onderneeming Farm 38
Figure 5.1 - Proposed Project Implementation Schedule 39

LIST OF TABLES

Table 3.1 - Summary of Estimated Project Costs 10
Table 3.2 - Detailed Estimated Project Costs 10
Table 3.3 – Key Economic Indicators of the Project 11
Table 5.1 - Determination of Final Project Sites 14

1 RATIONALE

1.1 Background

The Cooperative Republic of Guyana, as is the case of all Small Island Developing States (SIDS), face a myriad of socio-economic issues such as poverty and food security, climate change and environmental vulnerabilities which are often magnified given their (SIDS's) small economies and landmasses. Despite being minuscule contributors to greenhouse gases, SIDS, are already feeling the impacts of climate change. Coastal erosion, ocean acidification, and more intense and frequent storms and floods are having compounding negative impacts on agriculture, coastal and human settlements, health, and tourism sectors.

Challenges faced by SIDS related to extreme events such as hurricanes and heavy rains are exacerbated by the lack of resource capacity, high reliance on imports and limited financing to effectively implement management strategies for post-disaster activities and disaster risk reduction. Increasing vulnerability to external shocks and natural disasters creates economic and social pressures that compromise SIDS's ability to adopt a blue-green economy and achieve the Sustainable Development Goals (SDGs).

Parties at the 19th Conference of the Parties (COP19) to the UNFCCC in Warsaw in 2014 called upon each member state, regardless of its development status, to prepare its Intended Nationally Determined Contribution (NDC) to greenhouse gas (GHG) emissions reduction for the post-2020 period by the end of the first quarter of 2015.

The NDCs were viewed as the actions and targets that countries have signaled they will undertake to help keep global temperature rise below 2 degrees Celsius. They are expected to provide clear, quantifiable goals, such as the period of implementation, scope and coverage, in order to facilitate understanding and transparency. They are also expected to be ambitious in terms of their potential and capacity to achieve the commitments.

Guyana, as a conditional contribution in their NDC, committed to eliminating its near complete dependence on fossil fuels. It outlined its goal to *"develop a mix of wind, solar, biomass and hydropower to supply both the demand of the national grid and the energy requirements for towns and villages in Guyana's hinterland."*. These commitments were anchored in the Government's recognition of the impacts climate change can have on Guyana's developing economy. It is this recognition, and the Guyana's commitment to contribution to the mitigation of climate change, that lead to the development of the Guyana Low Carbon Development Strategy (LCDS). The LCDS acknowledged Guyana's expanding development and set up mechanisms to allow this development to be done on a low-emission pathway. The Strategy recognizes the need for Guyana to switch from nearly 100% dependence on fossil fuel-based electricity to clean, renewable energy supplies.

Globally, renewable energy costs, particularly solar and battery storage, have dropped significantly over the past five (5) years. Solar PV has become commercially dominant as the new source of renewable energy generation in energy markets worldwide[1]. From 2000 to 2016, energy production from solar PV has grown from nearly zero to over 300 terawatt-hours (TWh) globally. In addition, battery storage, which "firms" intermittent generation and alleviates transmission and distribution constraints, has realized cost declines of more than 60% over the past five (5) years[2] and is being installed and operated by utilities across CARICOM to save fuel, incorporate more renewable capacity and strengthen the grid[3].

[1] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Mar/RE_capacity_highlights_2018.pdf?la=en&hash=21795787DA9BB41A32D2FF3A9C0702C43857B39C

[2] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Electricity_Storage_Costs_2017_Summary.pdf?la=en&hash=2FDC44939920F8D2BA29CB762C607BC9E882D4E9

[3] https://renewableenergycaribbean.com/category/energy-storage/

1.1.1 GPL and LECI

The Guyana Power and Light Inc. (GPL) is a vertically integrated state-owned public utility that generates electricity in most of Guyana along the coast. GPL operates several grids, the Essequibo Coast Isolated System which covers Region 2, the Bartica Isolated System which covers portions of Region 7, the Wakenaam Isolated System and the Leguan Isolated System which covers the Islands of Wakenaam and Leguan in the Essequibo River respectively, and the Demerara-Berbice Interconnected System (DBIS) which is the largest grid (accounting for some 95% of GPL's total demand) and covers Regions 3, 4, 5 and 6. The total available capacity of the DBIS is approximately 204.1 Megawatts (MW) of which 57.6 MW are considered to be aged since they have been in operation for over 24 years. Similarly, the Essequibo Coast Isolated System has 12MW of installed capacity, but 7.2MW are considered unreliable due to them being aged high-speed mobile diesel generators. All of GPL's Power Plants utilize fossil fuels. At the end of 2020 GPL's customer base for all areas of operation encompassed 205,814 customers. Specifically, GPL has approximately 48,650 customers in Berbice and approximately 9,700 on the Essequibo Coast.

Outside of GPL's current coverage area, there are several smaller mini- and micro-grids that serve isolated communities in the Hinterland areas of Guyana. These grids are run by subsidiaries of the state-owned Hinterland Electrification Company Inc. (HECI). Of these subsidiaries, the Linden Electricity Company Inc. (LECI) operates the Linden Isolated System which supplies electricity to the bauxite mining town of Linden. LECI does not have any generation assets and purchases electricity from Bosai Minerals Group, who runs the Bauxite Mining Plant, via a Power Purchase Agreement expires at the end of 2021. LECI supplies customers on the eastern side of the Demerara River, and sells electricity to the Linden Utility Service Co-operative Society Limited (LUSCSL) which supplies customers on the western side of the Demerara River. At the end of 2018, the Linden Isolated Systems served 10,664 customers with LECI having 5,292 customers while LUSCSL has 5,372.

Bosai has a power plant that consists of six (6) 3MW diesel generators which are used to supply their own energy needs as well as the town. LECI purchases electricity from Bosai at a rate of GY$45/kWh (which is close to Bosai's cost of generation) and retails the electricity to residential customers at GY$5/kWh and business customers at GY$12/kWh while pensioners are allowed up to 300kWh a month for free. LECI sells electricity to LUSCSL at a rate of GY$1/kWh.

1.2 Motivation: Opportunity/Problem Statement

At the end of 2020, the Guyana Power and Light's (GPL) overall annual fuel consumption stands at approximately 1.07 million barrels of Heavy Fuel Oil (HFO) and 169.6 thousand barrels of Light Fuel Oil (LFO) at a total cost of US$74.8 million. This constitutes the most expensive element of the electricity production cost, amounting to 1.3% of the country's Gross Domestic Product (GDP)[4] and approximately 36% of overall Carbon Dioxide (CO_2) emissions.

Given the vast difference between the purchasing and selling price of electricity, LECI's operations are heavily subsidized by the government. In 2018, the Government's subsidy was calculated to be in excess of US$10M. Attempts to increase the Tariff in Linden to reduce the level of Government subsidy were met with unrest and protests by residents. Additionally, Bosai only utilizes approximately 30% of the generation from the power plant and utilizes high speed diesel generators that are aging. LECI's contract with Bosai mandates partial payments from LECI for repairs needed at the power plant.

As such, the DBIS, Essequibo Coast Isolated System, and the Linden Isolated System are all practically 100% dependent on imported HFO and diesel[5]. The lack of diversity in the power supply results in high generation costs which is further negatively impacted by the use of aging high-speed generators since these only serve to increase the cost of maintenance of the systems. Additionally, this dependency on imported fuel will continue to expose the already high generation costs to volatility of fuel prices on the world market and result in a carbon intensive electricity sector.

[4] 2020 Gross Domestic Product was US$ 5.7 billion. https://www.imf.org/en/Publications/WEO

[5] Approximately 4-5MW of roof-top, grid-ted solar PV has been installed in GPL's Grids (DBIS, Essequibo Coast, Etc) and 200-250kWp in Linden's grid. Also there is a 30MW biomass facility at the public sugar company in the DBIS, but this plant is not operational.

Therefore, a strategy based on increased use of renewable energy generation is of utmost priority to improve system reliability as well as to reduce the carbon intensive nature of the GPL and LECI grids as it will lead to significant reduction in the use of fossil fuels. Further, the use of indigenous resources will see an increased resiliency of the utilities since they would be partially shielded from the volatility of the global fuel market. The diversification of the energy generation matrix of these grids will result in operational (fuel and lubricants) and maintenance cost savings for GPL and a significant reduction in Government subsidy for LECI. This transition to solar energy for the production of electricity will therefore contribute to funding for system upgrades, including automatic generation control, improving overall system reliability and the resilience of GPL's and LECI's Transmission and Distribution network. Renewed access to revenues originally dedicated to fuel and subsidies would also aid in the repayment of debts. This will allow GPL and LECI to provide increased value to its customers through more reliable and affordable electricity service in Guyana. Further, while it is not expected that these projects will result in a direct reduction in Tariffs in GPL's Systems, the reduced impact of the volatility of the world fuel market on the Tariff Structures of the Utilities will directly result in an increased level of stability of these Tariff Structures which would be a transferred benefit to the customers. Additionally, given the already low tariffs in Linden that result in large government subsidies to LECI, it is expected that the magnitude of these subsidies be significantly reduced.

