

FORMULATING A NATIONAL ELECTRICITY GRID CODE AND DEVELOPMENT OF A NET METERING POLICY IN TIMOR- LESTE

Intelligent Energy Systems Pty Ltd
(IES) to the United Nations
Environment Programme (UNEP)

CONTRACT NO. UNEP/2024/33
(Umoja # 4700027873)

**Output 2: Solar Resource Data and
Insights for Timor Leste**

25 September 2025



© Copyright Intelligent Energy Systems Pty Ltd. No part of this document may be used or reproduced without Intelligent Energy Systems' express permission in writing.



Table of Contents

1	Introduction	4
1.1	Project Context	4
1.2	Output 2 Description	4
1.3	Timor Leste Renewable Energy Policy	4
1.4	Report Outcomes	6
1.5	Methodology and Approach (to Output 2)	7
1.6	Structure of this Report	7
2	Solar PV Concepts	8
2.1	Photovoltaics	8
2.2	Photovoltaic Cell Efficiency	8
2.3	Sun's Altitude	8
2.4	Irradiance (Insolation)	8
2.5	Solar Panel Orientation (Aspect & Tilt)	9
2.6	Household Electricity Connection	11
2.7	Satellite Imagery	11
2.8	Bright Rooftop	14
2.9	Building / Rooftop Construction	14
3	Data Sources	15
3.1	Population	15
3.2	Buildings	16
3.3	Environment	21
3.4	Solar Resources	26
4	Field Survey	29
4.1	Housing Stock	29
4.2	Available Rooftop Area	31
4.3	Available Land	31
5	Rooftop Solar PV	32
5.1	Consumer Classes	32
5.2	Assigning Rooftop Solar PV to Bright Rooftop Area	32
5.3	Building Footprints	34
5.4	Quality of Housing	38
5.5	Solar Technical Potential	39
5.6	Rooftop Solar PV Energy Production	41
6	Community-Owned Solar PV	43
6.1	Concept	43
6.2	Site Selection	44
6.3	Electricity Demand	44
6.4	Large Rural Towns by Household Counts & kWpeak Demand	45
6.5	Simulation	46
6.6	Community Solar PV Sizing	46
ANNEXES		49



1 Introduction

1.1 Project Context

The objective of the Technical Assistance is to develop a net metering policy and grid code that will encourage the development and integration of distributed energy resources in Timor Leste.

The Terms of Reference for the TA defines three outputs.

- Output 1: Development of implementation planning and communication documents
- Output 2: Solar Resource Data and Insights for Timor Leste
- Output 3: Net Energy Metering Policy for Timor Leste
- Output 4: Grid Code for DERs and IBRs in Timor Leste
- Output 5: GCF Concept Note

The outputs are sequential in nature but conduct of the work has from the outset considered net energy metering in Timor Leste, and particularly the need to provide a cheaper alternative to diesel-fired plants.

1.2 Output 2 Description

The Terms of Reference defines Output 2 as follows:

Output 2: Solar Resource Data and Insights for Timor Leste

The Implementing Partner will provide Timor Leste with insights into the potential of solar resource in the country. The partner will conduct an examination of the solar resource potential, topography, and capacity factors across the country. Additionally, if land-use GIS data is available and of sufficient quality, the Implementing Partner will explore the possibility of using it to refine the solar resource assessment.

The ToR envisaged the following Output 2 activities, addressing solar irradiance and capacity factors:

- *The Implementing Partner will examine solar resource data for Timor Leste to provide insights into the renewable energy potential for the country.*
- *Leveraging solar resource datasets (e.g., National Solar Resource Database, Renewable Energy Data Explorer, etc.), the Implementing Partner will calculate solar PV capacity factors for the country for different solar configurations (e.g., fixed, 1-axis tracking, etc.).*
- *The Implementing Partner will examine using topographical data for land exclusions for developable areas and work with partners in Timor Leste to investigate whether land-use geographical information system (GIS) data is available for further exclusions (e.g., forested areas, private land, protected areas, etc.).*

1.3 Timor Leste Renewable Energy Policy

The Government of Timor Leste has had a long-standing policy of renewable energy development commensurate with the socio-economic and environmental conditions prevailing in the country.

Procurement No. 0002004381 Solar Resource Data & Insights

In 2010, one of the big objectives of the IV Constitutional Government was to finish the external dependency of energy supply through the national development of alternative and renewable energies sources. It was anticipated that renewable energy schemes could “contribute to the extension of the energy distribution in the whole country, with strong impact in the improvement of the people’s quality of life and the promotion of investment and industrial growth, potential sources of job creation and revenues for the State”.

An international study conducted in 2010 concluded that Timor-Leste possesses a strong potential in the renewable energies area. “If well explored, there is potential to develop an installed capacity of ~450 megawatts. The potential for hydropower was found to be in the range of 252 - 352 megawatts. The potential of wind energy was found to be 72 megawatts, spread over sites at Larigoto, Bobonaro, Baucau, Fohobogor, Khoholau and Laleia”.

In 2021, the Asian Development Bank reported renewable energy potential as follows:

- Wind power. Estimated wind potential is 55 MW in seven locations: Aileu, Bacau, Bobonaro 1, Bobonaro 2, Laleia, Lariguto 1, and Lariguto 2. Selecting only wind sites close to 150 kV transmission lines—and therefore setting aside Aileu and Laleia—the potential is 30 MW.
- Solar power. Average daily horizontal irradiance is about 6 kWh per square meter. The government provides through EDTL SHSs to remote areas to which the grid is unlikely to extend in next 5–10 years. About \$1 million is budgeted in 2020–2021 for rural SHSs. The government is considering installing a 100 MW solar PV plant by 2023.
- Hydropower. Assistance through a Norwegian grant identified 14 economically viable hydropower projects, which can be viable in the dry season as well as the wet if designed with adequate storage capacity. Four sites now have completed feasibility studies, their generation potential ranging from 1.5 MW to 50.0 MW.

The ADB observed that average daily horizontal irradiance is relatively high at ~6 kWh per square meter, but the ability to exploit small scale solar PV has been hampered by a lack of investment in modernizing the existing distribution network, inter alia by replacement of aging distribution transformers, installation of distribution transformer meters, and improving protection of 20 kV lines, especially in Dili, where the network is old and tripping causes frequent service interruption. A Distribution Modernization project began in mid-2023 with support from the ADB and was completed in 2024.

The ADB reported that renewable energy installed capacity was 1.09 MW, mostly solar and some small hydropower generators. EDTL provided the following solar PV statistics showing that installed solar PV capacity totals ~2.3 MWp.

Table 1-1 Installed Capacity Solar PV (December 2024)

City	Installed PV Capacity (kWp)	City	Installed PV Capacity (kWp)
Aileu	17	Ermera	69
Ainaro	52	Liquica	803
Atauru	134	Lautem	51



Procurement No. 0002004381
Solar Resource Data & Insights

City	Installed PV Capacity (kWp)	City	Installed PV Capacity (kWp)
Baucau	48	Manatutu	61
Bobonaru	73	Manufahi	34
Covalima	14	RAEOA	48
Dili	894	Viqueque	26
Total		2,324	

Source: EDTL

Educational activities have been provided by the UN CTCN and its consortium partner The Energy and Resources Institute (TERI), with support from the Green Climate Fund, with the aim to develop capabilities in the installation of small-scale solar PV systems through an educational programme. The programme aimed to boost local people’s capacity and knowledge in installing and maintaining solar PV systems, and ultimately, to bring reliable and sustainable electricity, powered by renewable energy technologies, to “a hundred thousand people in remote villages and municipalities”.

1.4 Report Outcomes

The Terms of Reference refers specifically to distributed energy resources in the context of net metering.

