

Analysis of Current Electricity and Water Consumption Patterns in Public Buildings Throughout Dominica Report

**Consultancy for Technical and Economic
Feasibility of Solar Units and Water Storage on
Public Building in Dominica**

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1 INTRODUCTION

Climate change is expected to result in increasing severity of tropical storms and hurricanes, that could potentially impact water and power resources in Dominica. This project looks to increase climate resilience in Dominica and reduce greenhouse gas (GHG) emissions from fossil fuel dependence, by assessing the viability of installing solar units and water storage units in public buildings.

The purpose of this report is to summarize the initial findings of our field investigation that included visiting ten (10) public buildings, as recommended by the Stakeholders during the initial project meeting held in Dominica on March 1, 2023. These buildings were selected to represent the various types of public structures that our team were to assess regarding their suitability to install solar and water storage units. These buildings are listed in Table A below for your reference.

Table A. Ten (10) Identified Public Buildings to Analyse in the Field

Building ID	Date of Site Visit
Trafalgar Community Centre	May 5 th , 2023
Dominica Community High School	April 27 th , 2023
Newtown Health Centre	April 12 th , 2023
Mahaut Health Centre	April 12 th , 2023
Roseau Fisheries Complex	April 14 th , 2023
Dominica State College	April 11 th , 2023
Mahaut Primary School	May 3 rd , 2023
Dominica Meteorological Office	April 13 th , 2023
Vieille Case Community Centre	May 4 th , 2023
Sineku Resource Centre	May 10 th , 2023

With the field investigation programme concluded our team is in a better position to begin to provide consider solar and water storage system design options. We are also able to comment on similar systems that are installed in other Caribbean islands including a review of enabling factors such as regulatory frameworks.

Based on the collected data, we have identified some suitable design options for solar power generation and water capture/storage. This includes modular options for easy scalability.

2 BACKGROUND INFORMATION

2.1 Climate Data

The Commonwealth of Dominica is located in the Lesser Antilles, among the Windward Islands in the Eastern Caribbean, at 15.4°N,61.3°W, and has an average area of 750 square meters, measuring 48 km long and 29 km wide and a population of 71,941 Geographically, the island features one of the Caribbean's most rugged landscapes, with up to 69% covered by a mostly

unexploited, multi-layered rainforest. Its geography includes steep volcanic slopes and deep gorges, with elevations ranging from 300 to 1,400 meters above sea level. Morne Diablotins, at 1,447 meters, is the highest mountain, followed by Morne Trois Pitons, at 1,423 meters. This unique terrain and volcanic rock surface encourage water runoff to form cascading rivers, natural pools, and crater lakes¹

Dominica's climate is influenced by a combination of factors including the island's small size, proximity to the Caribbean Sea and the tropical North Atlantic Ocean, and steep topography. Dominica has a tropical climate that is hot and humid all year, with a comparatively cool and dry season from January to April and a rainy season from June to November, which coincides with the Atlantic Hurricane Season². The daily temperature and rainfall are 27°C and 200 mm, respectively. As shown in Figure A, The average temperature fluctuates between 3°C throughout the year. Meanwhile, the island receives about 2000 mm of rainfall a year, of which over 200 mm fall per month from July to November. The least rainy period is from February to April, with about 60 mm to 75 mm. Rainfall is heaviest in high-elevation areas. As a result, maximum precipitation amounts occur inland. The highest points Morne Diablotins and Morne Trois Pitons have a yearly rainfall of 300 mm, decreasing outward to 100mm toward the coast (see Figure B).

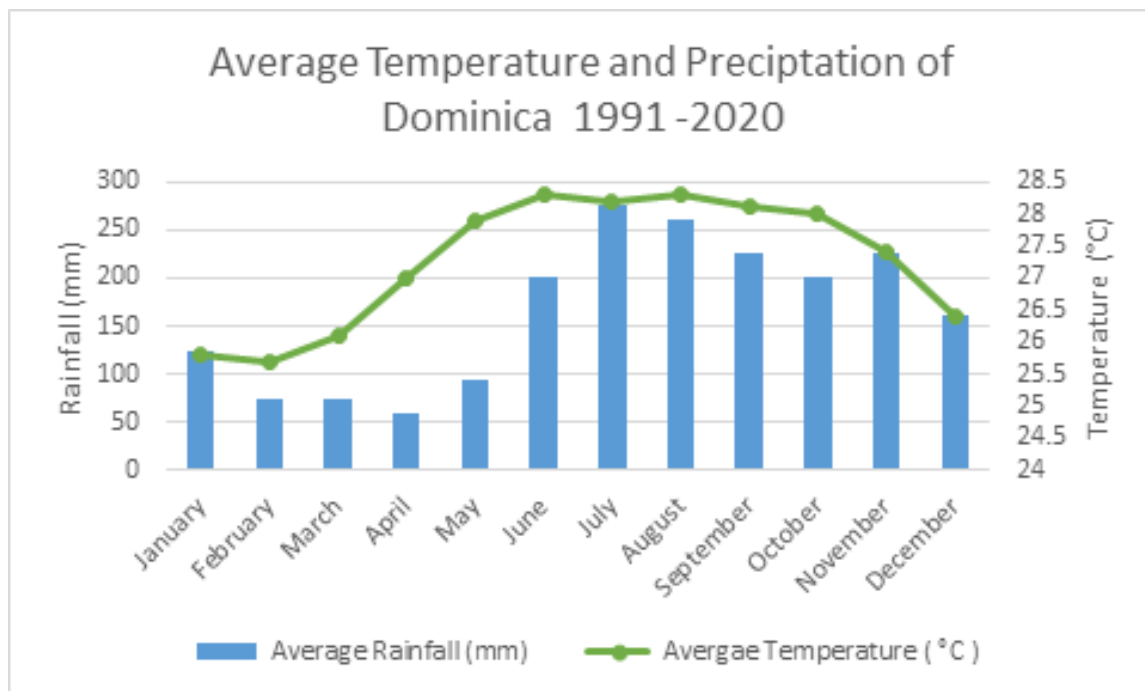


Figure A. Dominica's Average Temperature and Precipitation 1991-2020³

¹ Geography of Dominica. <https://countrystudies.us/caribbean-islands/60.htm>

² Country Profile: Dominica. The Caribbean Institute of Meteorology & Hydrology: <https://rcc.cimh.edu.bb/files/2018/06/Country-Profile-Dominica.pdf>

³ World Climate Guide: Dominica: <https://www.climatestotravel.com/climate/dominica>

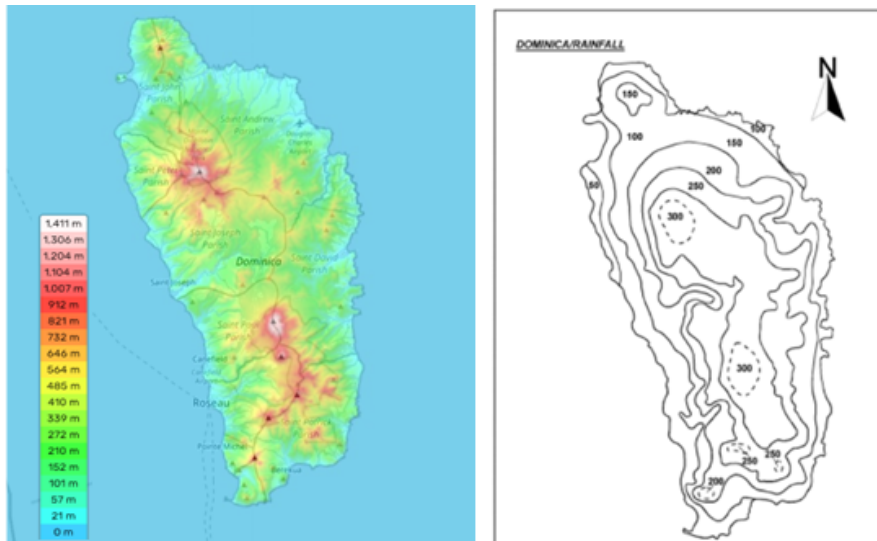


Figure B. Comparison of Topography and Annual Rainfall of Dominica⁴

2.2 Energy

The Dominica Electricity Services Limited (DOMLEC) has an installed capacity of 26.74MW, with a peak demand of 15.9MW and approximately 9% of losses. Of the total installed capacity 20.1 MW of is generated imported diesel, while the remaining 6.6MW is generated from Three hydroelectric plants (1.3 MW, 1.8 MW, and 3.5 MW) situated on the Roseau River.