1.3 Approach

Historically, financing of GPL's and LECI's grid and generation assets from the National Budget, loans from multilateral or development banks, or from the utility's own revenue generation. The Guyana REDD+ Investment Fund (GRIF) funds are available and in alignment with the position of the Government of Guyana to use the sum of US$81.9M for utility scale solar PV projects. As such, 33MWp of Solar PV with a minimum of 23MWh of Battery Storage have been identified for execution utilizing the funds in question. These projects are as follows:

- 15MWp of Solar PV with a minimum of 15MWh (1h) of Battery Storage for the Linden Isolated System,
- 8MWp of Solar PV with a minimum of 8MWh (1h) of Battery Storage for the Essequibo Coast Isolated System, and
- 10MWp of Solar PV for the Demerara-Berbice Interconnected System, specifically in Berbice.

These projects will provide a cost effective first step to transition to cheaper, greener generation that is consistent with what is being done by other Caribbean utilities and in line with the objectives of the LCDS. Furthermore, the project will act as a catalyst to further renewable energy investments, increased renewable energy penetration, lower carbon emissions, improved grid stability and a reduction in Government subsidies for the utilities. To enable the successful completion of these projects the following de-risking work will be undertaken before the project tender:

- Electrical Interconnection Assessment for each project interconnection;
- Battery Optimization Assessment to determine optimized battery capacities and use cases for the Linden and Essequibo Coast PV Projects;
- Topographical Surveys, and Geotechnical and Flood-Risk Assessments for each project site; and
- Environmental and Social Assessment (ESA) for a representative sample of the project sites; an Environmental and Social Management Plan (EMP) for the representative sample; and an Environmental and Social Management Framework (ESMF) for the full project.

Additionally, given the split of the load where the Linden Community's load is the major part of the load in the Grid, the current Power Purchase Arrangements in Linden would have to be thoroughly reviewed in order to ensure it is accommodative of the proposed changes in the operational aspects of the grid. Given the high level of penetration of the Solar PV farms, the possibility of Bosai buying power from LECI will have to be explored

2 PROGRAM OBJECTIVE AND DESCRIPTION

2.1 Objective

The execution of the projects that are a part of this Program will support Guyana's transition to the use of near-100% renewable energy sources and the diversification of the energy supply matrix via the use of cleaner and renewable energy sources in the electricity generation mix. Specifically, this program seeks to (i) reduce CO2 emissions; (ii) lower the cost of electricity generation while supporting the country's transition towards renewable energy-based generation.

Also, via the implementation of an associated Technical Cooperation (TC) Program[6], there will be critical capacity building activities executed that will see the capacities of Government utilities and agencies to plan, develop, implement and operate intermittent renewable energy systems being improved.

2.2 Program Components

The Program consist of two main components:

- Component 1: Solar PV Solutions in the Energy Matrix – this component will cover the investment in the 33MWp solar PV projects and associated energy storage systems as detailed in Section 2.3 and the technical de-risking activities outlined in Section 1.3. Additionally, the component will seek to encourage the participation of women in the operation and maintenance of these the solar PV facilities through targeted technical trainings and partnerships with local vocational training institutions.
- Component 2: Operation efficiency and reliability of the systems – this component will cover the investments required in the isolated systems of Linden and the Essequibo Coast to promote remote operation and digitization to improve system stability and resiliency.

The Program is expected to also finance the required project management costs, audits, and monitoring and evaluation of the project.

2.3 Description of Projects

The following projects are proposed for completion under the program over the next two (2) years:

- 15MWp of Solar PV with a minimum of 15MWh (1h) of Battery Storage for the Linden Isolated System,
- 8MWp of Solar PV with a minimum of 8MWh (1h) of Battery Storage for the Essequibo Coast Isolated System, and
- 10MWp of Solar PV for the Demerara-Berbice Interconnected System, specifically in Berbice.

The project sites are given in Annex I – Project Sites

2.3.1 Linden PV Project

The Linden Project will consist of three (3) 5MWp farms specifically at Block 37 (in the vicinity of Bamia on the Linden-Soesdyke Highway), Retrieve on the eastern side of the Demerara River, and Dacoura on the western side of the Demerara River. In addition, given the high level of penetration, the farms will be supported by a 15MW, 1hr

[6] The Technical Cooperation Program will see support being given towards the preparation and implementation of the larger Program.

(minimum) BESS for stability support to the grid. The Block 37 Farm will interconnect to the Amelia's Ward 13.8kV Load Feeder, the Dacoura Farm will interconnect to the Wismar 13.8kV Feeder, and the Retrieve Farm will interconnect directly to the 13.8kV Substation in the vicinity of Retrieve. Given the current and projected load in the Linden Community, the project will initially satisfy approximately 38% of the demand with an average annual generation of 24.03GWh resulting in approximately US$5.47M in savings from Government subsidies. Assuming a Grid Emission Factor of 0.854 tCO2/MWh, an estimated 20,752 tCO2 projected to be saved annually. It should also be noted, that since the Community's load is the major portion of the load in the system, the possibility of Bosai buying power from LECI during solar hours is not unlikely.

However, without further expansion of the solar farms, as the load grows the level of penetration will decrease. Likewise, the annual savings of purchases from Bosai would follow the same trend. These are shown in the figures below:

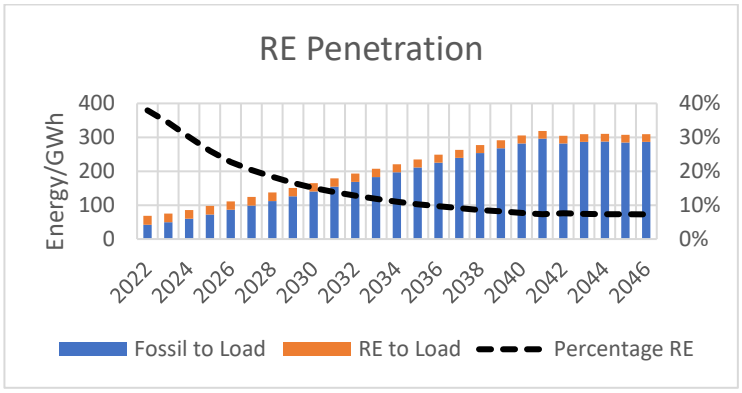

Figure 2.1 - RE Share for Linden Project

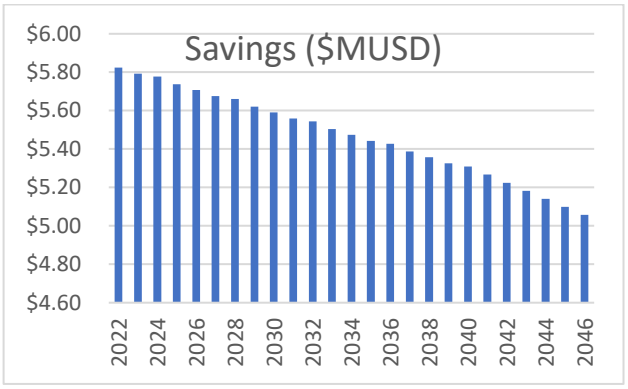

Figure 2.2 - Projected Savings for Linden Project

Also, considering the load to be supplied, the average generation mix for two sample years are given below.