Net metering applies to rooftop or ground mount PV systems that are connected to the grid power system. The owner of the PV system is a prosumer – they buy and sell power.

Net metering does not apply to:

- Off-grid systems; they do not export to a grid power system
- Community or State-owned solar PV systems; costs are typically recovered using a Feed-In-Tariff (FIT)
- Utility-scale solar PV systems typically export full production output, with no self-consumption

The technical potential of distributed solar PV systems is a theoretical maximum. In practice, the final potential depends on physical and market factors.

- Physical factors include the suitability of rooftops (useable area, tilt, aspect) and the structural integrity of buildings and building rooftops. The distribution network imposes a physical limit on total connected solar PV capacity due to the potential for unwanted voltage rise and other power quality issues; this physical limit is known as the hosting capacity of the distribution network
- Market factors include market costs of solar PV and net metering policy. Net metering policy determines the likely rate of development of solar PV capacity, notwithstanding the hosting capacity of the distribution network.
- Physical and market factors influence the range of allowed household power connections (volt-ampere ratings) Wiring sizes, fuse sizes and associated costs play a role in determining the

Rooftop solar PV is a well-suited technology for Timor Leste. In rural towns, it may be economical to use ground mounted structures, e.g. on school grounds, but this is a minor difference in approach.



A significant difference in approach would be to install community-based solar PV systems in rural towns. The high up-front investment costs of rooftop solar PV systems is likely to be prohibitive for many households in rural areas. Moreover, the nature of EDTL's distribution network (radial, long feeders) means that community-based solar PV systems can be more easily sized to comply with hosting capacity requirements, rather than having to manage a quota system.

1.5 Methodology and Approach (to Output 2)

The assessment of solar PV resources in the country has followed a series of steps.

Base Data

Step 1. Explore available data sources for use with GIS (satellite and LiDAR data)

Step 2. Map the topology, land use/land cover

Step 3. Table the demography of Timor Leste

Step 4. Map the solar irradiance levels and determine solar PV capacity factors across the country

Rooftop Solar PV

Step 5. Building footprints

Step 5a. Determine the building footprints by area

Step 5b. Adjust for the quality of construction of buildings and associated rooftops

Step 6. For each building determine the maximum technical potential, i.e. solar PV system size (kW), considering tilt and aspect of building rooftop

Community Solar PV

Step 7: Assess the potential for community solar PV systems. In certain cases it may be more economical and more effective to

1.6 Structure of this Report

This report presents insights into the potential of solar resource in the country. The results of an examination of the solar resource potential, topography, and capacity factors across the country are presented. This report is structured as follows:

- Section 2 explains basic solar PV concepts
- Section 3 lists available sources of quality land-use and demographic data from reliable sources
- Section 4 provides insights into the optimal deployment of solar PV technologies
- Section 5 provides an analysis of rooftop solar PV technical potential
- Section 6 examines community based solar PV

The practical potential of solar PV informs a net metering analysis. Net metering policy is addressed as a separate report under Output 3. In practice the hosting capacity of EDTL's distribution network further refines the potential for harnessing solar resources in the country; this issue is addressed as part of a separate report under Output 4, covering the Grid Code.



2 Solar PV Concepts

2.1 Photovoltaics

Photovoltaics (often shortened as PV) gets its name from the process of converting light (photons) to electricity (voltage), which is called the photovoltaic effect.

The photovoltaic effect is only possible because of the unique chemical structure of silicon.

Vast majority of today's solar panels are made from silicon and offer both reasonable prices and good efficiency (the rate at which solar cells convert sunlight into electricity).

Thin film cells involve 'doping' the silicon with certain rare earth minerals that enhance the efficiency of the solar cell conversion from light to energy.

2.2 Photovoltaic Cell Efficiency

Photovoltaic cell efficiency falls generally between 15 to 20%. This is because some light photons that hit a solar cell are reflected away from the cell's surface. Out of the photons that are absorbed, some have their energy turned into heat in a process of internal recombination instead of producing electric current.

A solar panel with 20% efficiency and an area of 1 m² will produce 200 kWh/yr if exposed to a solar irradiance value of 1000 Watts/m² for 2.74 hours a day.

2.3 Sun's Altitude

The angle of the Sun's rays to the surface of the Earth is important, because more energy is captured if the Sun's rays fall at 90° to the plane of orientation of a solar cell. The Earth is tilted 23.5 degrees from the plane of its orbit around the sun, and the angle of the Sun's rays to the Earth's surface varies throughout the year.

The motion of the Sun relative to the Earth can be visualized at this NASA website https://astro.unl.edu/naap/motion1/animations/seasons_ecliptic.html

2.4 Irradiance (Insolation)

Solar insolation, also known as solar irradiance, refers to the power per unit area received from the Sun. As sunlight passes through the Earth's atmosphere, it is absorbed and scattered. This means that some sunlight is received at the Earth's surface as direct radiation, and some is received as diffuse radiation.

Direct irradiance is the part of the solar irradiance that directly reaches a surface; diffuse irradiance is the part that is scattered by the atmosphere; global irradiance is the sum of both diffuse and direct components reaching the same surface.

- GHI, Global Horizontal Irradiation
- DNI, Direct Normal Irradiation
- DIF, Diffuse Horizontal Irradiation

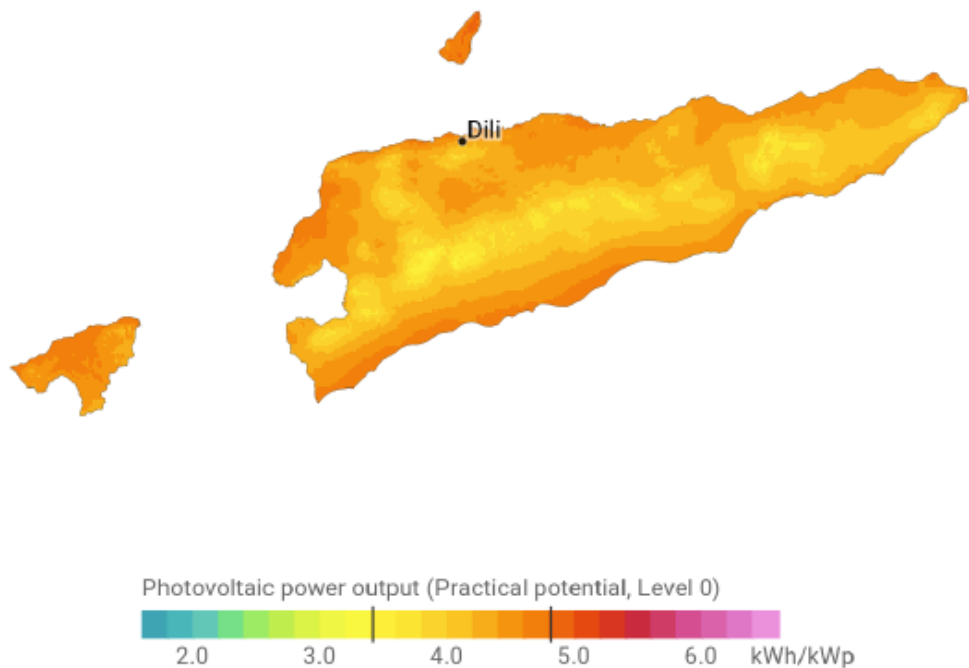


GHI and DIF are referred to a surface horizontal to the ground, while DNI is referred to a surface perpendicular to the Sun. Higher values of DIF/GHI ratio represent a higher occurrence of clouds, higher atmospheric pollution or higher water vapor content.

GHI represents a theoretical potential in kWh / m². At a given site, GHI is modulated by local air temperature, wind and snow, atmospheric pollution, dust, and other geographical factors. Satellite measurements are used to determine the needed factors adjustments.