Dominica typically uses about 103.1 GWh per year, per the DOMLEC 2020 annual report⁵. Electricity use decreased by about 23% after Hurricane Maria's destructive effects on the electrical grid in 2017. Figure C illustrates how Dominica's recovery has been slowly improving through an increase in energy production between 2018 and 2020. Commercial usage accounts for around 50% of Domica's energy consumption, which is followed by residential use (41%), street lighting (1%), and hotel use (1%), as shown in Figure D⁶. Dominica is one of the few Caribbean countries whose population has 100% access to electricity⁷.

⁴ Annual report 2020. The Dominica Electricity Services Limited (DOMLEC): <https://www.domlec.dm/wp-content/uploads/AR2020.pdf>

⁵ Annual report 2020. The Dominica Electricity Services Limited (DOMLEC): <https://www.domlec.dm/wp-content/uploads/AR2020.pdf>

⁶ Dominica Energy Snapshot. NREL (August 2022) [ETI Energy Snapshot - Dominica](#)

⁷ Energy Profile: Dominica. IRENA (2020): [Dominica Central America and the Caribbean RE SP.pdf \(irena.org\)](#)

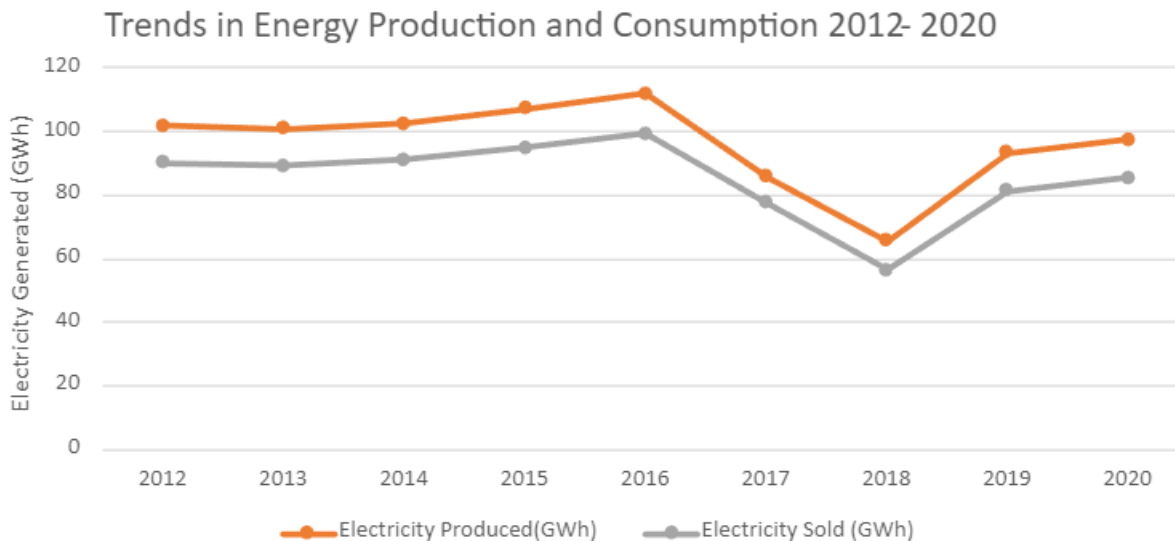


Figure C. Trends in Dominica's Energy Production and Consumption⁸

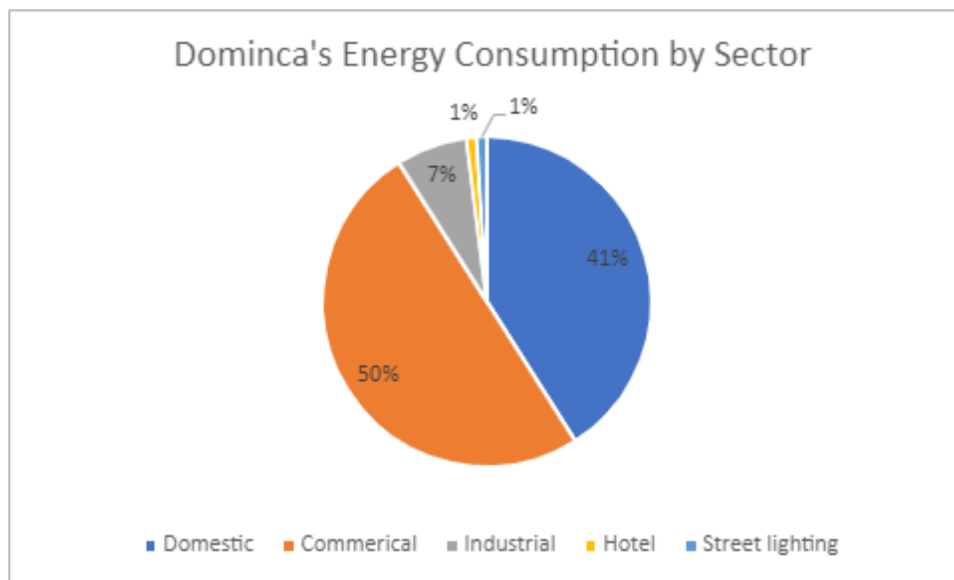


Figure D. Dominica's Energy Consumption by Sector

2.2.1 Solar Energy Potential

Dominica has a very high potential for solar energy, with a global horizontal irradiation (GHI) range of 3.95 to 5.80 kWh/m² ⁹. GHI on the west coast of Dominica exceeds 5 kWh/m². This is also the

⁸ Annual report 2020. The Dominica Electricity Services Limited (DOMLEC): <https://www.domlec.dm/wp-content/uploads/AR2020.pdf>

⁹ Global Solar Atlas v2.8. The World Bank (2023). <https://globalsolaratlas.info/map?c=15.424558,-61.362076,10&r=DMA>

location with the greater population density, and where most buildings considered in this study are located. As a result, solar PV installations are expected to generate significant amounts of energy, with specific photovoltaic power ranging from 3.23 to 4.78 kWh/kWp¹⁰.



Figure E. Global Horizontal Irradiation Map for Dominica¹¹.

2.3 Existing Policy Framework

2.3.1 Power

Dominica, like many island nations, relies on imported fossil fuels, with electricity costs reflecting global oil price fluctuations. Its power policies and legislation are focused on promoting the development of a sustainable energy sector and increasing access to reliable and affordable electricity for all citizens.

¹⁰ Global Solar Atlas v2.8. The World Bank (2023). <https://globalsolaratlas.info/map?c=15.424558,-61.362076,10&r=DMA>

¹¹ Global Atlas 2.0, Solar resource data: Solargis. The World Bank (2020). <https://solargis.com/maps-and-gis-data/download/dominica>

Dominica has three operational hydroelectric plants on the Roseau River that produce 27.4% of the island's electricity demands with capacities of 1.3 MW, 1.8 MW, and 3.5 MW, with an additional 17 MW potentially available. Dominica Electricity Services Limited (DOMLEC) is the sole electric utility, with an installed electrical generating capacity of 23.8 megawatts (MW) with a peak demand of 17.2 MW. The average electricity tariffs in 2020 were \$0.384 USD/kWh for residential, \$0.381–\$0.411 USD/kWh for commercial, and \$0.375 USD/kWh for industrial.

Dominica has established a National Energy Plan that was revised in 2014, it states the country's objective of using sustainable and indigenous resources to make electricity generation on the island self-sufficient. The scenario described is for Dominica to become a net exporter of electricity from its geothermal resources with potential estimates ranging from 300 MW to 1,390 MW. Dominica is expected to develop more than 100 MW of geothermal power and expects early-stage investment through the World Bank's Geothermal Development Plan.

The Electricity Supply Act was enacted in 1996 and provides a regulatory framework for the generation, transmission, and distribution of electricity in Dominica. The law establishes the Dominica Electricity Services Ltd. (DOMLEC) as the only electricity utility company which is regulated by the Independent Regulatory Commission (IRC) who is responsible for regulating the electricity sector and ensuring that electricity services are provided in a safe, reliable, and affordable manner. IRC granted two licenses to DOMLEC: 1) a non-exclusive generation licence; and 2) an exclusive licence to transmit, distribute and supply electricity within Dominica.