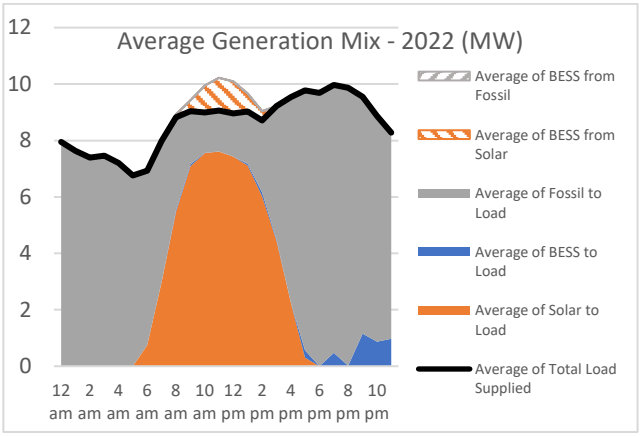

Figure 2.3 - Linden Average Generation Mix 2022

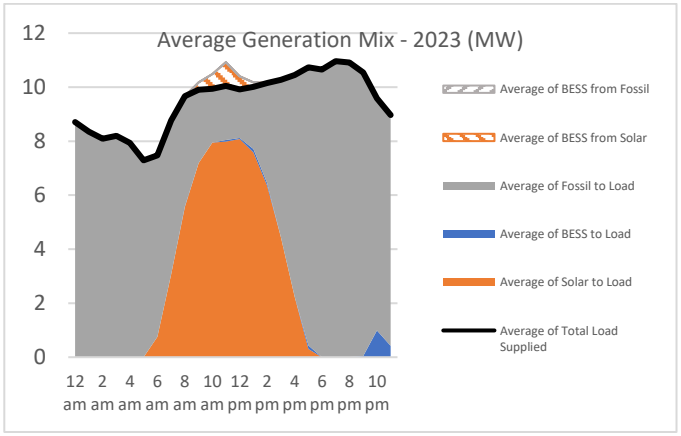

Figure 2.4 - Linden Average Generation Mix 2023

2.3.2 Essequibo Coast PV Project

The Essequibo Coast project will consist of two (2) farms specifically 4.4MWp at Ondereeming and 3.6MWp Lima Sands. In addition, given the high level of penetration, the farms will be supported by an 8MW, 1hr (minimum) BESS for stability support on the grid. The Onderneeming Farm will interconnect to the South 13.8kV Feeder, while the Lima Sands Farm will interconnect to the North 13.8kV Feeder. Given the current and projected load on the Essequibo Coast, the project will initially satisfy approximately 28% of the demand with an average annual generation of 12.21GWh resulting in approximately US$2.11M in savings from displaced fossil fuel generation and from not having to use fossil fuel generation as spinning reserve. Using the Grid Emission Factor of the Essequibo Coast of 0.76 tCO2/MWh, an estimated 9,278 tCO2 projected to be saved annually. Without further increases in the size of the farms, the level of penetration and savings given the load growth are shown in the figures below.

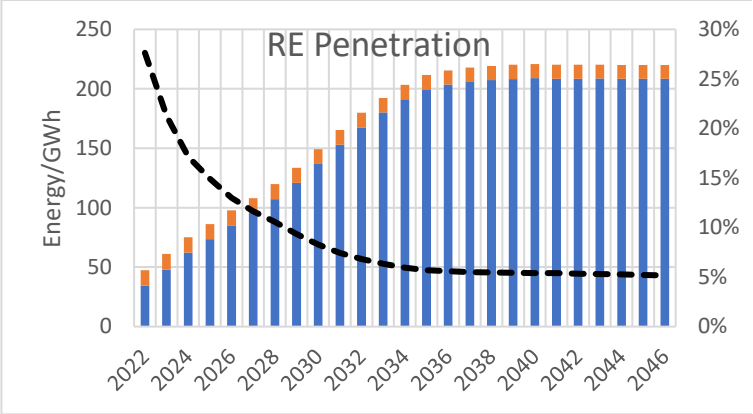

Figure 2.5 - RE Share for Essequibo Coast Project

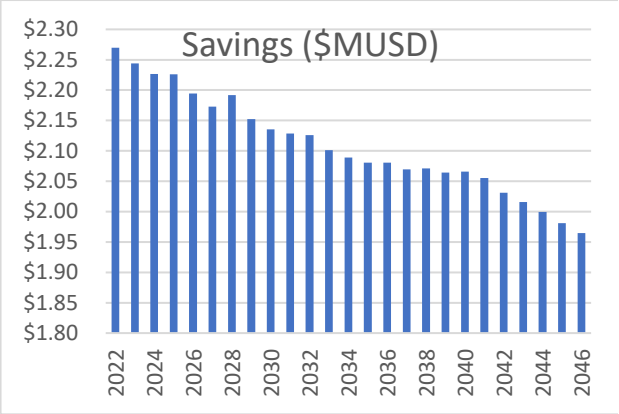

Figure 2.6 - Projected Savings for Essequibo Coast Project

Also, considering the load to be supplied, the average generation mix for two sample years are given below.

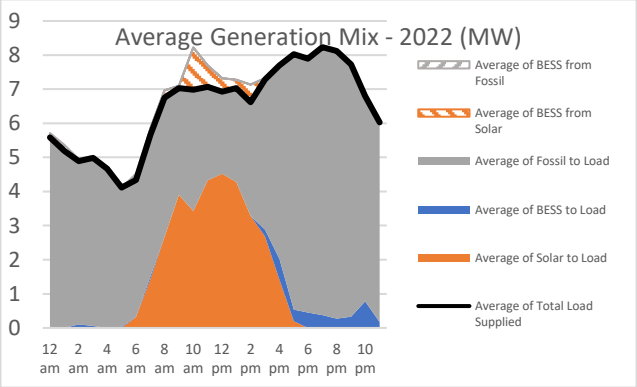

Figure 2.7 - Essequibo Coast Average Generation Mix 2022

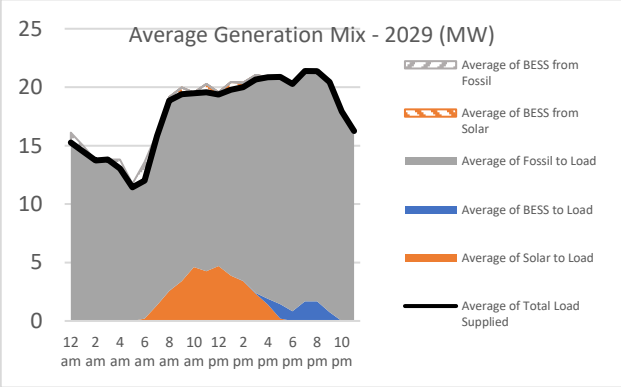

Figure 2.8 - Essequibo Coast Average Generation Mix 2023

2.3.3 Berbice PV Project

In Berbice, three (3) farms will be built. 4MWp at Trafalgar on the West Coast of Berbice; 2MWp at Prospect on the East Coast of Berbice; and 4MWp at Hampshire in Corentyne, Berbice. The Trafalgar and Prospect farms will interconnect via an express 13.8kV line to the 13.8kV busbar at the Onverwagt and Canefield substations respectively. The Hampshire farm will interconnect to the Canfield F3 13.8kV Feeder. Ultimately, the farms will be a part of the DBIS and will only satisfy a very small portion of the demand of the DBIS. However, the distributed nature of the project will serve to support the distribution network and reduce losses by supplying power closer to the load. The farms will generate approximately 16.78GWh annually. This will result in approximately US$1.53M in savings from displaced fossil fuel generation. With the DBIS's Grid Emission Factor of 0.661 tCO2/MWh, a total of 11,089 tCO2 will be reduced. The average generation mix for 2023 is given below.

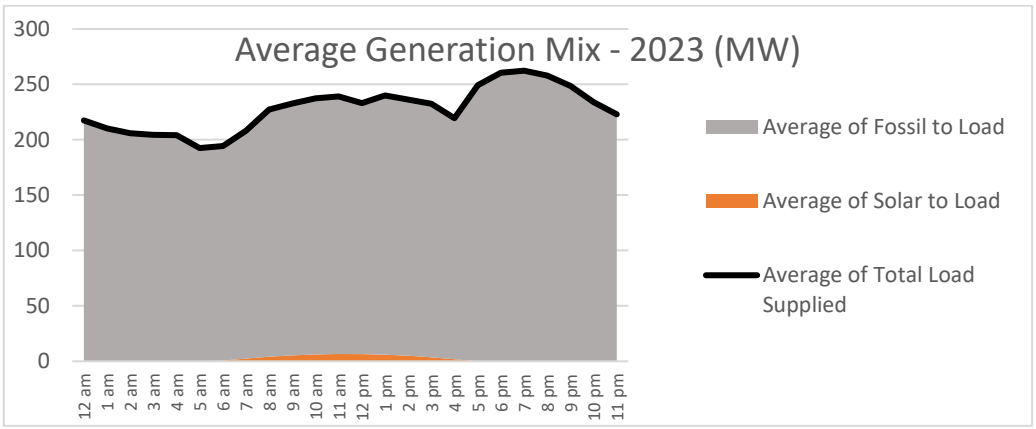

Figure 2.9 - DBIS Average Generation Mix 2023

2.4 Verifiable Performance Indicators

The following Verifiable Performance Indicators are proposed for the 33MWp Solar Project:

1. Percentage of Renewable Energy in the Energy Supply Matrix of the DBIS, Essequibo Coast Isolated System, and Linden Isolated System.
2. Total of tCO2 emissions avoided.
3. Reduction in Cost of Generation for GPL and LECI.
4. Liters of fossil fuel not used annually.
5. USD saved from avoided fossil fuel purchases annually in the DBIS and Essequibo Coast Isolated System.
6. USD of subsidies saved from reduced expensive energy purchases for the Linden Isolated System.
7. Number of substations upgraded with Energy Management Systems/Geographic Information Systems/Remote Control Systems.
8. Number of women's groups empowered via active production activities.

It should be noted that these indicators will be refined upon the completion of the Cost Benefit Analysis and Gender and Social Analysis during the project preparation activities being funded by the TC.