The practical potential is PVOut measured in kilowatthours per installed kilowatt-peak of PV system capacity (kWh/kWp) per day.

Figure 1 PVOut (kWh/kWp)



Source: World Bank

Note that PV Out has units of kWh / kWp per day. This metric represents the average daily energy output (in kilowatt-hours, kWh) per kilowatt-peak (kWp) of installed photovoltaic capacity under local solar resource conditions.

2.5 Solar Panel Orientation (Aspect & Tilt)

Capture of the maximum amount of sunlight throughout the year requires that the aspect (direction), and the tilt of solar panels, consider the movement of the Sun in the sky throughout the year.

General rules are 1/ solar panels installed in locations below the equator need to face north, and those above the equator need to face south, and 2/ the optimum tilt of a solar panel is closely related



to the latitude at the location of the panel, e.g. in Dili the latitude is ~ 9 degrees and the optimum tilt is ~ 9 degrees.

The Department of Electrical and Electronic Engineering, National University of Timor Lorosa'e, published a study in 2018, titled "Tilted Angle of a PV Panel and Its Direction of Installation for Optimum Output Performance". Simulations and tests were carried out and it was determined that the optimum aspect of solar panels installed in Dili is due North and the optimum tilt is 10 degrees. The study confirms that the the optimum tilt of a solar panel is closely related to the latitude at the location of the panel.

A tilt of 10 degrees is relatively flat as shown by the example in Figure 2.

Figure 2 **Example of Tilt in a Location near the Equator**



Source: PLN Persero, Indonesia

The pitch of rooftops of small to medium sized buildings is typically 30 degrees. To achieve a 10-degree tilt for a solar panel installed on a rooftop with a 30-degree pitch requires an offset mounting structure. Not only is it costly to achieve an acceptable mechanical solution, but it has a poor aesthetic as the panels are not mounted flush with the roof line. If panels are simply installed at a tilt of 30 degrees, i.e. flush with the surface of the rooftop, the solar output will be considerably reduced.

Large buildings with flat or low angle rooftops do not present a problem for a low tilt panel installation.



2.6 Household Electricity Connection

The capacity of household electricity connections is important from the point of view of solar PV capacity. For example, a 2kW solar PV rooftop scheme that exports most of its power output to the distribution grid, would need a 2200 VA electricity connection. The fuse or miniature circuit breaker that protects household consumers, and the PV wiring must be adequately rated for maximum power.

The following table provides a statistical breakdown of household connection capacity in Sulawesi Indonesia, where economic conditions are like Timor Leste. A large proportion of the connections are low capacity given that international experience suggests that solar PV is un-economical at capacities below 2kW peak.

Table 2-1 Household Connection

Connection Capacity (VA)	%
450	37.0
900	48.0
1,300	13.5
2,200	1.0
3,500 and above	0.5

Source: Consultant

Household connection is not further considered in this report, it is addressed under Output 3 net metering policy.

2.7 Satellite Imagery

Photo-imagery is useful for estimating the amount of sunlight energy received by a given surface area, for example the area of a solar PV panel. The resolution of the image is important because higher resolution generally results in higher accuracy estimates of potential solar output.

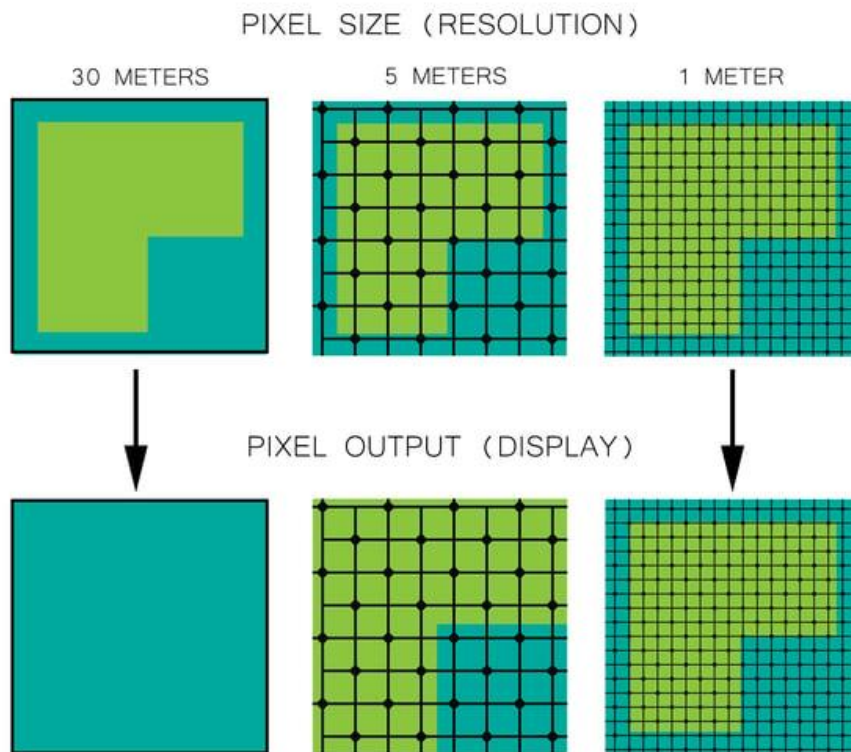
2.7.1 Resolution

Resolution can be understood as the distance represented by a pixel in an image.

An image with a 30-meter resolution means that every pixel in the image represents a 30 m by 30 m square on the ground. At a 30m resolution, small structures such as solar panels or rooftops become 'invisible'. This effect is illustrated by the following figure.



Figure 3 Resolution



Source: Consultant

At higher resolutions, structures can be 'extracted' using software tools, i.e. automation improves efficiency of the solar PV assessment.

2.7.2 DTM / DEM / DSM

Satellite data imagery makes use of bi- or tri-stereo cameras installed on satellites.

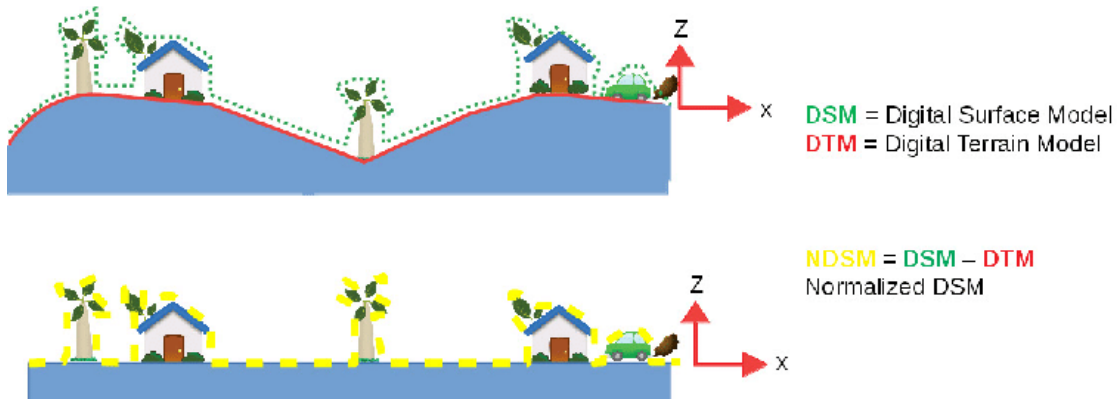
The common datasets are

- DTM (or DEM) – Digital Terrain Model (or Digital Elevation Model). A DTM dataset is constructed by measuring the distance from the satellite to the Earth's surface and subsequently determining altitude relative to a datum.
- DSM – Digital Surface Model. The measurement principle is the same as for a DEM, but in this case the height of objects such as vegetation and buildings are also captured.

If resolution is high, an nDSM can be computed. An nDSM enable the reconstruction of building roof forms e.g. gable vs. flat, as well as the estimation of tilt, orientation, and surface area of the roof. An nDSM is a useful dataset to support placement of solar panels.