Renewable Energy Incentive Program: The Renewable Energy Incentive Program was launched in 2019 to encourage the development of renewable energy projects in Dominica. The program provides financial incentives, such as tax exemptions and duty waivers, to businesses and individuals who invest in renewable energy projects. This does not conflict with the role of DOMLEC as a non-exclusive producer under the Electricity Supply Act if all the energy produced is consumed on site. If the producer has excess energy DOMLEC must agree to have it enter its exclusive transmission network.

Dominica is also a participating country in the Caribbean Community's Caribbean Renewable Energy Development Programme—an initiative of the Energy Ministers of the Caribbean Community region established to change the renewable energy market. The Programme is the expression of the CARICOM sustainable energy policy which recommends and promotes the development of renewable energy sources. This includes the use of Solar Photovoltaic technology.

2.3.2 Water

Like many other island nations in the Caribbean Sea, Dominica faces unique challenges when it comes to water management. However, Dominica's distinction from most of the countries in the Eastern Caribbean region with respect to its abundance of rivers and water. This abundance is such that other Caribbean countries consider Dominica as an alternative source of water supply in times of need and the government of Dominica has positioned itself to be an exporter of bulk water.

Dominica has several policies and regulations in place to ensure that the country's water resources are managed sustainably and that all citizens have access to safe and reliable drinking water.

One of the key pieces of water legislation is the **Water and Sewage Act** of 1991, which is intended to establish the orderly development, use and conservation of water resources, and providing the public with dependable water supply and sewerage services. It provides a framework for the management of the country's water resources and outlines the responsibilities of the government, private sector, and individuals in protecting and conserving water. It also establishes and provides a legal framework for the Water and Sewerage Company Limited (WASCO), which is responsible for the planning, development, and management of the country's water resources.

The Water and Sewerage Act refers to "rooftop catchments" defined as "any installation or device suitable for the collection of rainwater on the roof of buildings or dwelling houses" also noting the "Company may procure and protect land on which it elects to erect, operate and maintain ground catchments for the supply of water" or they "may, at the request of the owner or occupier of any building or dwelling house, provide technical and financial assistance towards the installation of rooftop catchments on such building or dwelling house".

This means that rooftop rainwater capture is provided for in the Act and "The Company" ("Dominica Water and Sewerage Company Limited and also any person duly authorised by the Company") may choose to provide technical and financial assistance to "towards" private rainwater capture systems.

(Reference: [http://www.oas.org/dsd/environmentlaw/waterlaw/documents/Dominica-Water and Sewage Act \(1989\).pdf](http://www.oas.org/dsd/environmentlaw/waterlaw/documents/Dominica-Water%20and%20Sewage%20Act%20(1989).pdf))

In addition to the Water and Sewage Act, Dominica developed the National Water Policy in 2005 to provide guidance on the sustainable management of water resources in the country. This policy outlines several goals, including increasing access to safe drinking water, improving the efficiency of water use, and protecting water resources from pollution and degradation.

According to the Dominican government **2011 Population and Housing Census Report**, 65 percent of the households had direct access to piped water supply to the dwelling (an increase of 18 percent since 2001), and a further 8 percent had water to the yard, and 14 percent had piped water to a public standpipe.

In 2011 Dominica established an **Integrated Water Resources Management (IWRM) Policy** to build on previous policy development efforts and transition to an effective governance and technical framework for water.

The Dominican government has also established a special Cabinet for the water sector "to define, coordinate, and monitor water related policy, strategy, programs, actions, and budget" and the country is updating the National Hydrological Plan previously prepared in 2012. The new plan (2023) is to "provide updated data on water availability and demand by regions and economic sectors" and "present a roadmap for prioritization of investments in the water sector, particularly oriented towards water resources management".

(Reference: <https://www.rvo.nl/sites/default/files/2021/08/DR-Water-Sector-Report-2021.pdf>)

2.3.3 Social and Gender Considerations

Both the social and economic appropriateness of power and water solutions, such as rainwater harvesting (RWH), need to be considered across the various targeted sectors, such that potential barriers to investing in and implementing such solutions are considered and addressed. In general, the McGill research (Suchorski, 2009) seemed to conclude that gender was less important an indicator for water access and use than was development. The average water consumption per person ranged from a low of 104 L/day/cap to a maximum of 128 L/day/cap, with gender indicated as a negligible factor. The division of labour within a household with respect to water related tasks was significant from a gender perspective with women spending an average of 12.6 hrs/week on water-related domestic tasks; while males and children spending an average of 5.6 hrs/week and 1.7 hrs/week, respectively.

With limited capacity for water security solutions comes increased vulnerability (FAO 2016). In their 2016 report on drought management and water security in the Caribbean, the Caribbean Institute for Meteorology and Hydrology and the Land and Water Division within the Food and Agriculture Organization of the United Nations explained the particular vulnerability of small farmers, children, rural communities, and communities associated with lower income brackets. It is our understanding that findings from this report played a role in including these sectors (vulnerable rural communities, and farmers) to be incorporated into this water storage programme.

Specific to gender, Suchorski (2009) explored the ways in which gender roles impacted water usage in households across communities. In general, women engage in more water related tasks within the household, such as cooking, cleaning, and washing, and therefore tended to report greater amounts of water usage.

3 FIELD INVESTIGATION

3.1 Site Descriptions

Brief site descriptions are provided for the ten (10) public buildings identified for our field investigations. Further details associated with these site visits are provided in Appendix 1 and 2 for reference.

3.1.1 Dominica State College

The Dominica State College (DSC – see Figure F, Figure G, and Figure H) is a tertiary education institution, located in Stockfarm, in the west of Dominica. DSC's facilities are spread across three main areas in Stockfarm: Upper Campus, Lower Campus, and the N1/N2 areas. The Upper Campus consists of numerous concrete buildings, constructed in the early 2000's. The lower campus consists of a couple older buildings, with the rest of the campus consisting of newer concrete buildings constructed in 2013, the same time as the N1/N2 buildings. Most of DSC's buildings suffered from moderate or significant damage due to Hurricane Maria in 2017, and their roofs were reconstructed following this event. The facility consists of a mix of single-phase and three-phase wired buildings.

Twelve buildings at Dominica State College were assessed, spread across the Upper Campus, Lower Campus, and N1/N2 Sections. Details of each building are outlined in Table B, Table C, and Table D.



Figure F. Dominica State College, Upper Campus, Main Building



Figure G. Dominica State College, Lower Campus, Main Buildings A, B, and C



Figure H. Dominica State College, Lower Campus, Library Building



Figure I. Dominica State College, N1 and N2 buildings

3.1.2 Newtown Health Centre

The Newtown Health Centre (Figure J) is the primary health clinic for the capital, Roseau, and surrounding areas. The health centre is a single, two-storey structure, with walls constructed out of concrete. There are 3 roofs on the building, two of which are concrete roofs overlain with aluminium sheeting, sloping shallowly in the north, south, east, and west directions. The third roof is a flat concrete roof, accessible from the second floor.

All roofs are in very good condition and seemingly suitable for the installation of rooftop solar PV, pending a structural assessment of the roof. Solar panels will be best placed on the sloping, aluminium-sheet covered rooftops. The facility is wired for three-phase power, and distribution

panels are located near the interior staircase on the first and second floors. From the site visit, a completely suitable location for storing electrical equipment for the solar system was not identified, and there are two storage options for this equipment: The open storage area near the interior staircase on the first floor, and the wall of the accessible porch on the second floor. The first location will require a clearance of the storage area and the installation of a secure door, while the latter location requires the construction of a custom storage unit to fit the necessary solar PV supporting equipment.



Figure J. Newtown Health Centre

3.1.3 Mahaut Health Centre

The Mahaut Health Centre (Figure K) is a clinic located on the west coast of Dominica, serving the community of Mahaut, and nearby areas in the Parish of St. Paul. The structural details of the building are nearly identical to Newtown Health Centre, consisting of a single two-storey concrete building, with two mildly sloping concrete roofs overlain with aluminium sheeting, and one accessible flat concrete roof.

The best location for solar panels is the sloping roof of the building, while the most suitable location for supporting solar PV equipment is in the storage area near the interior staircase on the first floor. Unlike Newtown Health Centre, the storage area at Mahaut Health Centre is secure, accessible only through a door which is locked most times of the day. The facility is wired for single-phase electricity, and distribution panels are located on the first and second floors.