2.5 Outputs and Outcomes

2.5.1 Project Outputs

The following Outputs are all deliverables of the 33MWp Utility Scale Solar PV Project:

1. 33MWp of Solar PV Farms installed.
2. At least 33MW, 33MWh of Battery Energy Storage Systems installed.
3. Reduction in the consumption of fossil fuel for electricity generation.
4. Savings from reduced fossil fuel purchases in the DBIS and Essequibo Coast Isolated System.
5. Reduction in Government Subsidies for Energy Purchases in Linden.
6. Upgrades to Substations with Energy Management Systems/Geographic Information Systems/Remote Control Systems.
7. Empowerment of Women's Groups via active production activities.

2.5.2 Project Outcomes

The following Outcomes will be recognizable changes because of the 33MWp Utility Scale Solar PV Project:

1. The reduction and avoidance of CO2 emissions in electricity generation via the diversification of the energy supply matrix with the introduction of renewable energy-based sources of energy (specifically solar PV).
2. The reduction in generation costs at two state-owned utilities via:
    a. the reduction of the financial burden of fuel purchases at GPL for the DBIS and Essequibo Coast Isolated Systems
    b. the reduction of the financial burden of expensive energy purchases at LECI for the Linden Isolated System.

3 FINANCIAL INFORMATION

The total estimated cost for the project is US$81.9M as follows:

Item	Costs ($US)
Solar PV Farms	$46,200,000.00
BESS	$15,640,000.00
Site Development	$8,863,500.00
13.8kV Interconnecting Lines	$4,290,000.00
Capital Works Sub-Total	$74,993,500.00
Soft Costs	$1,499,870.00
Contingency	$5,406,630.00
Total	**$81,900,000.00**

Table 3.1 - Summary of Estimated Project Costs

It should be noted that all site development costs are subject to being reviewed after geotechnical assessments are completed for each project site. Also, the estimates for the interconnecting lines provide for concrete poles to be used. The soft costs budgeted for would cover project development and project management related costs, and public awareness activities.

The following detailed costs are projected[7]:

Item	Quantity		Unit Cost (US$)		Final Cost (US$)
Linden PV Project					
Solar PV Farm	15	MWp	1,400,000.00	/MWp	$21,000,000.00
BESS	15	MWh	680,000.00	/MWh	$10,200,000.00
Site Development	75	acres	46,900.00	/Acre	$3,517,500.00
13.8kV Interconnecting Lines	15	km	78,000.00	/km	$1,170,000.00
Capital Works Sub-Total					$35,887,500.00
Soft Costs				2%	$717,750.00
Contingency				7%	$2,587,297.00
Total					$39,192,547.00
Essequibo Coast PV Project					
Solar PV Farm	8	MWp	1,400,000.00	/MWp	$11,200,000.00
BESS	8	MWh	680,000.00	/MWh	$5,440,000.00
Site Development	40	acres	59,900.00	/Acre	$2,396,000.00
13.8kV Interconnecting Lines	20	km	78,000.00	/km	$1,560,000.00
Capital Works Sub-Total					$20,596,000.00
Soft Costs				2%	$411,920.00
Contingency				7%	$1,484,861.00
Total					**$22,492,781.00**
Berbice PV Project					
Solar PV Farm	10	MWp	1,400,000.00	/MWp	$14,000,000.00
Site Development	50	acres	59,000.00	/Acre	$2,950,000.00
13.8kV Interconnecting Lines	20	km	78,000.00	/km	$1,560,000.00
Capital Works Sub-Total					$18,510,000.00
Soft Costs				2%	$370,200.00
Contingency				7%	$1,334,472.00
Total					**$20,214,672.00**

Table 3.2 - Detailed Estimated Project Costs

[7] Per-unit estimated costs for PV and BESS are based on estimates considering projections and databases on costs from NREL, IRENA, and the Asian Development Bank. Site development costs are based on initial estimates based on rates on the Guyanese Market. Interconnecting Line Costs are based on estimates for linework using Cosmos conductors and concrete poles. All capital estimates are subject to review pending the detailed analysis being done in the Cost Benefit Analysis for the Program.

It should be noted that since the Projects are intended to be executed via an EPC Turnkey arrangement, all associated insurance and other project related costs are lumped in the capital estimate provided.

While the project utilizes what is essentially "grant" financing, the following economic indicators were calculated considering a project life of 25 years, an 8% discount rate, and the current costs of generation in the three systems as follows: Linden - US$0.23/kWh; Essequibo Coast – US$0.17/kWh; and DBIS – US$0.17/kWh. Additionally, it should be noted that the cost of generation for the DBIS was reduced to US$0.08/kWh from the year 2025 given the Government's target to have natural gas generation from 2024. The following economic indicators were obtained:

Project	Internal Rate of Return	Levelized Cost of Energy (US$/kWh)	Average Annual Savings (US$)	Estimated Per-Unit Costs (US$)[8]
Linden	13%	0.17	$5,467,493.97	$2.61/Wp (w/BESS)
Essequibo Coast	7%	0.19	$2,109,524.16	$2.81/Wp (w/BESS)
Berbice	6%	0.12	$1,529,130.74	$2.02/Wp (wo/BESS)

Table 3.3 – Key Economic Indicators of the Project

[8] Estimated costs for site development vary by location.

4 ANNEX I – PROJECT SITES

4.1 Site Acquisition Methodology

The identification of possible locations for the various projects is constrained by the availability of land; proximity to existing infrastructure, particularly access roads and GPL substations; and the solar resource potential. Given the resource map shown below in Figure 4.15.1. The area of land required was determined based on an estimation of 5 acres per MWp of installed capacity, which would provide adequate space for the solar panels, battery storage, roads, switchgear, proper buffer areas and other required infrastructure. The solar resource potential at each site was estimated for crystalline silicon modules with a fixed system loss of 14%. The European Commission's Photovoltaic Geographical Information System (PVGIS) (http://re.jrc.ec.europa.eu/pvgis.html), which utilizes satellite images to calculate solar radiation data, was used. The PVGIS-SARAH dataset was chosen, since it has hourly time resolution, a spatial resolution of 3 arc-minutes, and covers Guyana for a time-series of 2005-2016.

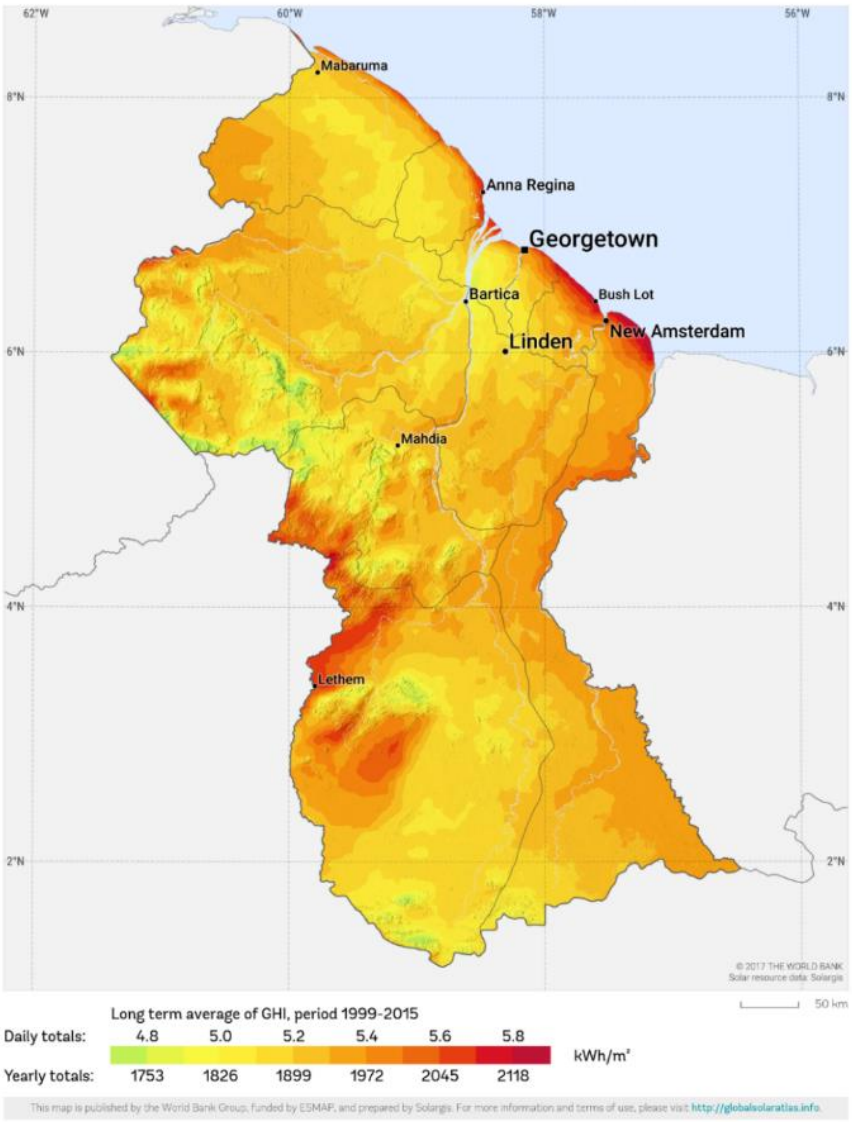

Figure 4.1 - GHI across Guyana[9]

[9] Obtained from the Global Solar Atlas developed by SOLARGIS for the World Bank Group - https://solargis.com/maps-and-gis-data/download/guyana/

Table 4.11 below gives an indication of the alternatives that were assessed for project sites.