Figure 4 Normalized Digital Surface Model (DSM)



Source: Consultant

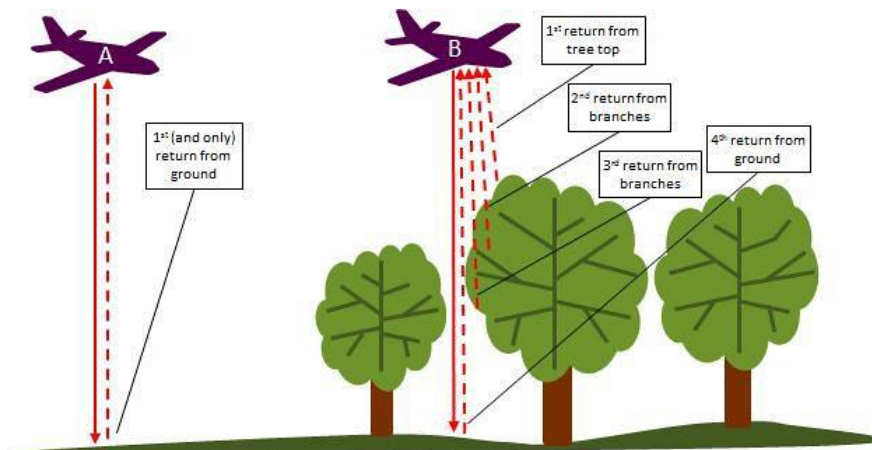
2.7.3 LiDAR

LiDAR stands for Light Detection and Ranging. The measurement technique produces a high-resolution surface model to centimetre accuracy.

LiDAR point density is the number of LiDAR points per unit area; dense point clouds improve the accuracy of derived models where the portion of the Earth's surface being mapped is complex or mountainous, i.e., where the surface elevation changes rapidly.

LiDAR is a more costly method of data capture than using satellites due to the time-intensive nature of the data capture.

Figure 5 LiDAR Image Capture



Source: Consultant

LiDAR imagery provides centimetre-level accuracy. Output is LAS or LAZ point cloud data files that are processed to provide a filtered Digital Surface Model (nDSM). Online search and enquiries made of commercial data providers failed to identify LiDAR data for Timor Leste.



In any case, for rooftop extraction / classification, metre-level accuracy is sufficient. Tri-stereo satellite imagery provides metre-level accuracy, data capture is cheaper than LiDAR (imagery from commercial service providers), and it is a potential alternative to LidAR. Output of tri-stereo imagery can be an nDSM, or data that can be further processed to produce an nDSM.

2.8 Bright Rooftop

The 'bright' rooftop is the area of a roof that is not shaded from the Sun. South of the equator, a 'bright' rooftop will be north facing, and clear of trees or adjacent buildings.

There are three methods for estimating bright rooftop area.

Table 2-2 Bright Rooftop Area Techniques

	Advantages	Disadvantages
Constant-value Methods	<ul style="list-style-type: none"> This method is based on a selection of fixed sizes of rooftop; it is a coarse method 	<ul style="list-style-type: none"> Cannot extract 'bright' rooftop areas Results difficult to validate, accuracy relatively low
Manual selection methods	<ul style="list-style-type: none"> These methods are detail-specific and enable assumptions based on specific knowledge of regions, building types, roof types 	<ul style="list-style-type: none"> Very time-intensive across large areas Can identify 'bright' rooftop areas
GIS-based methods (automated)	<ul style="list-style-type: none"> Best for wide area assessments Can extract 'bright' rooftop areas Can correlate with solar PV data for yield estimation 	<ul style="list-style-type: none"> Accuracy of GIS-based methods no better than above without high-resolution data e.g. LiDAR

Source: National Renewable Energy Laboratory (NREL)

A variation on the constant-value method involves using building footprints extracted from Open Street Maps (OSM). When the OSM data extracts are imported to GIS, the building footprint areas can be computed. The aspect of all buildings is also available but the rooftop type (gable, flat, etc) is not.

2.9 Building / Rooftop Construction

OSM data does not include any information regarding the quality of construction of the building / rooftop. This information can only be determined using field survey techniques and statistical methods.



3 Data Sources

This Section of the report provides a review of data sources that have been identified as pertinent to an assessment of solar PV potential in Timor Leste. The data sources are arranged in categories of demography, environment and solar resources.

3.1 Population

According to the Timor-Leste Population and Housing Census 2022 (Preliminary Results), Timor Leste has a population of 1.34 million residing in an area of 14,954 square kilometres. The population density varied considerably across the municipalities. The urbanized municipality of Dili had a population density of 1,425 persons per square kilometre in 2022, whereas Manatuto had a density of 36 persons per sq. km.

Table 3-1 Population

Municipality	Population Count		Population %		Area (sq.km)	Population Density	
	2015	2022	2015	2022		2015	2022
Aileu	48,837	54,631	4.1	4.0	676	72.2	80.8
Ainaro	63,136	72,989	5.3	5.5	870	72.6	83.9
Atauro	9,274	10,302	0.8	0.8	141	66	73.3
Baucau	123,203	133,881	10.4	10	1,508	81.7	88.8
Bobonaro	97,762	106,543	8.3	8	1,381	70.8	77.2
Covalima	65,301	73,909	5.5	5.5	1,207	54.1	61.3
Dili	268,005	324,269	22.6	24.2	228	1,177.4	1,424.7
Ermera	125,702	138,080	10.6	10.3	771	163.1	179.1
Lautem	65,240	69,836	5.5	5.2	1,813	36	38.5
Liquica	71,927	83,689	6.1	6.2	551	130.6	151.9
Manatuto	46,619	50,989	3.9	3.8	1,786	26.1	28.6
Manufahi	53,691	60,536	4.5	4.5	1,327	40.5	45.6
Oecusse	68,913	80,726	5.8	6	817	84.3	98.8
Viqueque	76,033	80,054	6.4	6	1,880	40.4	42.6
Timor-Leste	1,183,643	1,340,434	100	100	14,954	79.2	89.6

Source: Timor-Leste Population and Housing Census 2022 (Preliminary Results)

Given that persons per household is consistent across Timor Leste, population density is a general indicator of the sparsity of buildings.

Household counts by location are available from the government census of 2022, specifically from Chapter-4-TLPHC-Census-report-Basic-tables.



Table 3-2 Household Counts (2022)

	Urban	Rural
Aileu	491	8,445
Ainaro	0	2,055
Baucau	3,496	20,869
Bobonaro	2,259	17,539
Covalima	1,968	12,411
Dili	46,271	9,756
Ermera	2,110	21,819
Lautém	2,336	10,515
Liquiçá	800	13,654
Manatuto	815	7,700
Manufahi	1,282	9,267
Oecussi	3,042	14,088
Viqueque	862	15,379
Total	65,732	163,497

Source: Chapter-4-TLPHC-Census-report-Basic-tables

3.2 Buildings

3.2.1 Satellite Imagery

Satellite imagery of settlements in Timor Leste is available from Google Earth and Open Street Maps. The density / sparsity of settlements naturally varies from urban to rural locations.



Figure 6 Urban



Source: Google Earth

Figure 7 Rural



Source: Google Earth

Google Earth and Open Street Maps data can be imported into GIS as separate layers.



3.2.2 Building Footprints

Geofabrik is a German non-profit organization that maintains an open data repository of building footprints extracted from Open Street Maps data. The data repository for Timor Leste can be found here <https://download.geofabrik.de/asia/east-timor.html>

When the data is imported into GIS, it is possible to compute the areas of the building footprints. GIS can also be used to filter the data to extract various building types, e.g. residential houses, schools, hotels, commercial premises, public and government offices, according to the OSM designations.