Figure K. Mahaut Health Centre

3.1.4 Dominica Meteorological Office (Met Office)

The Met Office (Figure L) is located in Jimmit, on the west coast of Dominica. It consists of a single, three-storey concrete building, with a flat, concrete roof, accessible through a door on the rooftop. The flat concrete roof is in visibly very good condition, pending a structural assessment. It is a suitable location for installing solar panels using a tilt-mount system to orient the panels adequately on the flat concrete roof. The Met Office has a dedicated storage room, which will be a suitable location for solar panel supporting equipment. The room also includes distribution panels. Additionally, the building is supported by three-phase power.



Figure L. Dominica Meteorological Office

3.1.5 Roseau Fisheries Complex

The Roseau Fisheries Complex (Figure M and Figure N), located in the capital city, Roseau, is a facility under the control of the Ministry of Agriculture, Fisheries, Blue, and Green Economy. The facility is spread across two buildings – the main office/industrial building and secondary small sheds for mechanical work and boat repair. The main office/industrial building is a concrete building which includes office space, mechanical rooms, market space for fish vendors, and industrial cold storage and ice production rooms. The facility is wired for three-phase electricity, with large electrical loads from the freezing, storage, and ice production requirements.

The roof of the main office/industrial building consists of an aluminium sheet roof, covering most of the area of the building, with a flat concrete roof/walkway covering the rest of the area. The aluminium sheet on the roof is in visibly very good condition, and it is a suitable location for installing flush-mounted rooftop solar panels.

The main office/industrial building also includes a large electrical room, consisting of electrical panels, switches, and electrical compressors for the facility. This location is also suitable for the supporting solar PV equipment.



Figure M. Roseau Fisheries Complex, Main Office/Industrial Building



Figure N. Roseau Fisheries Complex, Mechanical Workshop Buildings

3.1.6 Dominica Community High School

The Dominica Community High School (DCHS – see Figure O) is located on the outskirts of Roseau. The school has two main buildings: a one-storey concrete buildings (which historically served as the school's classrooms), and a relatively recent two-storey concrete building, which includes

classrooms, storage rooms, and a computer room on the north end of the school's compound. The school uses single-phase electricity.

Only the roof of the two-storey concrete building is considered as a potentially feasible location for solar panels, as the one-storey building is susceptible to theft of PV systems (which occurred in the past). The roof of the two-storey building is flat and built out of concrete, and it is in generally good condition. This building also includes a moderately sized storage room on the east end of the ground floor, and it will serve as a suitable location for placing PV inverters.



Figure O. DCHS One-storey (left) and Two-storey buildings (right)

3.1.7 Mahaut Primary School

Mahaut Primary School (Figure P), located in Mahaut, Dominica, consists of a long-arrow shaped two-storey building. Operations commenced at the newly constructed school in October 2022, serving a population of 140 students, while also acting as a hurricane shelter for the community of Mahaut. The school is currently oversized relative to its current student population; however it includes ample storage and roof space in/on the building.

The school uses three-phase electricity, and it includes a dedicated electrical and storage room on the first floor. Another storage room exists on the second floor, near the central staircase, and it is located in a cooler area with more space, making it a more suitable location to place PV inverters and other supporting equipment for the solar PV system. The building's roof is relatively flat and made out of concrete, but it does not include any sealant over the concrete. As a result, small surface cracks have begun to appear. Prior to the installation of any solar PV or water

storage units on the building's roof, it is strongly encouraged that a sealant be placed on the concrete roof to prevent cracks and avoid future leakages through the concrete.



Figure P. Mahaut Primary School

3.1.8 Vieille Case Resource Centre

Vieille Case Resource Centre (Figure Q), is located in Vieille Case on the north coast of Dominica. The building was recently constructed within the last two years, and it has been occupied since 2022 by the Vieille Case Community Centre, Post Office, and Innovation Centre (IT Room). However, the building consists of at least 5 more rooms which are currently unoccupied, along with a large meeting room on its western end.

The building is served by Three-phase electricity, and a sizeable storage room exists on the first floor, with almost 16 feet of wall space for installing PV inverters, and more than 45 square feet of floor space for the installation of battery storage systems.

The roof of the building has two different profiles: a flat concrete roof, and a sloped aluminium sheet roof. Both roof profiles are in good condition and are suitable locations for installing solar PV systems.



Figure Q. Vieille Case Resource Centre

3.1.9 Trafalgar Community Centre

Trafalgar Community Centre (Figure R) is located in Trafalgar, in the Roseau Valley Region in Dominica. The building was constructed in 2021 and serves as the location for the Trafalgar Village Council, and an Innovation Hub (computer room) for the community. The building also includes two other vacant office spaces, and a large meeting room for community events. Overall, most rooms in the building remain unoccupied during the day.

Trafalgar Community Centre is served by single-phase electricity, while the most suitable location for solar panels were identified as the flat concrete roof and pitched aluminium roof of the building. The concrete roof has an extensive amount of mold, and the roof will require repair and sealing before solar panels or water storage equipment can be placed on it.

The most suitable location for solar PV inverters and supporting equipment is below the stairs leading to the second-floor porch on the east end of the building. The building includes a storage room on the first floor; however, the room is significantly occupied with mail and emergency equipment.



Figure R. Trafalgar Community Centre

3.1.10 Sineku Resource Centre

The Sineku Resource Centre (Figure S) is located in Sineku in the Kalinago Territory on the east coast of Dominica. The building serves as an emergency shelter for the Sineku community, and it was recently rehabilitated in 2021 by the International Organization for Migration (IOM), with funds from the United States Agency for International Development (USAID). The Sineku Resource Centre is not occupied during the weekday or weekends by any entities or organizations from the Sineku community, and therefore the building remains closed most days, with no regular opening hours.

The building is fitted with an aluminum sheet roof and 2-inches by 8-inch rafters spaced two feet apart. The roof is in good condition, and overall, in suitable shape for installing solar modules on it. The interior of the building was not accessible during the site visit, and a definitive location for siting PV inverters could not be located. However, it is likely that adequate space may exist in relatively empty rooms on the west end of the building on the ground floor.



Figure S. Sineku Resource Centre, Front View facing North

3.2 Solar / Electrical Analysis

For solar units, our team collected information regarding location, type of electrical connection (single-phase or three-phase), roof condition, pitch of roof, shading/obstacles on roof, electricity meter location/number, distribution panel location, and potential location for solar PV inverters. For buildings which were already served by an existing generator unit we collected information regarding the type of generator units, capacity, size, working regime, working status (on duty, off-duty, damaged, etc.) and maintenance needs. Other useful data retrieved included the generator's year of installation, voltage, phase power, and whether it was connected to national grid. We also estimated the units' endurance against climate events (preventive measures, protection systems, storage possibilities, etc.) and collected electrical consumption records for each building in order to identify any consumption patterns.

A summary of the findings of the site assessments determining the suitability for each facility to accommodate solar PV installations is provided in Table B. Further details pertaining to the site conditions are provided in Appendix 1.