Location	Size	Comments
Berbice Sites		
Sheet Anchor, Canje, Region 6	5 acres	The Sheet Anchor location was initially identified by the GLSC on April 10, 2021. However, it was subsequently revealed by the Commissioner of the GLSC that this location has historically been troubled by protests whenever moves are made to utilize the "open" land in the area. This means that that extensive community engagements would be required before the acquisition can proceed. As such, due to this and the small size of the land available, this site was eliminated as a possible project site.
Belvedere, Corentyne, Region 6	15 acres	Belvedere was identified by the GLSC on April 10, 2021. However, site visits conducted by GPL staff on May 14, 2021, lead to the discovery that the site identified by GLSC has been allocated to citizens as house-lots by the Central Housing and Planning Authority. This means that the site was never available for GPL acquisition and was therefore eliminated as a possible project site.
Hampshire, Corentyne, Region 6	15 acres	As a result of the issues discovered at the Belvedere Site on May 14, 2021; the GLSC identified an alternate area in Hampshire, Corentyne to the south of the public road. Visits made on May 14, 2021 revealed that the land is of good quality and there is no indication of competing interests. The GLSC is processing GPL's acquisition of this project site.
No. 61-63, Corentyne, Region 6	20 acres	Lands in this area were also identified by GLSC on April 10, 2021. However, further checks by the Senior Land Officer in the area revealed that a family is claiming that their lands include the area identified by GPL. Given the time that this would take to resolve, GPL has decided to eliminate this site as a possible project site.
Pln. Prospect (Canefield Village), Canje, Region 6	50 acres	GPL had requested to acquire this project site from NICIL on 11-Sep-2019. An updated request was submitted on 12-Apr-2021. NICIL has since indicated to GPL that it is processing the surveys and valuations required for GPL to acquire the sites. This site is a portion of lands formerly under cane cultivation and was previously surveyed for GPL. GPL continues to work with NICIL to advance these acquisitions and was granted permission to commence de-risking work at the location by NICIL on April 30, 2021.
Onverwagt/Trafalgar, West Coast Berbice, Region 5	30 acres	Following discussions with the General Manager of MMA/ADA, a joint site visit was made on 12-Apr-2021. The land is suitable for project use. A formal request for the acquisition of the identified site was dispatched on April 21, 2021 to the Minister of Agriculture. The MMA/ADA granted GPL permission to utilize the site identified on April 27, 2021. GPL submitted a formal application for the land on the May 4, 2021 and is working with the MMA to have the required cadastral survey completed for conveyance.

Essequibo Sites		
Onderneeming, Essequibo Coast	15 acres	This site was visited on 13-Apr-2021. GLSC indicates that the site is currently unoccupied and has no competing interest and as such can be acquired by GPL. GPL submitted an application for this site on April 30, 2021 and the GLSC is processing GPL's acquisition of this project site.
Rear of Lima Sands, Essequibo Coast	10 acres	This site located at the "2nd Sand" and was visited on the 13-Apr-2021. A portion currently has a squatter who claims to have applied to lease the occupied portion. GLSC has indicated that the portion that is unoccupied can be acquired by GPL. GPL submitted an application for this site on April 30, 2021 and the GLSC is processing GPL's acquisition of this project site.
Rear of Bush Lot, Essequibo Coast	15 acres	GLSC has indicated several portions of land that were leased to individuals in Lots for homesteads. Majority of the lands are undeveloped and unoccupied and as such, GLSC has indicated that they can be acquired by GPL. Site visits were done on the 13-Apr-2021. A formal request for the acquisition of the identified sites was dispatched on April 21, 2021. GPL and GLSC met on April 28, 2021 and it was indicated that the process to reposes these lands would take at least six (6) months. Since this timeline is not feasible, this site was eliminated as a possible project site.
Pln. Opposite, Essequibo Coast	15 acres	Pln. Opposite was visited on 14-Apr-2021. The lands identified were under the control of one owner who is now deceased. GLSC indicated that the lease expired since 2012 and was not renewed. The children and grandchildren have an active dispute over the administration of the estate of the deceased person, even though the lease has expired. Given the ongoing legal dispute, the GLSC are unwilling to process GPL's applications for the site. As such, this site was eliminated as a possible project site.
Linden Sites		
Block 37/Bamia, East Bank Demerara River, Region 10	35 acres	Joint site visits were done on 7-Apr-2021 with NICIL. Initially, Block 37, Retrieve, and Wisroc were identified by NICIL as available for GPL acquisition. However, GPL and NICL held additional site visits on April 24, 2021 to the Region and it was determined that there were too many squatters at the Wisroc Location, which would make surveying difficult and would result in significant social implications. As such, an alternative site at Dacoura was identified. NICIL began cadastral surveys on May 3, 2021 and completed the same on May 7, 2021. In the interim NICIL has granted permission for GPL to commence de-risking work at the locations on April 30, 2021. NICIL is currently processing GPL's acquisition of the Block 37, Retrieve, and Dacoura sites.
Retrieve, East Bank Demerara River, Region 10	25 acres	
Wisroc, West Bank Demerara River, Region 10	25 acres	
Dacoura, West Bank Demerara River, Region 10	15 acres	

Table 4.1 - Determination of Final Project Sites

4.2 Final Project Sites

4.2.1 Linden Locations

Figure 4.2 - Location in Retrieve, Region 10 (25 acres)

Point R1	Point R2	Point R3	Point R4
6.006370629, -58.29385027	6.002425096, -58.29483467	6.002511789, -58.29259452	6.006457322, -58.29161011

Figure 4.3 – Photo of Retrieve Site

It is proposed that the Retrieve Solar Farm be interconnected to the Amelia's Ward 13.9kV Load Feeder (shown in purple) via a short 13.8kV Line (under 1km, shown in red). This interconnection has to be assessed in the interconnection assessment.

Figure 4.4 - Proposed interconnection of the Retrieve Farm

Figure 4.5 - Location in Block 37, Region 10 (35 acres)

Point B1	Point B2	Point B3	Point B4
6.025546611, -58.24218408	6.02839744, -58.24135037	6.028134951, -58.23746503	6.025302068, -58.23836203

Figure 4.6 - Photo of Block 37 Site

It is proposed that the Block 37 Solar Farm be interconnected to the Amelia's Ward 13.9kV Load Feeder (shown in purple) via a short 13.8kV Line (under 1km, shown in red). This interconnection has to be assessed in the interconnection assessment.