The Geofabrik dataset does not include bright rooftops area details or any details regarding the quality of the building or rooftop construction. This latter information can only be determined through field surveys.

Figure 8 **Open Street Maps**



Source: Open Street Maps; mapped by Consultant using QGIS

3.2.3 Building Construction Quality

The quality of building construction is available from a government housing report based on the following classification framework.



Procurement No. 0002004381
Solar Resource Data & Insights

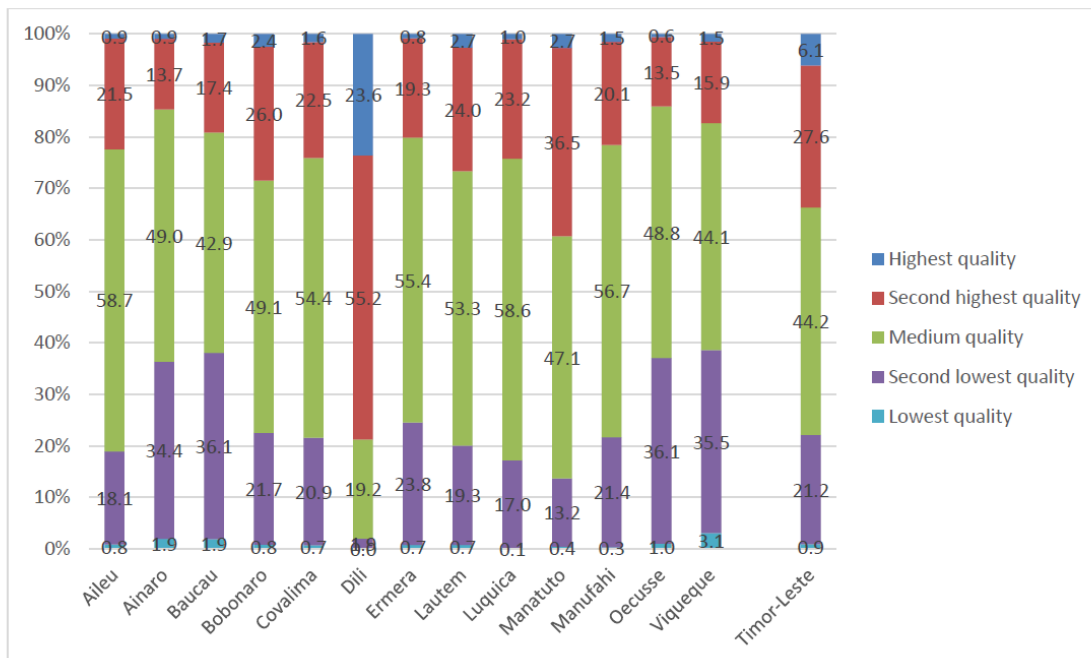
Table 3-3 Building Quality

Quality	Walls		Floor		Roof		Dwelling Condition	
	Material	Code	Material	Code	Material	Code	Material	Code
1	Concrete/ Brick	1	Tile	2	Tile	3	Good	1
2	Bamboo	3	Concrete/Brick	1	Concrete	1	Mediocre	2
3	Rock	7	Wood	3	Corrugated Iron/Zinc	2	A little Damaged	3
4	Palm Trunk	6	Bamboo	5	Asbestos	4	Severely Damaged	4
5	Corrugated iron/Zinc	4	Soil/Clay	4	Palm Leaves/Thatch/Grass	6		
6	Wood	2			Bamboo	5		
7	Clay/soil	5						

Source: 2015-Housing-characterics-thematic-report_consolidated

The 2015 Housing report found that at the national level, most dwellings (44%) are of medium quality, 6% of dwellings are of the highest quality, and only 0.9% are of the lowest quality. In Dili, around one in every four dwellings are of the highest quality, around 80% of dwelling are ranked in the top-quality categories, and none of the enumerated dwellings are classed as being of the lowest quality. In contrast, in Ainaro, Baucau, Oecusse and Viqueque over a third of all dwellings are categorised as being either of lowest or second lowest quality. The implication is that many houses outside of Dili may not be suitable for a rooftop PV installation.

Figure 9 Households by Housing Quality Ranking



Source: 2015-Housing-characterics-thematic-report_consolidated



Procurement No. 0002004381
Solar Resource Data & Insights

The 2022 Census provides statistics for building types across Timor Leste.

Table 3-4 Building Type

Urban/rural location, construction material of outer walls	Broad type of housing unit, presence of basic facilities or type of housing unit				
	Total	Conventional dwelling			Other Housing Unit
		Total	With all basic facilities	Not with all basic facilities	
Timor-Leste	241,019	240,606	5,075	235,531	413
Concrete / brick	128,650	128,466	4,437	124,029	184
Wood	3,222	3,200	32	3,168	22
Bamboo	35,745	35,687	82	35,605	58
Corrugated iron / zinc	25,599	25,544	238	25,306	55
Clay / soil	2,543	2,535	27	2,508	8
Palm trunk (bebak)	40,994	40,959	240	40,719	35
Rock	3,283	3,279	11	3,268	4
Other	983	936	8	928	47
Urban	67,164	67,043	3,509	63,534	121
Concrete / brick	53,687	53,610	3,225	50,385	77
Wood	358	356	17	339	-
Bamboo	854	851	-	845	-
Corrugated iron / zinc	6,613	6,591	155	6,436	22
Clay / soil	259	259	9	250	0
Palm trunk (bebak)	4,864	4,859	90	4,769	5
Rock	299	299	-	297	-
Other	230	218	5	213	12
Rural	173,855	173,563	1,566	171,997	292
Concrete / brick	74,963	74,856	1,212	73,644	107
Wood	2,864	2,844	15	2,829	20
Bamboo	34,891	34,836	76	34,760	55
Corrugated iron / zinc	18,986	18,953	83	18,870	33
Clay / soil	2,284	2,276	18	2,258	8
Palm trunk (bebak)	36,130	36,100	150	35,950	30
Rock	2,984	2,980	9	2,971	4
Other	753	718	-	715	35

Source: 2022- Chapter-4-TLPHC-Census-report-Basic-tables

The table above is published in a fully elaborated form for all municipalities, as a public domain document.



Procurement No. 0002004381
Solar Resource Data & Insights

As a general rule buildings of concrete / brick construction will have rooftops made of materials that can support rooftop solar PV installations. Table 3-5 indicates the % of ‘eligible’ buildings in each Municipality. The percentages have been derived by weighting the counts of eligible buildings in urban and rural areas using the data in Table 3-4.

In the following table, a scaling factor of 60% means that 40% of buildings are unsuitable for rooftop solar PV due to low quality construction.

Table 3-5 Scaling Factors for Building Quality

Municipality	Scaling Factor
Aileu	64.7%
Ainaro	51.1%
Baucau	52.6%
Bobonaro	59.8%
Covalima	43.3%
Dili	94.8%
Ermera	57.4%
Lautém	69.8%
Liquiçá	56.6%
Manatuto	65.9%
Manufahi	42.4%
Oecussi	50.9%
Viqueque	45.6%

Source: Consultant

3.3 Environment

3.3.1 Terrain

Terrain is captured by satellite imagery in the form of a DTM or DEM that can be visualized using GIS software. For the purposes of solar PV design, terrain can be evaluated in terms of hill shade effects, slope and aspect (to the Sun).

Hill shade, slope and aspect can be visualized using GIS, but the true power of GIS is that it can screen out locations that fall outside acceptable bounds for each of these parameters, both individually and collectively.

The core dataset required is a Digital Elevation Model (DEM) generated from satellite readings. Online searches located DEMs for Timor Leste with 30m and 90m resolutions. One of the source sites for a Timor Leste DEM can be found at <https://portal.opentopography.org/>



3.3.1.1 Hill Shade

Hill shade is particularly important in mountainous terrain because of the potential for solar panels to be shaded at certain times of the day. Solar panels are best located where there is no hill shade, i.e. on ridges or on north facing slopes that are not close to adjacent hills.