Table B. Solar / Electrical Site Assessment Summary

Building ID	Electrical Connection Type	Standby Generator? (Y/N)	Standby Generator Capacity (kVA)	Roof Condition	Electrical Services Condition	Recommended Renewable Energy System for Building
Education						

Building ID	Electrical Connection Type	Standby Generator? (Y/N)	Standby Generator Capacity (kVA)	Roof Condition	Electrical Services Condition	Recommended Renewable Energy System for Building
Dominica State College – Buildings A, B, C	Three-Phase	N	N/A	Very Good	Very Good	Solar PV only
Dominica State College – Carpentry Building	Three-Phase	N	N/A	Good	Good	Solar PV only
Dominica State College – Library	Three-Phase	N	N/A	Very Good	Very Good	Solar PV only
Dominica State College – Building N1	Three-Phase	N	N/A	Very Good	Poor	Solar PV only
Dominica State College – Building N2	Three-Phase	N	N/A	Very Good	Poor	Solar PV only
Dominica State College – Tourism Building	Single-Phase	Y	52 kVA	Good	Good	Solar PV only
Dominica State College – Confucius Classroom	Single-Phase	Y	52 kVA	Good	Good	Solar PV only
Dominica State College – General Studies Building	Single-Phase	Y	52 kVA	Good	Good	Solar PV only
Dominica State College – Creative Caribbean Building	Single-Phase	N	N/A	Good	Good	Solar PV only
Dominica State College – Main Building & Office	Single-Phase	Y	52 kVA	Poor	Good	Solar PV only
Dominica State College – Jolly’s Mini Pharmacy	Single-Phase	Y	52 kVA	Good	Good	Solar PV only
Dominica Community High School	Single-Phase	Y	5.5 kVA	Good	Good	Solar PV only

Building ID	Electrical Connection Type	Standby Generator? (Y/N)	Standby Generator Capacity (kVA)	Roof Condition	Electrical Services Condition	Recommended Renewable Energy System for Building
Mahaut Primary School	Three-Phase	N	N/A	Good	Good	Solar PV only
Community						
Vielle Case Community Centre	Three-Phase	N	N/A	Concrete Roof: Good Aluminum Roof: Very Good	Very Good	Solar PV and battery storage
Trafalgar Community Centre	Single-Phase	Y – Not yet installed	12 kVA	Concrete Roof: Poor Aluminum Roof: Good	Good	Solar PV only
Sineku Resource Centre	Single-Phase	N	N/A	Good	Good	Solar PV only
Health						
Mahaut Health and Wellness Centre	Single-Phase	N	N/A	Very	Very good	Solar PV and battery storage
Newtown Health Centre	Three-Phase	N – Generator to be installed in coming weeks	TBD	Very good	Very good	Solar PV only
Other Sectors						
Roseau Fisheries Complex	Three-Phase	Y – Generator on site, but not yet installed	310 kVA	Very good	Very good	Solar PV only
Dominica Meteorological Office	Three-Phase	Y	N/A	Very good	Very good	Solar PV and battery storage

3.3 Water Storage Analysis

With respect to water capture systems, our team recorded the location of water capture/storage units (if any existed), type of system, capacity, size, operation, maintenance needs and water usage data. We also analyzed if there were any potential health risks (water quality issues, and mosquito proliferation) pertaining to the capture/storage units and assessed the units' anticipated endurance against climate events (preventive measures, protection systems, and storage possibilities).

We also collected water consumption records for each building from DOWASCO in order to identify any water usage patterns, however DOWASCO was unable to provide this data for all the buildings identified. Further investigation is required to potentially fill this data gap.

A summary of the water storage analysis is provided in Table C and Table D. Further details regarding the potential water collection systems are presented in Appendix 2.

Table C. Water Storage Summary

Building ID	Storage Type	Location of Storage	Is System Scalable?	How Sustainable is Building?	Can Water Capture System Operate Under Hazardous Conditions?	Any Design Recommendations?
Education						
Dominica State College	Rubber tank above ground	Ground setup	Y	Many buildings form campus and most not sustainable.	Yes, certain buildings act as an emergency shelter prior, during or after a natural hazard.	The college has a storage tank with a capacity of 15,000 imp gal. Most structures have timber roofs which makes them vulnerable.
Dominica Community High School	Rubber tanks at ground (existing, Nos.-6)	Ground setup	Y	New extension has concrete roof so additional tanks can be installed at roof level	Yes, this school was newly refurbished under BNTF 9. The new refurbishments enabled the school to be resilient in case of natural hazards.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Mahaut Primary School	Rubber tank above ground	Roof setup	Y	Sustainable	Yes, this school is newly built with design considerations to make it less vulnerable and more resistant to natural hazards. It was constructed in 2022.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Community						
Vieille Case Community Centre	Rubber tank at roof	Roof setup	Y	Building commissioned in 2021. Concrete roof exists so units can be placed there. No roof sealant applied and cracking observed.	Yes, this community centre was newly constructed in 2021, with design considerations to make it less vulnerable and resistant to natural hazards.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Trafalgar Community Centre	Rubber tank at Roof	Roof setup	Y	Building commissioned in 2021. Concrete roof exists so units can be placed there. No roof sealant applied and cracking observed	Yes, this community centre was newly constructed in 2021, with design considerations to make it less vulnerable and resistant to natural hazards.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.

Building ID	Storage Type	Location of Storage	Is System Scalable?	How Sustainable is Building?	Can Water Capture System Operate Under Hazardous Conditions?	Any Design Recommendations?
Sineku Resource Centre	Rubber tanks at ground level (existing, Nos.-2)	Ground setup with cable fastening.	Y	Building renovations done in 2021. Sufficient lands available to increase tanks. Resizing of pump maybe required.	Yes, however this structure has a timber roof.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Health						
Mahaut Health and Wellness Centre	Rubber tank above ground	Ground setup	N	Same design as Mahaut Health Center	Yes, this health centre was newly constructed in 2021, with design considerations to make it less vulnerable and resistant to natural hazards.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Newtown Health Centre	Rubber tank above ground	Ground setup	N	Leaks on roof existing	Yes, this health centre was newly constructed in 2021, with design considerations to make it less vulnerable and resistant to natural hazards.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Other Sectors						
Roseau Fisheries Complex	Rubber tank above ground	Roof setup	Y	Sustainable	Yes, this building was rehabilitated and upgraded in 2022, with design considerations to make it less vulnerable and resistant to natural hazards.	Both a rainwater storage system utilizing a gravity fed circulation system and a rainwater storage system utilizing a pump powered by a solar panel can be utilized on this site.
Dominica Meteorological Office	Rubber tank above ground	Roof setup	Y	Sustainable	Yes, this building was recently built and appears to meet recent code changes with many sustainable features (eg concrete roof).	There is existing water storage on the roof, however, this can be augmented and in addition inclusion of PV system. Sufficient roof space exists to house these systems.

Table D. Water Consumption Data

Building ID	Monthly Consumption (imperial gallons)						Recommended Storage (48 hr)
	Oct. 2022	Nov. 2022	Dec. 2022	Jan. 2023	Feb. 2023	Mar. 2023	
Education							
Dominica State College	10,149	15,828	33,919	24,476	24,610	63,820	2057.2
Dominica Community High School	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available	6000.0
Mahaut Primary School	70,387	132,982	47,886	56,774	54,971	47,329	4884.9
Community							
Vieille Case Community Centre	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available	4000.0
Trafalgar Community Centre	2,181	3671.14	2,858	294	720	603	122.9
Sineku Resource Centre	36,130	69,390	19,520	10,550	5,560	2,580	1711.1
Health							
Mahaut Health and Wellness Centre	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available	4000.0
Newtown Health Centre	5,641	4,434	5,535	5,020	4,625	7,420	389.0
Other Sectors							
Roseau Fisheries Complex	Data not available	Data not available	Data not available	Data not available	4000	4000	1000
Dominica Meteorological Office	3,852	7,694	7,565	6,191	6,280	6,466	453.0

Although the water usage data is useful to understand the amount of potable water that each public building uses, it is difficult to determine how much is currently used for non-potable use, such as irrigation. Assuming each building would not use rainwater for laundry or flushing toilets, this leaves the primary use for rainwater harvesting to be used solely for irrigation purposes. During our field visits to the ten (10) public buildings we tried to gather information as to possible volume that each building might use towards irrigation purposes, and this information has been illustrated

in Table E. However, most Stakeholders were unsure as to how much irrigation water could be used. Therefore, this information requires further investigation.

Table E. Estimated Amount of Irrigation Water Needed at Each Public Building

Building ID	Irrigation Water Needed (gpd)
Trafalgar Community Centre	TBD
Dominica Community High School	500
Newtown Health Centre	TBD
Mahaut Health Centre	TBD
Roseau Fisheries Complex	TBD
Dominica State College	TBD
Mahaut Primary School	TBD
Dominica Meteorological Office	TBD
Vieille Case Community Centre	TBD
Sineku Resource Centre	TBD

Based on the information from Table E, we are not able to provide conclusive estimates on the volumes needed at each building, other than the Dominica Community High School. Regardless, a variety of design options including drawings, with varying storage volumes, are provided in Appendix 4. Further details are also discussed in Section 5.2.1.

4 SIMILAR SYSTEMS ANALYSIS

4.1 Solar

Numerous resilient solar PV designs and reports informed the guidance and recommendations for the solar PV recommendations on the public buildings. A summary of these guidelines is provided in Table F.