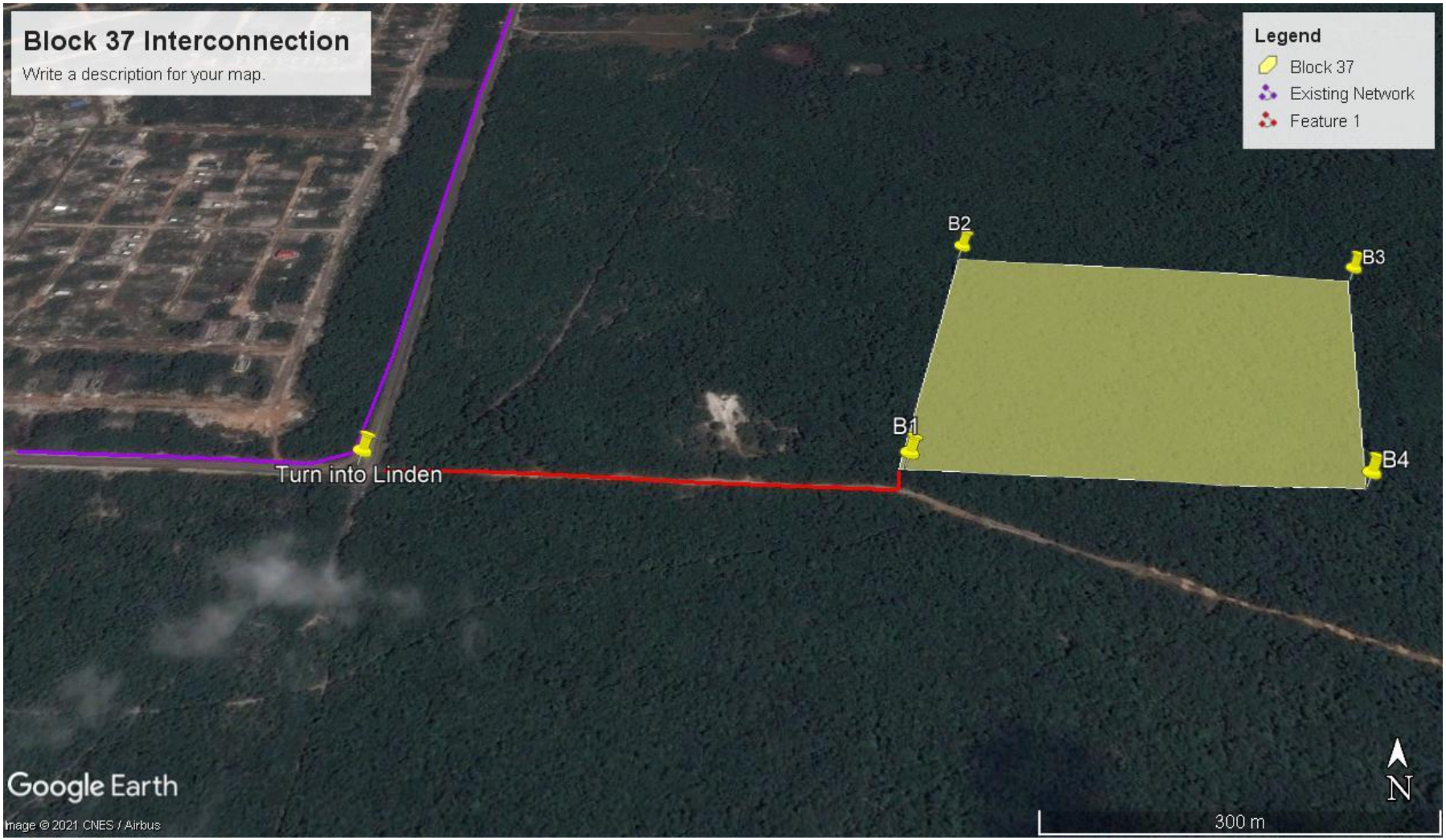

Figure 4.7 - Proposed interconnection of the Block 37 Farm

Figure 4.8 - Location in Dacoura, Region 10 (10 acres)

Point D1	Point D2	Point D3	Point D8
5.986254133, -58.32147209	5.986488753, -58.32168946	5.986279785, -58.32208642	5.985869783, -58.32334107

Point D9	Point D5	Point D6
5.987433156, -58.3238507	5.987712073, -58.32069873	5.987396167, -58.320436

Figure 4.9 - Photo of Dacoura Site

It is proposed that the Dacoura Solar Farm be interconnected to the Wismar 13.8kV Load Feeder (shown in purple) via a short 13.8kV Line (under 1km, shown in red). This interconnection has to be assessed in the interconnection assessment.

Figure 4.10 - Proposed interconnection of the Dacoura Farm

4.2.2 Berbice Locations

Figure 4.11 – Location in Pln. Prospect, East Canje Berbice, Region 6 (50 acres)

Point A	Point B	Point C	Point D
6.256532°, -57.490559°	**6.255589°, -57.485936°**	**6.251774°, -57.485645°**	**6.252849°, -57.490230°**

Figure 4.12 - Picture of Prospect Site

It is proposed that the Prospect Solar Farm be interconnected to 13.8kV busbar at via a short 13.8kV Line (under 1km, shown in red). This interconnection has to be assessed in the interconnection assessment.

Figure 4.13 - Proposed interconnection of the Prospect Farm

Figure 4.14 - Location in Hampshire, Corentyne, Berbice, Region 6 (15 acres)

Point H1	Point H2	Point H3	Point H4
6.250548, -57.366710	6.253236, -57.365953	6.252803, -57.364326	6.250070, -57.365110

Figure 4.15 - Picture of Hampshire Site

It is proposed that the Hampshire Solar Farm be interconnected to the Canefield F3 13.9kV Load Feeder (shown in white) via a short 13.8kV Line (under 1km, shown in red). This interconnection has to be assessed in the interconnection assessment.

Figure 4.16 - Proposed interconnection of the Hampshire Farm

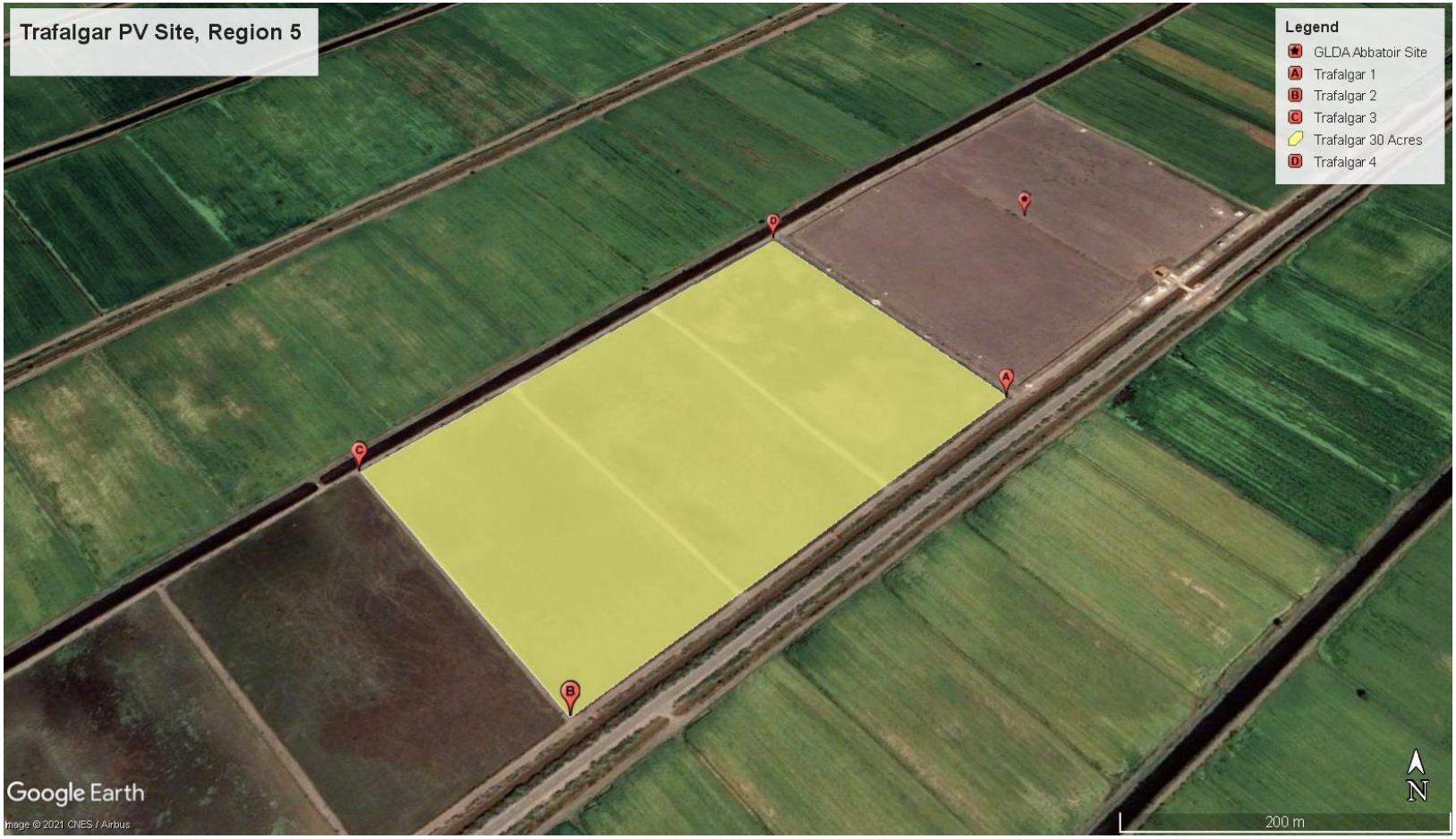

Figure 4.17 - Location in Onverwagt, West Coast Berbice, Region 5 (30 acres)

Point A	Point B	Point C	Point D
6.407878°, -57.641421°	6.405204°, -57.644381°	6.407118°, -57.646009°	6.409792°, -57.643084°

Figure 4.18 - Picture of Trafalgar Site

It is proposed that the Block 37 Solar Farm be interconnected to the Onverwagt 13.8kV Busbar via a 1.7km 13.8kV Line (shown in yellow). This interconnection has to be assessed in the interconnection assessment.

Figure 4.19 - Proposed interconnection of the Trafalgar Farm

4.2.3 Essequibo Coast Locations

Figure 4.20 - Location in Lima Sands, Essequibo, Region 2 (10 acres)

Point A	Point B	Point C	Point D
7.292642°, -58.545230°	**7.294820°, -58.545781°**	**7.294462°, -58.547192°**	**7.292276°, -58.546641°**

Figure 4.21 - Picture of Lima Sands Site

It is proposed that the Lima Sands Solar Farm could be interconnected to the West 13.8kV Load Feeder (shown in yellow) via a short 13.8kV Line (under 1km, shown in red) or to the North 13.8kV Feeder via a 7km 13.8kV line (shown in blue). These interconnections has to be assessed in the interconnection assessment, but given the load on the North Feeder, the interconnection to the North Feeder is preferred.