GIS can be used with a DEM to compute and visualize hill shade and to quantify its effect on solar insolation. The GIS hill shade tool takes the elevation angle and azimuth of the Sun as inputs to the computation. The angle and azimuth can be determined by an online tool such as https://www.sunearthtools.com/dp/tools/pos_sun.php?lang=en. As these parameters continually change, the accuracy of the estimate of solar insolation depends on how many computations are made across the year.

Figure 10 below is a visual representation of hill shade for a particular time of day.

3.3.1.2 Slope

Slope is specified in degrees (0 to 90) or percent grade. Slope is important because highly graded slopes above 40 degrees are impractical sites for ground mounted PV panels.

GIS has a 'slope' function. Figure 11 below has been produced using GIS and a 30m DEM, providing a visual representation of slope with settlements overlaid.

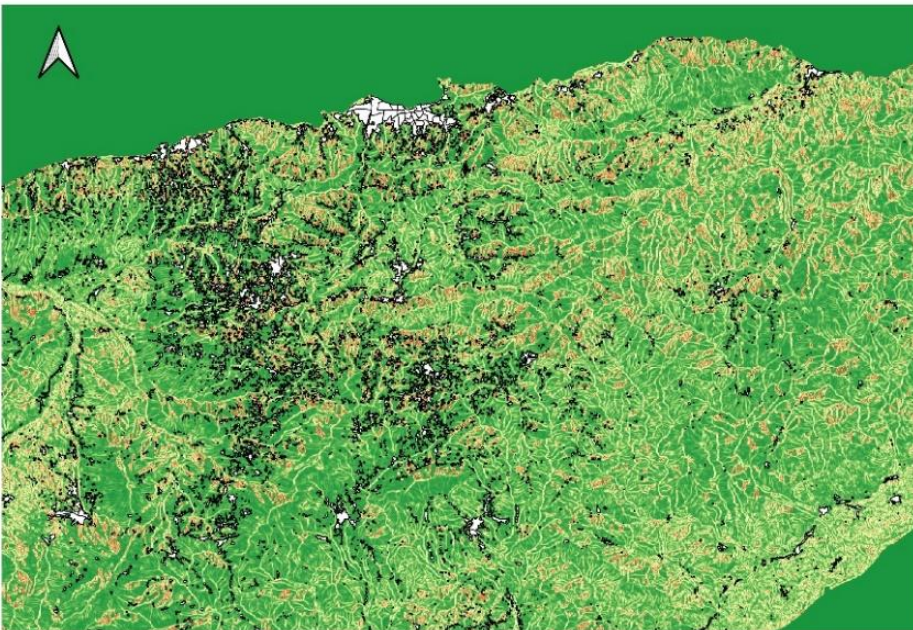
3.3.1.3 Aspect

In the case of Timor Leste, selection of sites with a north-facing aspect is best as such locations receive the highest solar irradiation during daylight hours. Aspect can also be visualized by using colour, as shown by Figure 12 below.

Figure 10 Hill Shade



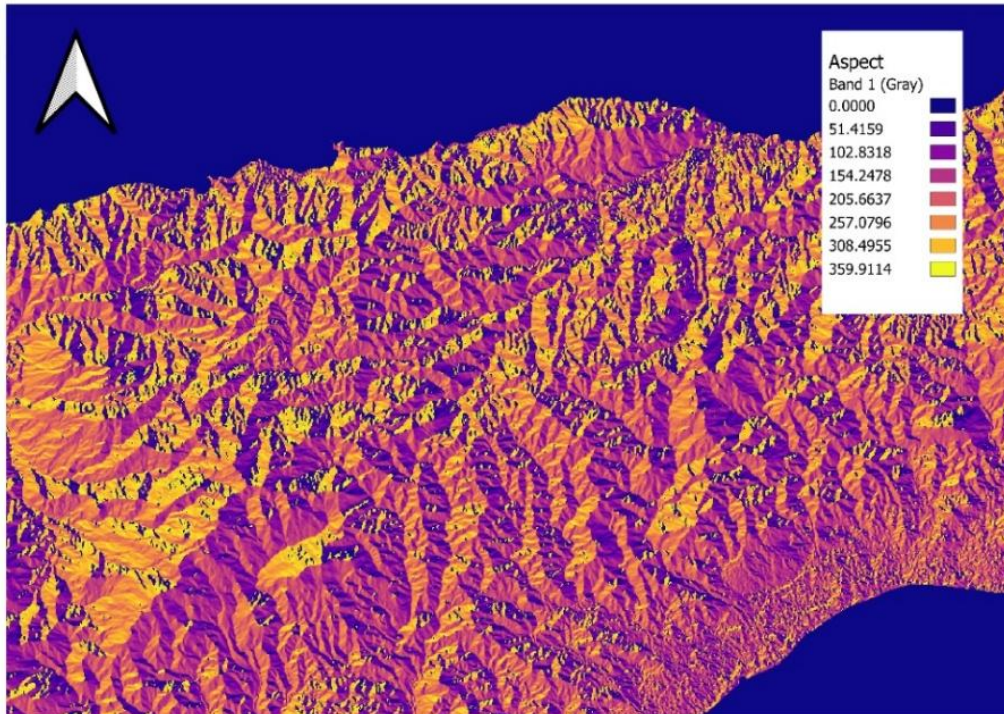
Figure 11 Slope



Source: Consultant, colourization is based on the grade of the slope, with darker colours representing higher slopes



Figure 12 Aspect



Source: Consultant; Yellow represents a north facing location, purple / black colours face south

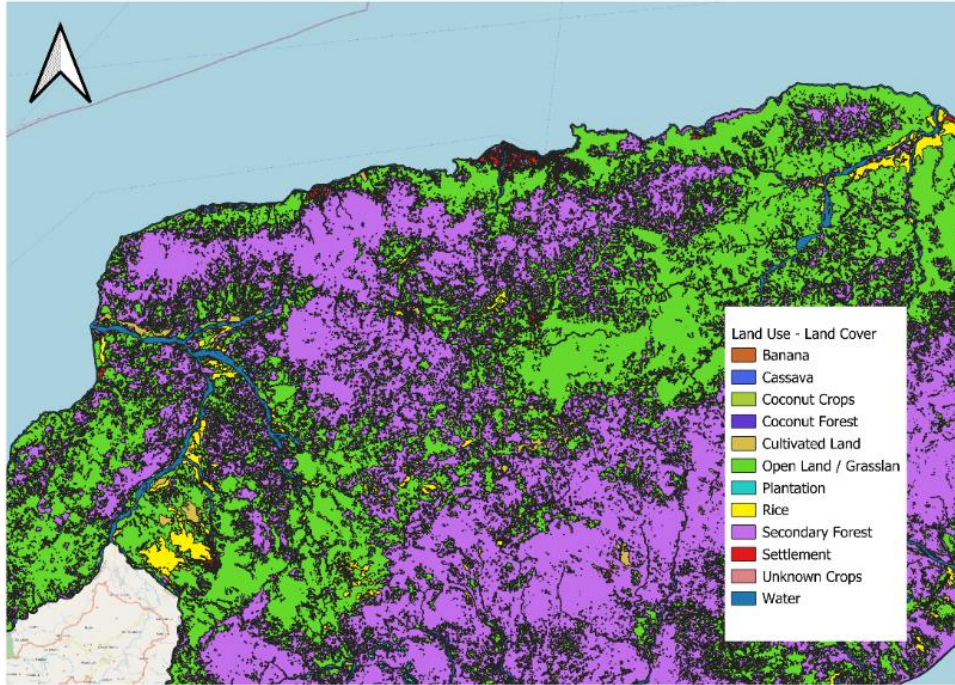
3.3.2 Land Use / Land Cover

A land use / land cover dataset was found through online search. The dataset was created in March 2022. As agricultural land use tends to change slowly over timescales of decades, the dataset is relevant.