Table F. Related Reports on Resilient Solar PV Systems

	Document	Main Takeaways
National Renewable Energy Laboratory (NREL)	Solar Photovoltaics in Severe Weather: Cost Considerations	Resilience of solar PV systems is based on quality assurance (QA) in system design, quality control (QC) during installation, and ongoing operations and maintenance (O&M). 13 storm hardening measures for solar PV systems were identified, and cost guidance associated with each measure, including: system audit, locking fasteners, through bolting, module selection, three-framed rail system, etc.

	Document	Main Takeaways
	for Hardening PV Systems ¹²	
United States Federal Emergency Management Agency (FEMA)	Rooftop Solar Panel Attachment: Design, Installation, and Maintenance ¹³	<p>Recommended guidance and best practices to increase the wind resistance of solar panels in the U.S. Virgin Islands were developed in a FEMA report, informed by the experiences of Hurricanes Irma and Maria in 2017. For hurricane-prone regions, guidance included:</p> <ul style="list-style-type: none"> ▪ Using microinverters instead of string inverters, as they have a greater chance of allowing undamaged panels to produce electricity if other panels are damaged. ▪ Specifying PV panels and rail/rack systems that have UL 1703 and UL 2703 listing (as applicable), and an ICCAC 428 evaluation report, and ▪ Specifying that PV panels are not installed over roof drains and there is a walkway between rows of rooftop PV panels so bolted connections can be checked manually, along with numerous additional recommendations.
Rocky Mountain Institute	Solar Under Storm Part I: Select Best Practices for Resilient Ground-Mount PV Systems with Hurricane Exposure ¹⁴	<p>From the experiences of Hurricanes Harvey, Irma, and Maria in the Caribbean, the root causes of failure for ground-mount solar PV systems came from clamp failures, undersized racks, under-torqued bolts, a lack of bolt locking solutions, and a lack of racking support. Solar Under Storm provides clear specifications for ground-mount PV systems, including:</p> <ul style="list-style-type: none"> ▪ Using high-load PV modules (5,400 Pascals) ▪ Requiring a structural engineering review and wind-tunnel report review ▪ Specifying a bolt hardware locking solution and bolt quality control process ▪ Specifying through bolting of modules as opposed to top-down or T-clamps

¹² Solar Photovoltaics in Severe Weather: Cost Considerations for Storm Hardening PV Systems for Resilience. NREL (2020). <https://www.nrel.gov/docs/fy20osti/75804.pdf>

¹³ Rooftop Solar Panel Attachment: Design, Installation, and Maintenance. FEMA (2018).

¹⁴ Solar Under Storm Part I: Designing Hurricane Resilient PV Systems. RMI (2018). <https://rmi.org/insight/solar-under-storm/>

	Document	Main Takeaways
		<ul style="list-style-type: none"> Requiring structural engineer review of lateral loads Not using self-tapping screws Specifying dual post pier foundations
Rocky Mountain Institute and The Clinton Foundation	Solar Under Storm Part II: Select Best Practices for Resilient Roof-Mount PV Systems with Hurricane Exposure ¹⁵	Informed by the experience of Hurricanes Harvey, Irma, Maria, and Dorian, Solar Under Storm Part II investigated the failures of roof-mounted PV systems, and best practices for installing resilient rooftop PV systems. Recommendations for building resilient rooftop PV systems focused on specifications and collaboration. Specifications include identifying a project QA/QC process, where and how to attach the modules to the roof, specifying high-load PV modules, and more. While the importance of collaboration focused on ensuring solar PV designers and installers collaborate with module and racking suppliers for more efficient solutions to deal with wind load challenges faced on solar modules, and installers and module suppliers working together to ensure the local availability of specified modules, racking, and fasteners.

Similar Solar PV and battery storage installations on government facilities in the Caribbean were also informed the analysis and recommendations for the solar PV assessment on the identified public buildings, as shown in Table G.

Table G. Related Solar PV Installations in the Caribbean

Project	Size	Project Overview
Dominica School Microgrid Project	10.64 kW DC solar PV plus 10 kW / 76 kWh battery energy storage	This project provides resilient, renewable energy solutions at two schools in Dominica, Morne Prosper Primary School, and Paix Bouche Primary School. Installed in 2022, The systems will create microgrids at the schools, providing capabilities to operate both as a grid-connected and off-grid systems supplying critical loads at the schools.
Abaco School Microgrids Project	86 kW DC solar PV plus 45 kW /	This project provides resilient, renewable energy solutions at three schools in Abaco, The Bahamas that also double as emergency shelters. The solar PV and battery storage projects at Central Abaco Primary School, Man-o-War

¹⁵ Solar Under Storm Part II: Select Best Practices for Resilient Roof-Mount PV Systems with Hurricane Exposure. RMI and the Clinton Foundation (2020). <https://rmi.org/insight/solar-under-storm/>

Project	Size	Project Overview
	194 kWh battery energy storage	Primary School, and Great Guana Cay School. The three schools suffered significant damage due to Hurricane Dorian in 2019 and were 'built back better' with the Category 5 rated solar PV and battery storage installations being completed in 2023. The systems reduce the cost of electricity at the schools while providing backup power to critical loads during grid outages.
Anatol Rodgers High School Energy Retrofits Project	250kW DC solar PV only	As the first renewable energy installation on a public building in The Bahamas this project retrofitting one of the larger secondary schools in the country with solar PV and energy efficiency equipment. Completed in 2019, this initiative has opened the door for several other solar PV projects at government facilities since.
SVG Community College Arts & Sciences Campus Solar PV Project	95kW DC solar PV only	Designed for Category 5 hurricane wind speeds this project included the installation of solar PV arrays on flat and pitched roofs at the school. Completed in 2021, it is the second largest rooftop solar PV system at a public facility in St. Vincent & the Grenadines and significantly reduces the institution's electricity costs and carbon footprint.
Evesham Health Centre Solar PV Project	50kW DC solar PV only	The 50kW solar PV system at the Evesham Health Centre in rural St. Vincent & the Grenadines is the country's largest renewable energy system at a health care facility. This flat roof installation is designed for Category 5 winds and to reduce the electricity cost of the building while demonstrating the value of renewable energy to the surrounding community.

4.2 Rainwater

Table H illustrates several other documented rainwater harvesting (RWH) programmes throughout the Caribbean that were examined in order to gain information related to lessons learned that could be applied towards this initiative.

Table H. Related RWH Programmes and Documentation

Author	Project / Document Name	Main Takeaways (Obtained from the associated project / document referenced within this table)
Government of Bermuda,	Proper Maintenance of	Every 3 months disinfect the supply tank using 2 – 4 oz of regular unscented bleach for every 1,000 gallons of water and mix thoroughly.

Author	Project / Document Name	Main Takeaways (Obtained from the associated project / document referenced within this table)
Ministry of Health (MoH)	Tank Water Systems (GN404)	<p>Use wire pineapples on down spouts to prevent leaves from entering the tank (these must be cleaned regularly).</p> <p>The Government of Bermuda requires RWH tanks to be cleaned every 6 years to remove debris that forms a decomposing layer at the bottom of tanks and can cause the liberation of hydrogen sulphide (H₂S) gas.</p> <p>Use fine wire mesh on overflows and vents to prevent mosquitoes from entering.</p> <p>If water becomes stagnant, chlorinate, and then aerate water by running garden hose onto the roof to create an aeration/recirculation loop.</p>
Government of Bermuda, MoH	Solutions for Common Tank Problems (GN405)	<p>Fish (guppies) along with insect screens on vents and overflows to be used to prevent mosquito breeding.</p>
Global Water Partnership-Caribbean (GWP-C)	Mainstreaming RWH to Build Climate Resilience in the Caribbean Water Sector	<p>GWP-C has been active in the region helping to promote RWH through knowledge sharing and capacity building. They have developed along with partners, several online toolboxes, which contains videos, brochures, technical information, and other media relating to the safe use of RWH.</p> <p>Several Caribbean countries (see extract from Table I below) have already enforced some legislation regarding RWH especially related to building codes. Barbados is included in this list with a requirement to build RWH tanks for every new building. Incentives by the BWA are \$0.50 per gallon of stored capacity (Indicative National-level legislation programmes and policies supporting RWH' can be found in Table I.</p> <p>Policies and legislation promoting and incentivising the use of RWH are the most effective means of mainstreaming RWH practices and these efforts need to be increased.</p>
The Caribbean Environmental Health Institute, funded by United Nations	Handbook on Rainwater Harvesting for the Caribbean (2009)	<p>RWH is the oldest form of water collection and remains one of the easiest and cost-effective means of collecting water to date.</p> <p>Caribbean islands started out completely reliant on RWH for water and have over the years developed municipal supply systems transferring populations reliance to</p>