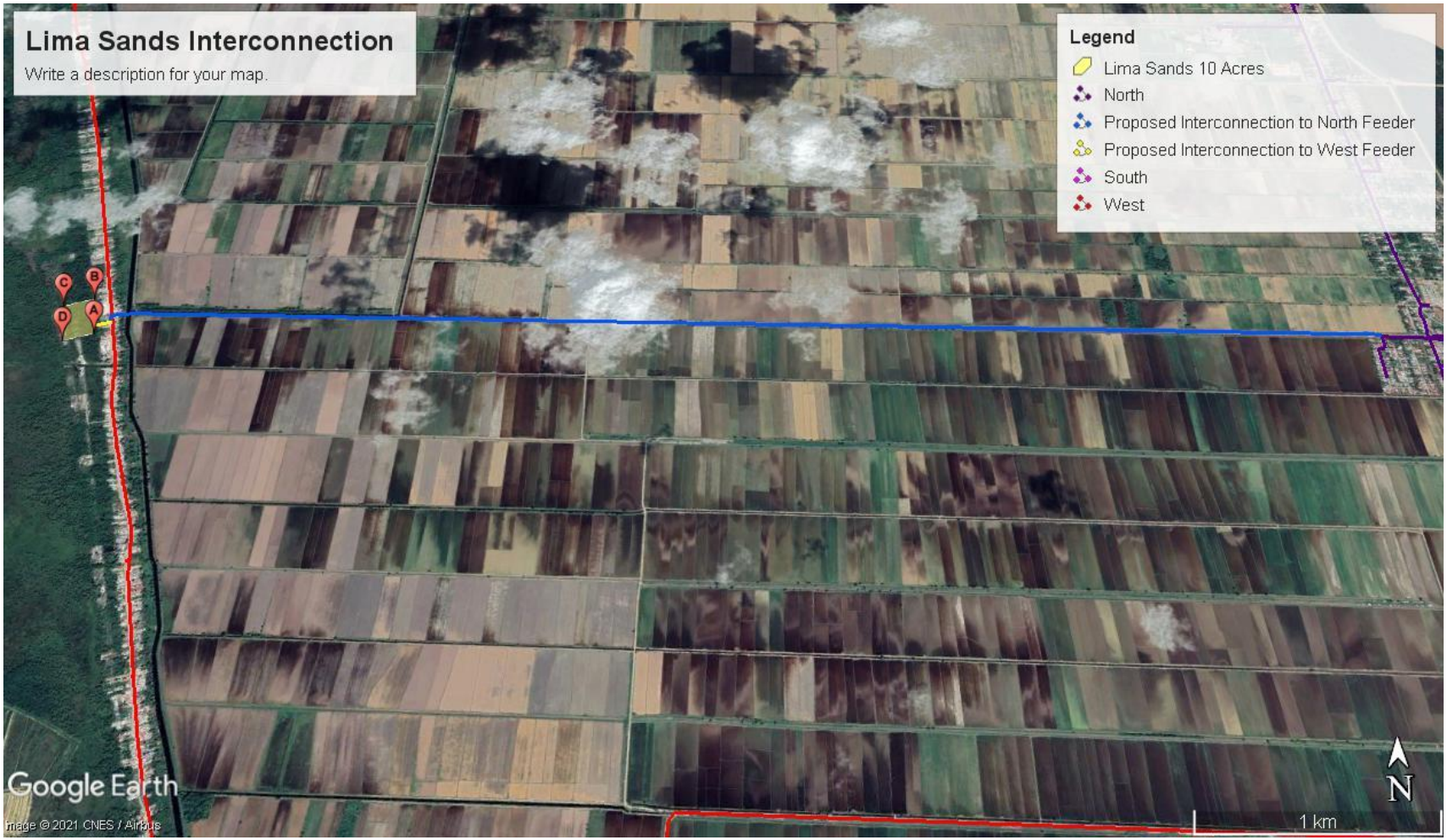

Figure 4.22 - Proposed interconnection of the Lima Sands Farm

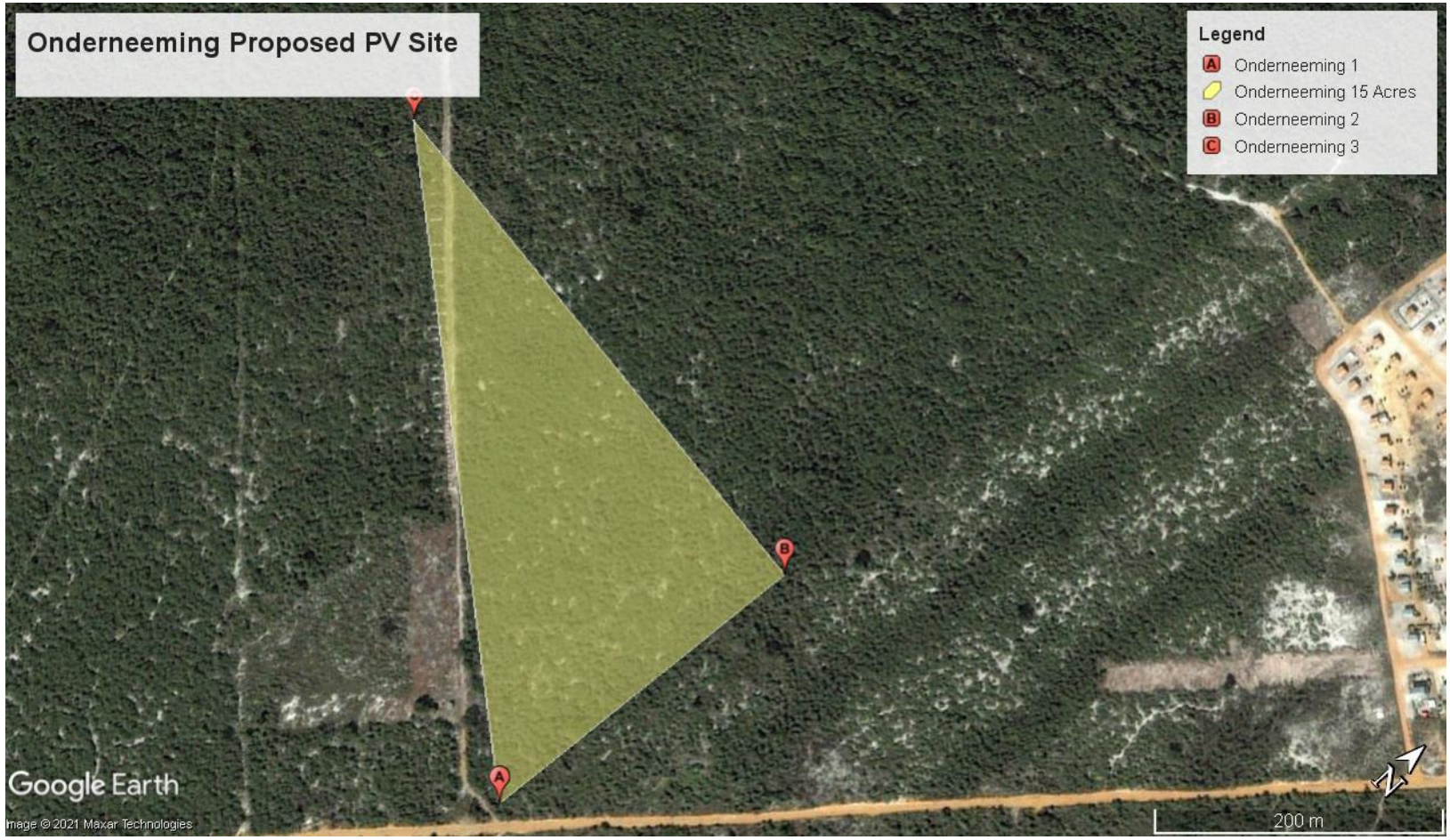

Figure 4.23 - Location in Onderneeming, Essequibo, Region 2 (15 acres)

Point A	Point B	Point C
7.094515°, -58.509426°	**7.096821°, -58.509253°**	**7.097106°, -58.513436°**

Figure 4.24 - Picture of Onderneeming Site

It is proposed that the Onderneeming Solar Farm be interconnected to the South 13.8kV Load Feeder (shown in green) via a short 13.8kV Line (under 1km, shown in blue). This interconnection has to be assessed in the interconnection assessment.