Land use / land cover is visualized by GIS as shown in Figure 13 below. Using GIS, the LULC dataset can be further refined by filtering to exclude areas that are considered ineligible for solar PV development.



Figure 13 Land Use / Land Cover



Source: https://risk.spc.int/layers/geonode:timor_lestoneste_vector/metadata_detail



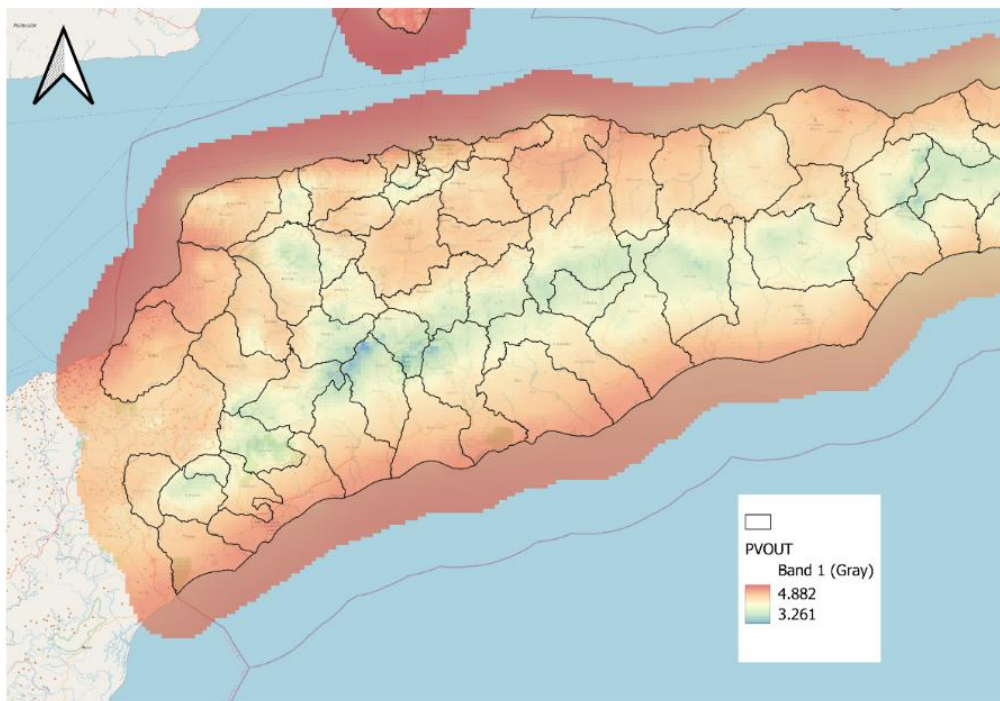
3.4 Solar Resources

3.4.1 Solar Irradiance

3.4.1.1 World Bank

The World Bank commissioned Solargis to prepare a solar irradiation dataset for East Timor. Solargis processed satellite data using advanced techniques. The dataset is based on measurements up to 2022. The dataset includes estimates for Global Horizontal Irradiance (GHI in Watts per sq m) and its components, and for PV Out which is a capacity factor measure expressed as kWh / kWpeak. The following figure shows that solar PV efficiency is higher in the coastal areas of Timor Leste.

Figure 14 Solar PV Capacity Factors as PV Out (kWh/kWp)



Source: Solargis

The Solargis database can be found here <https://globalsolaratlas.info/download/timor-leste>

3.4.1.2 PV GIS-Sarah

The European Commission maintains a website that maps the solar PV output around the globe. The site can be found here https://re.jrc.ec.europa.eu/pvg_tools/en/#TMY

The web site is particularly useful because TMY files can be generated for a selected location. TMY files are Typical Meteorological Year flat files that contain hourly weather data sets covering a typical year of weather for a specific location. TMY files include Global Horizontal Irradiance (GHI) and its components.



The TMY data can be used to generate typical daily solar production profiles for locations of interest.

(At the time of writing of this report, the TMY files for Timor Leste could be downloaded but the data was found to be corrupted).

3.4.1.3 Climate.Onebuilding.Org

An alternate site that provides TMY data specifically for the Southwest Pacific region can be found at https://climate.onebuilding.org/WMO_Region_5_Southwest_Pacific/default.html. This information is valuable because it is based on solar irradiance measurements at various weather stations around the country.

3.4.2 Solar Irradiance Capacity Factors

Solar irradiance (GHI) is specified in Watts per sq. metre. It is the average energy of solar insolation per square metre.

Solar irradiance capacity factors have been estimated for locations across the island of Timor Leste. The estimate is based on TMY data for average days, in selected locations. The solar irradiance Capacity Factor is defined as the ratio of average solar PV irradiance to peak irradiance in units of Watts per sq metre. This Capacity Factor based on GHI should not be confused with the capacity factor of a solar panel (PV Out); the conversion of solar irradiance to electricity involves significant efficiency losses.

Table 3-6 Solar Irradiance Capacity Factor (GHI basis)

Area	Solar Irradiance Capacity Factor
Gleno	31.9%
Comoro (near Baucau)	31.0%
Dili	32.0%
Cakung	32.2%
Viqueque	32.2%
Average	32.0%

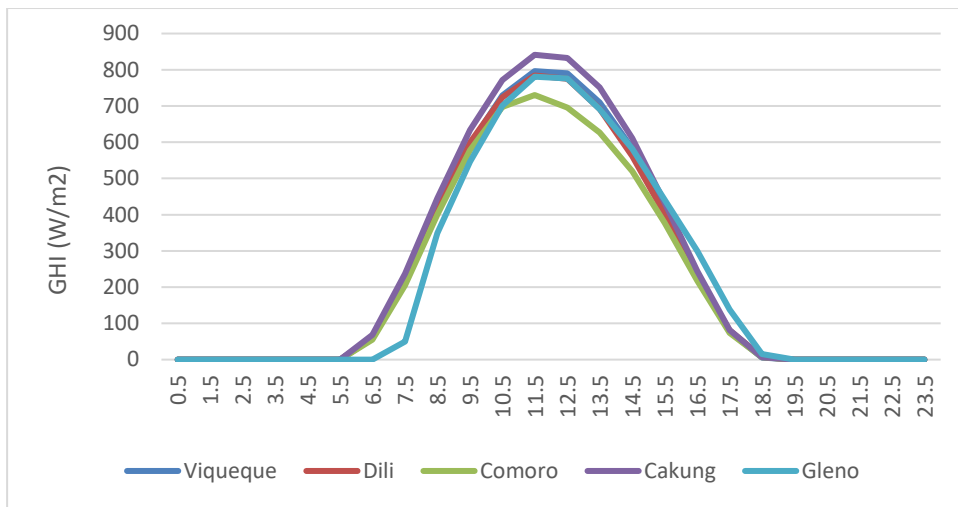
Table 3-7 GHI Variance Across Timor Leste

Location	Whours / m2 / day	Variance
Viqueque	2,816	1%
Dili	2,776	0%
Cakung	2,979	7%
Comoro	2,593	-7%
Gleno	2,686	-3%
Average	2,770	Range +/- 7%

Source: Consultant



Figure 15 Daily Solar Irradiance Profiles (GHI)



Source: Consultant

3.4.3 Solar PV Capacity Factor

Using PVGIS data, peak GHI is estimated to be 1015 W/m². After loss and temperature correction, average PV Out is estimated to be 1481 kWh/kWp. The solar PV Capacity Factor computes as $1,481/8760 = 16.9\%$.