Author	Project / Document Name	Main Takeaways (Obtained from the associated project / document referenced within this table)
Environment Programme (UNEP)		<p>centralised systems which are now exposed to the effect of climate change. RWH remains a very climate resilient technology.</p> <p>Techniques to reduce the pollution of the water and tank by leaves, bird droppings and other debris which can compromise water quality. These include first flush systems, baffle tanks, downpipe inlet with break ring, float with flex hose for outlet, and different configurations for overflows to help preserve the stored water quality.</p> <p>Types of storage tank can include the cistern (integrated into building foundation), plastic food grade material above ground tanks (more recently used and modular), and fiberglass tanks which can be made custom but are generally the most expensive option.</p> <p>Water pressure can be provided by a pressurized system (pump, pressure bladder, pressure switch and check valve) or a head pressure system (elevated tank which provides water by gravity).</p> <p>Filtration can be used to further improve quality of water, and this is installed after the collection system.</p> <p>Rainwater can become contaminated by pollutants in the atmosphere including Sahara dust, during capture by toxic paint or chemicals on catchment (roof) surfaces as well as biologically by faecal deposits made by rodents, birds etc. In addition, stored water can become infested by mosquitoes or other aquatic life that makes its way into storage tanks. The handbook goes into detail on how to help prevent and deal with these possible forms of contamination.</p> <p>Filtration followed by ultra-violet (UV), chlorination, and boiling are demonstrated as ways to ensure safety of water when used for drinking purposes.</p>
Maya Trotz & Wainella Isaacs	Water Sector Resilience Nexus for Sustainability in Barbados Outputs (2018)	<p>Any building erected after 1996 in Barbados must provide a rainwater storage tank to capture water for secondary or non-potable uses.</p> <p>Residential structures with 139 to 279 m² (1,500 to 3,000 ft²) of roof area require a 13.6 m³ (3,593 gal) tank; a residence greater than 279 m² (3,000 ft²) of roof area requires a tank of 27.3 m³ (7,212 gal) and all commercial and industrial buildings require a</p>

Author	Project / Document Name	Main Takeaways (Obtained from the associated project / document referenced within this table)
		tank with a volume computed on the basis of 193 L/m ² of roof area (Hutchinson 2010).
Andrew P. Hutchinson, C.Eng, MICE, P.Eng.	Rainwater Harvesting – Case Studies from the Barbados Experience (2010)	<p>Andrew Hutchinson points out that "In Barbados, the current potable supply of 57.9M m³/year (15G US gals per year) represents some 13% of the total precipitation for a 40" rainfall year or 8.6% of the total precipitation for a 60" rainfall year." This highlights the case for RWH techniques to be adapted in the face of a 'water scarce' island.</p> <p>Major RWH projects have already been undertaken in Barbados to provide non potable water alternatives when requests for potable water irrigation were denied, considering creating potable water from private systems is currently not permitted in Barbados. All potable water must be obtained from the Barbados Water Authority (BWA).</p>

Although the Government of Bermuda MoH provides an alternative cleaning program from what the Government of Dominica currently has in place, this information can be used for future consideration if the cleaning recommendations ever require to be modified.

In addition, the following list, that is not exhaustive, considering St. Lucia and Jamaica also have RWH programmes developed, shows various government initiatives across the region relating to the capture and utilization of rainwater.

Table I. RWH Legislation/Instruments from the Region¹⁶

Country	Legislation/ Instrument	RWH components
Antigua & Barbuda	Draft IWRM Policy	Policy recognises <i>inter alia</i> the need to invest in RWH. The policy was developed with financial and technical support from GWP-C
Barbados	Legislation, incentives	Rainwater tanks must be installed on every building as of 1996 (König 2001), new residential buildings must include water storage facilities. Incentives are offered in the form of \$0.50 per gallon (3.79l) of installed tank capacity by the Barbados Water Authority (United Nations Environment Programme n.d.).
Bermuda	Building codes	Eighty (80) percent of any home's roof has to be converted into a rainwater catchment area (Institute for International Urban Development 2015).
Grenada	Legislation	New residential properties must be equipped with RWH systems (United Nations Environment Programme 2010).
Grenada	National RWH Programme	Awareness raising, capacity building, legislative and policy reform, infrastructural development and administration, and monitoring and evaluation form the basis of this programme developed in 2006 (Caribbean Environmental Health Institute 2006).
Grenada	Water Policy/ Roadmap	The IWRM Roadmap speaks to RWH capacity building.
Turks and Caicos	Government support, legislation	Public rainfall catchments were constructed by the government. Regulations require that all developers construct cisterns at a size of 100l/m ² of roof area.
US Virgin Islands	Legislation	Legislation requires that all new houses constructed include guttering and cisterns (United Nations Environment Programme n.d.). Cistern construction is regulated by the U.S. Virgin Islands Building Code (United Nations Environment Programme n.d.).

Rainwater harvesting and surface water impoundments in rural settings are frequently used for potable water purposes following treatment. From a regulatory perspective, the proliferation of private potable water systems presents several problems including decreased utility revenues and concerns regarding maintaining the integrity of the public water distribution system with respect to potential cross-connections between public and private systems. However, the implementation of appropriate non-potable plumbing code provisions and keeping storage reservoirs for such systems isolated through an air gap is frequently implemented to address cross-connection concerns. The implementation of private rainwater harvesting systems are expected to have a beneficial impact on the existing DOWASCO public water system which could be challenged to meet public water demands under climate change influenced drought conditions or after a large storm event such as a hurricane. At the very least, the ability to store and distribute

¹⁶ Source: Global Water Partnership-Caribbean; Mainstreaming Rainwater Harvesting (RWH) to Build Climate Resilience in the Caribbean Water Sector.

water within building for non-potable applications (i.e. dual-plumbing systems to supply water for toilet/urinal flushing, laundry and irrigation, for example) would reduce public potable water demands.

5 RECOMMENDATIONS

5.1 Solar

5.1.1 Potential Designs

Due to many factors including high solar irradiance levels, high cost of utility power, and the generally declining cost of solar equipment, solar PV systems provide one of the best solutions for reducing the electricity costs of the buildings that have been assessed. When coupled with battery storage, solar PV systems can potentially provide additional value streams including further energy cost savings and backup power. Solar PV installations have been proposed for all sites.

Solar PV systems were sized for each site based on the general conditions stated in DOMLEC's Distributed Renewable Energy Policy (2016, version 2.00). This document indicates that the allowed capacity of distributed generation (DG) systems of 150kW and lower is limited to the average monthly consumption for the past 12 months divided by 150 and multiplied by 1.5.

Electricity billing information for the DOMLEC accounts at each site was used to determine the size PV systems that would be permitted at each site. Consumption figures for the 12-month period from April 2022 to March 2023 was used for each site. Any months where the average daily consumption was significantly lower than that of other months were considered outlier months where the usage was not used in calculating the overall average monthly consumption.

See Table J for a summary of the average monthly consumption that was determined for each site and the outcomes of the solar PV sizing exercises that have been done for each facility. Note that the Dominica State College has 11 electricity accounts for the various buildings on its campus and therefore a similar number of solar sizing exercises were carried out for that site. Also, three sites have been earmarked for solar PV and battery storage assessments including the Mahaut Health & Wellness Centre, the Dominica Meteorological Office, and the Vieille Case Community Centre. The assessments have been completed for all three sites. Additionally, there are some sites where the roof space available is insufficient to accommodate the maximum allowable solar PV system. In these cases, the system sizes proposed are reflective of the usable roof space at each facility.

In addition to proposed solar PV system and battery storage sizes Table J also indicates estimated costs for installations at each site. Appendix 3 provides potential layouts of the solar PV arrays that could be installed at these sites.