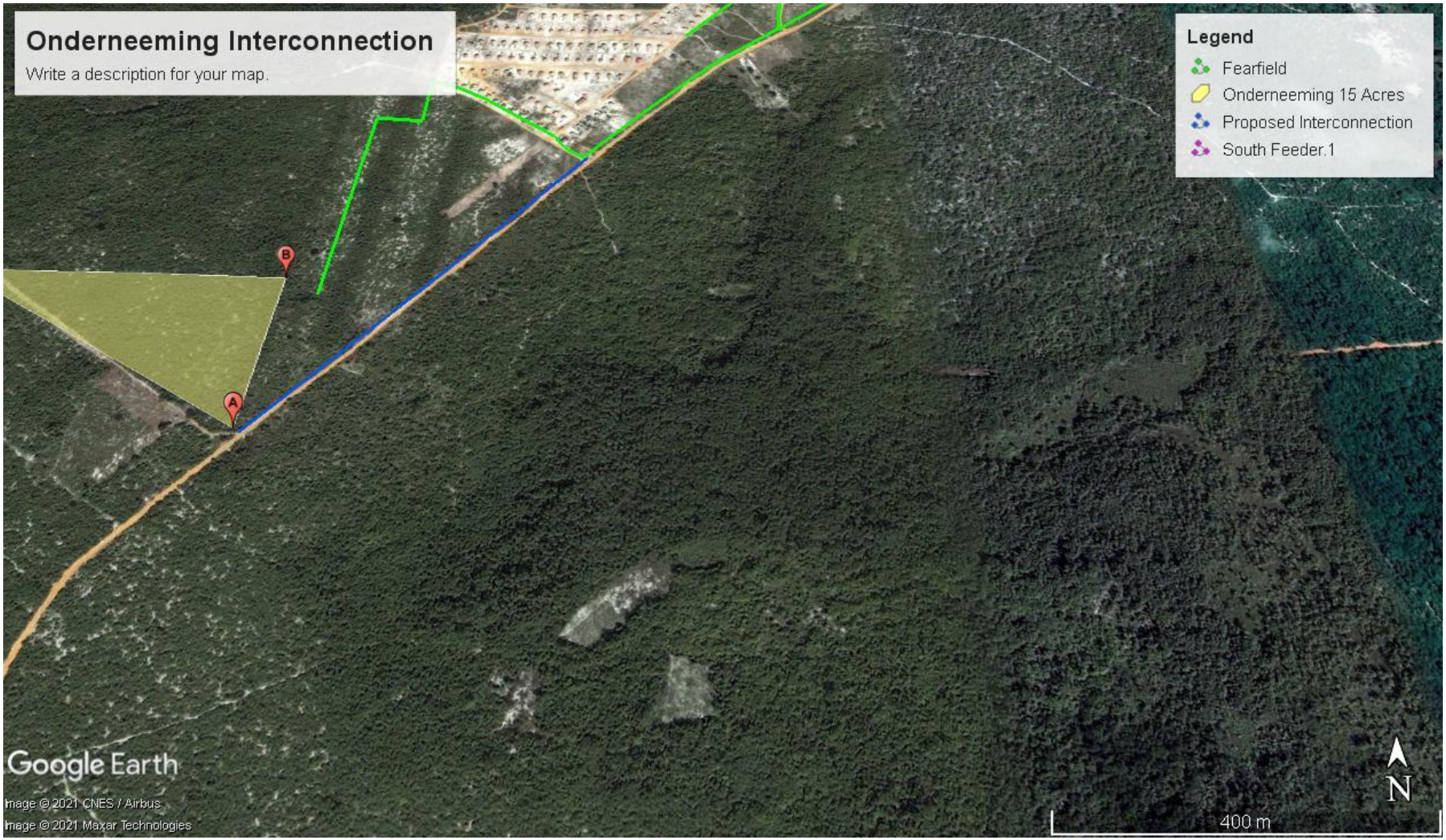

Figure 4.25 - Proposed interconnection of the Onderneeming Farm

5 ANNEX II - PROJECT IMPLEMENTATION SCHEDULE

ID	Task Name	Duration	Start	Finish
0	**GUYSOL Tentative Workplan**	**714 days**	**Tue 23/03/21**	**Fri 15/12/23**
1	1 Government Approval/IADB Notification	6 days	Tue 23/03/21	Tue 30/03/21
2	**2 IADB Approval Process**	**261 days**	**Wed 31/03/21**	**Wed 30/03/22**
3	2.1 Development and Approval of Project Profile	105 days	Wed 31/03/21	Tue 24/08/21
4	2.2 Development and Approval of Programme	156 days	Wed 25/08/21	Wed 30/03/22
5	**3 GPL Processes**	**159 days**	**Wed 31/03/21**	**Mon 08/11/21**
6	3.1 Completion of Project Concept Note	60 days	Thu 15/04/21	Wed 07/07/21
7	3.2 Aquistion of Project Sites	89 days	Wed 31/03/21	Sat 31/07/21
8	3.3 Completion of De-risking Activities	143 days	Thu 15/04/21	Mon 01/11/21
9	3.4 Preparation of Pre-Qulification Documents	41 days	Mon 19/07/21	Mon 13/09/21
10	3.5 Preparation of Request for Proposal Documents	40 days	Tue 14/09/21	Mon 08/11/21
11	**4 Tender Pre-Qualification**	**55 days**	**Tue 14/09/21**	**Mon 29/11/21**
12	4.1 Publish Pre-qualification	25 days	Tue 14/09/21	Sun 17/10/21
13	4.2 Evaluate Short-List	31 days	Mon 18/10/21	Sun 28/11/21
14	4.3 Publish Short-List	1 day	Mon 29/11/21	Mon 29/11/21
15	**5 Tender Process**	**180 days**	**Tue 09/11/21**	**Mon 18/07/22**
16	5.1 Publish RFP	60 days	Tue 09/11/21	Sun 30/01/22
17	5.2 Evaluate Tenders	51 days	Mon 31/01/22	Sun 10/04/22
18	5.3 No-Objection and Review	41 days	Mon 11/04/22	Sun 05/06/22
19	5.4 Cabinet Approval	16 days	Mon 06/06/22	Sun 26/06/22
20	5.5 Contract Negotiation	16 days	Mon 27/06/22	Sun 17/07/22
21	5.6 Contract Award	1 day	Mon 18/07/22	Mon 18/07/22
22	6 EPC Contract Execution	18 mons	Mon 01/08/22	Fri 15/12/23

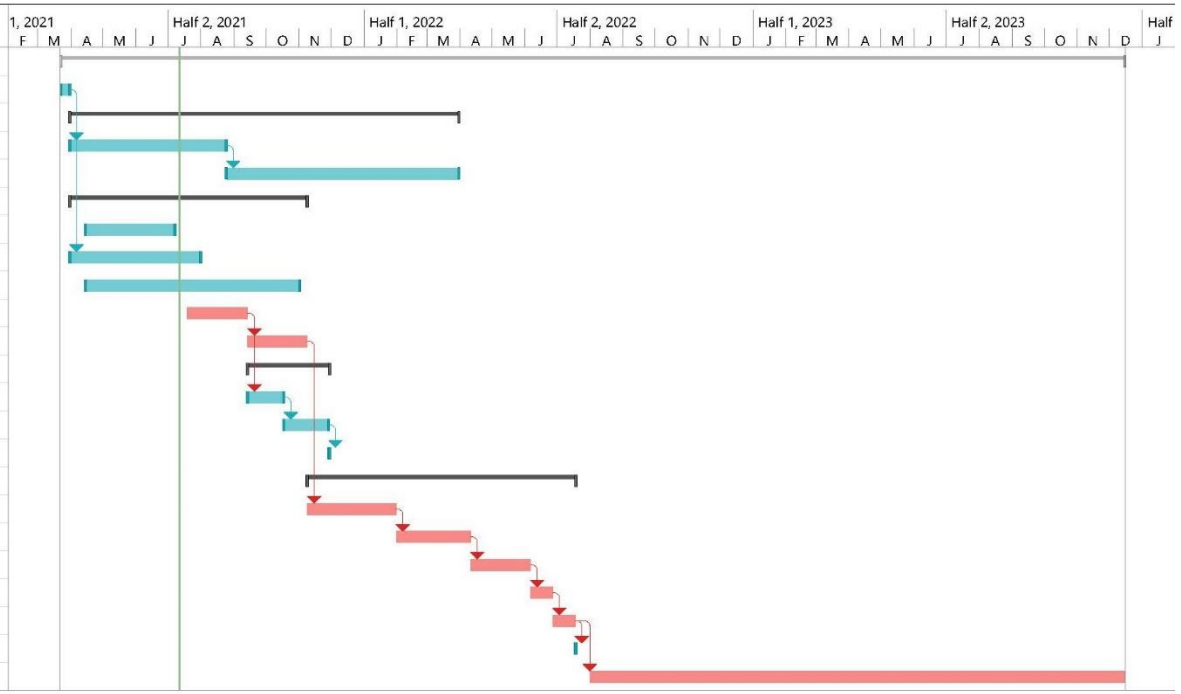

Figure 5.1 - Proposed Project Implementation Schedule