Table J. Solar PV & Battery Storage System Capacities and Costs

Building ID	Average Monthly Electricity Usage (kWh)	Maximum Permitted Solar PV System Size (kWac)	Proposed Solar PV System Size (kWac/kWdc)	Solar Panels Required (420W panels)	Battery Storage System Size (kWac/kWh)	Estimated Cost (USD)
Education						
Dominica State College – Buildings A, B, C	1,044	10.4	10 / 10.9	26	N/A	\$19,600
Dominica State College – Carpentry Building	2,051	20.5	20 / 21.8	52	N/A	\$34,950
Dominica State College – Library	504	5	5 / 5.8	14	N/A	\$12,950
Dominica State College – Building N1	244	2.4	2 / 2.52	6	N/A	\$6,950
Dominica State College – Building N2	290	2.9	3 / 3.3	8	N/A	\$8,400
Dominica State College – Tourism Building	105	1.1	1 / 1.2	3	N/A	\$3,500
Dominica State College – Confucius Classroom	538	5.4	5 / 5.8	14	N/A	\$12,950
Dominica State College – General Studies Building	848	8.5	8 / 9.2	22	N/A	\$20,350
Dominica State College – Creative Caribbean Building	151	1.5	1.5 / 1.6	4	N/A	\$4,650
Dominica State College – Main Building & Office	2,032	20.3	20 / 21.8	52	N/A	\$34,950
Dominica State College – Jolly’s Mini Pharmacy	601	6	6 / 6.7	16	N/A	\$14,800
Dominica Community High School	314	3.1	3 / 3.3	8	N/A	\$8,400

Building ID	Average Monthly Electricity Usage (kWh)	Maximum Permitted Solar PV System Size (kWac)	Proposed Solar PV System Size (kWac/kWdc)	Solar Panels Required (420W panels)	Battery Storage System Size (kWac/kWh)	Estimated Cost (USD)
Mahaut Primary School	1,491	14.9	15 / 16.8		N/A	\$30,250
Community						
Vieille Case Community Centre	132	1.3	3 / 1.6	4	6 / 11.4	\$25,650
Trafalgar Community Centre	267	2.7	2.5 / 2.9	7	N/A	\$8,100
Sineku Resource Centre	26	0.3	0.3 / 0.4	1	N/A	\$1,200
Health						
Mahaut Health and Wellness Centre	614	6.1	6.1 / 6.7	16	10 / 30	\$59,800
Newtown Health Centre	3,157	31.6	6.1 / 6.7	16	N/A	\$14,800
Other Sectors						
Roseau Fisheries Complex	8,710	87.1	57 / 59.6	142	N/A	\$95,400
Dominica Meteorological Office	1,920	19.2	10 / 10.9	26	20 / 68	\$103,700

5.1.2 Weather-Resilient Solar PV Installations

With the annual threat of hurricanes solar PV systems in the Caribbean need to be designed and installed in a manner that affords the best chance of survival when impacted by these storms. RMI has published three reports that provide recommendations for designing solar PV systems in this manner. One of these reports, “Solar Under Storm Part II: Select Best Practices for Resilient Roof-Mount PV Systems with Hurricane Exposure”, speaks specifically to solar PV array installed on building roofs. The following is a list of many of the recommendations from that report:

- Require installation of PV modules only in wind Zones 1 and 2 for pitched-roof systems;
- Adopt minimum mechanical attachment specifications;
- Use top-down clamps that do not retain more than one module per clamp to avoid cascading failures;

- Require vibration-resistant fasteners;
- Ensure QA/QC during installation;
- Avoid self-tapping screws for structural loading in the design;
- Verify racking vendor meets recommended analysis and minimum mechanical attachment scheme;
- Install positively retained wind deflector with vibration-resistant solution;
- Specify high load (target 5,400Pa front load rating) PV modules; and
- Require structural engineering in accordance with ASCE 7 and site conditions, with sealed calculations for wind forces, reactions, and attachment design.

5.1.3 Proposed Solar PV Monitoring

Monitoring of a solar PV system is an important aspect of system operation that allows for the verification of system performance, identification of technical issues and defects, and determination of economic return on the investment. Best practice dictates that system monitoring should be available both at the site of the installation and remotely. Many manufacturers of PV equipment provide monitoring features that allow users to view equipment status, electrical parameters and statistics, and on-site weather conditions.

A solar PV system monitoring system should provide the following information to users:

- Real time AC and DC electrical characteristics, including power, energy, voltage, current, frequency, power factor, inverter status, fault codes and diagnostics;
- DC earth fault monitoring at the inverter input;
- Where a meteorological station is installed information on solar irradiance, ambient air temperature, back of module temperature, wind speed, and wind direction should be provided; and
- Where battery storage is installed information on battery voltage, temperature, state of charge, state of health, and charge/discharge cycles should also be provided.

5.2 Water

5.2.1 Potential Designs

The design considerations, for RWH storage systems focused on three main categories:

- Potential tank installation location;
- Cost options associated with each design consideration; and
- Various tank sizes that are available.

Using these design considerations, a variety of water collection system options were generated, that include design drawings (illustrated in Appendix 4), as well as unit costs (included in Appendix 6). Each design option will need to be considered when conducting field verifications to finalize the selection process to match the most appropriate system for each building type.

5.2.2 Proposed RWH Monitoring and Guidelines

Keeping insects, especially mosquitos, out of RWH tanks is very important. Installing RWH systems comes with the responsibility of ensuring these systems are safe, reliable, and well maintained, and this responsibility may not want to be left to an individual or group who currently maintains the public building. In order to constantly verify the proper maintenance and operation of the water storage systems, it is proposed that a computer maintenance management system (CMMS) be employed and managed by the 3rd party installation team(s) that builds the systems. A CMMS system should be selected that can:

- Store documentation (best practices, standard operation procedures, manuals, toolkits, etc);
- Store information on all assets (pumps, tanks, etc);
- Store information on location of each asset on a map of Barbados including storage capacity and details of installation;
- Store information on points of contact at each property;
- Provide digital work orders that can be signed as completed by clients and are logged under each asset;
- Provide a means of work order requests (a way to raise issues and log response time) from clients and stakeholders;
- Provide scheduling and alerts for service visits;
- Provide a digital checklist for such service visits;
- Record and display data collected in the field in visual formats;
- Provide a troubleshooting guide for service providers and clients; and
- Provide a single point of communication between all parties.

The water storage systems require maintenance that should include:

- Cleaning or replacing water filter(s);
- Verification of water quality in tank (free chlorine and bacteria detect/non detect test);
- Pump maintenance (as per vendor recommendations);
- Update of CMMS that water system has been serviced and is in good condition; and
- On-going trouble shooting and issue response by provider.

5.2.3 Proposed Cleaning Schedule for Rainwater Harvesting Tanks

We recommend the following cleaning schedule for non-potable water tanks, such as RWH system storage tanks:

- Cleaning of tanks can be done once a year during the dry season and disinfected using sodium hypochlorite; and
- Any filters attached can be disinfected with sodium hypochlorite weekly and rinsed in fresh water and/or replaced as required.

We also suggest the following be taken into consideration when maintaining RWH systems:

- Use wire pineapples on down spouts to prevent leaves from entering the tank (these must be cleaned regularly);
- Use a fine wire mesh on overflows and vents to prevent mosquitoes from entering, and monitor this screen to make sure it is not compromised over time; and
- If the rainwater were to be used for potable water (in the future), and it becomes stagnant (e.g. occupants absent from their home for an extended period of time), physical cleaning followed by a chemical clean (as described above) should be followed.

6 CLOSURE

Integrated Sustainability would like to thank the CTCN for the opportunity to work on this project and for your support. We trust that this report meets your needs and expectations. If you have any questions, please contact the undersigned at any time.

Sincerely,

Nick St-Georges, P.Eng.
Civil Engineer, Project Manager

Sidney Jules
Solar Systems Expert

7 REFERENCES

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- Suchorski, A., 2009. Socio-economic and Physical Development Influences on Water use in Barbados. Dissertation for McGill University, Department of Bioresource Engineering. https://www.mcgill.ca/cariwin/files/cariwin/aliciasuchorski_watergender_barbados.pdf

Appendix 1 – Field Data Collection – Power

Appendix 2 – Field Data Collection – Water

Appendix 3 – Solar Proposed Design Layouts

Appendix 4 – RWH Proposed Design Layouts

Appendix 5 – Cost Estimate - Solar

Appendix 6 – Cost Estimate - RWH