The typical efficiency for a modern monocrystalline or high-quality polycrystalline panels falls between 15 – 22%. A standard 330W panel has an area of 1.7 m². The IEC Standard Test Condition (STC) of 1,000 W/m² yields an efficiency of $330 / (1.7 \times 1000) = 0.194$, or 19.4%.

A peak GHI of 1015 W/m² and a capacity factor of 16.9% is equivalent to a peak yield of 197 W/m². A single panel of 1.7 m² can be expected to produce 335 Watts. This is equivalent to 4.05 kWh/kWpk per day.



4 Field Survey

This Section discusses the observations and findings of a field survey conducted at Gleno, Metinaro, and Dili in August 2024.

Observations were made in respect of the sparsity of buildings and the suitability of buildings for rooftop PV (building aspect, rooftop pitch, building / rooftop construction quality).








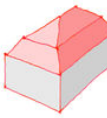




The field survey was not based on rigorous statistical sampling techniques, rather the survey was in the form of a walk-around inspection of buildings to develop a general appreciation of the suitability of buildings for rooftop PV and the availability of land suitable for ground mounted PV.

4.1 Housing Stock

4.1.1 Rooftop Type

The dominant type of rooftop observed during the walk arounds was the gabled type. This was invariably the case for schools and government offices. Rooftops were mostly of the corrugated iron type. The roof pitch of the gables was observed to be typically around 30 degrees.

Figure 16 Rooftop Types

Rooftop -type						
Name	flat	skillion	gabled	half-hipped	hipped	pyramidal
Rooftop -type						
Name	gambrel	mansard	dome	onion	round	saltbox

Source: Consultant

4.1.2 Buildings

Buildings were observed to be of varied quality of construction, in line with the 2022 Census statistics presented in Section 3.2.3 above. The walk arounds confirmed that buildings constructed from concrete / bricks with corrugated iron rooftops were generally suitable for rooftop installations from a mechanical perspective, i.e. the weight of solar panels can be supported.

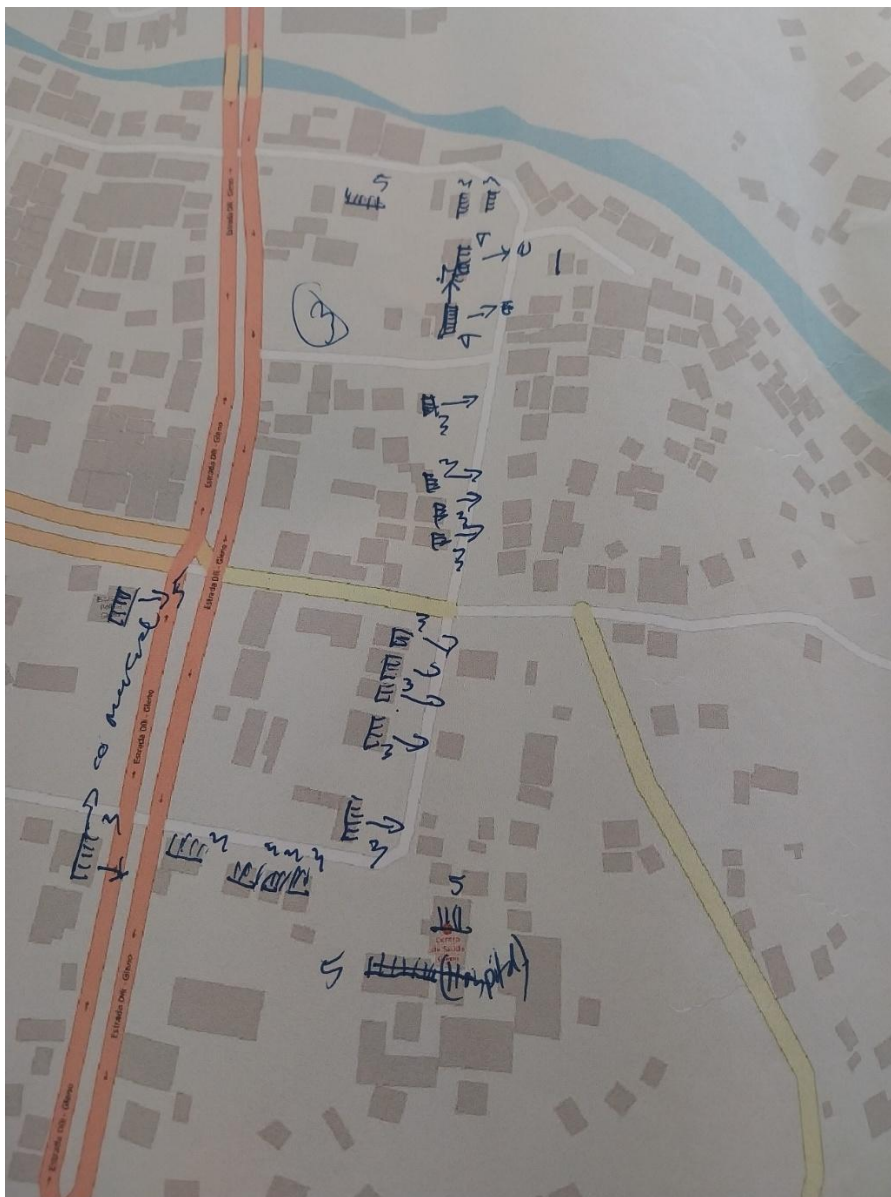


4.1.3 Rooftop Aspect

The aspects of a sample of rooftops (orientation of the rooftop relative to due north) were recorded during the walk arounds.

The aspects of buildings were observed to vary widely. As is typically the case for settlements, the aspect of buildings was found to be a function of the alignment of land parcels with roads, and of the shape of land parcels. It was found that around 50% of buildings have a long-axis rooftop facing east west.

Figure 17 Example of Field Inspection Sheet (Gleno)



Source: Consultant



4.2 Available Rooftop Area

In a paper published by the National Renewable Energy Laboratory (NREL) titled “Estimating Rooftop Suitability for PV: A Review of Methods, Patents, and Validation”, Dec 2013, the authors present the results of a rooftop solar PV study spanning the globe. The key finding was that the percent of total rooftop area suitable for PV ranged from 15 to 65% for residential and larger buildings. Residential buildings in developing countries scored closer to 15%, while larger buildings were somewhat invariant across countries.

The Consultant’s experience in developing countries accords with NREL’s study. The rooftop pitch and building aspect observed during the field inspections carried out in Gleno, Metinaro and Dili, and subsequent examination of building footprint maps, indicate that the suitability of rooftops for solar PV in Timor Leste is consistent with the NREL study findings.

Accordingly, Timor Leste factors of rooftop availability are set at 15% and 30% for residential and larger buildings respectively.

4.3 Available Land

It was observed during the walk arounds, and confirmed from satellite images, that there is ample land available in the urban areas of most villages outside of Dili. This opens the possibility to install ground mount solar PV systems instead of using rooftops.

As an example, an average sized school requires a 2kW solar PV system for own-use, which could be easily accommodated on school land in most cases in a secure fenced-off area. This approach is simpler from the point of view of achieving a 10% tilt, supports optimum orientation of panels, can avoid shaded areas, and cleaning of panels is straightforward.

Figure 18 **School of Gleno**



Source: Consultant

Outside of Dili, there is also ample land for community-based solar PV systems. A small parcel of land would be required in most cases, and the installation could be designed and installed to maximize the solar capacity factor.



5 Rooftop Solar PV

This Section of the report provides insights into the technical potential of rooftop solar PV capacity that could be installed in Timor Leste.

5.1 Consumer Classes

Categorisation of buildings is undertaken in line with consumer classes. International experience, and available Timor Leste building inventory data, suggests the following categories for Timor Leste.

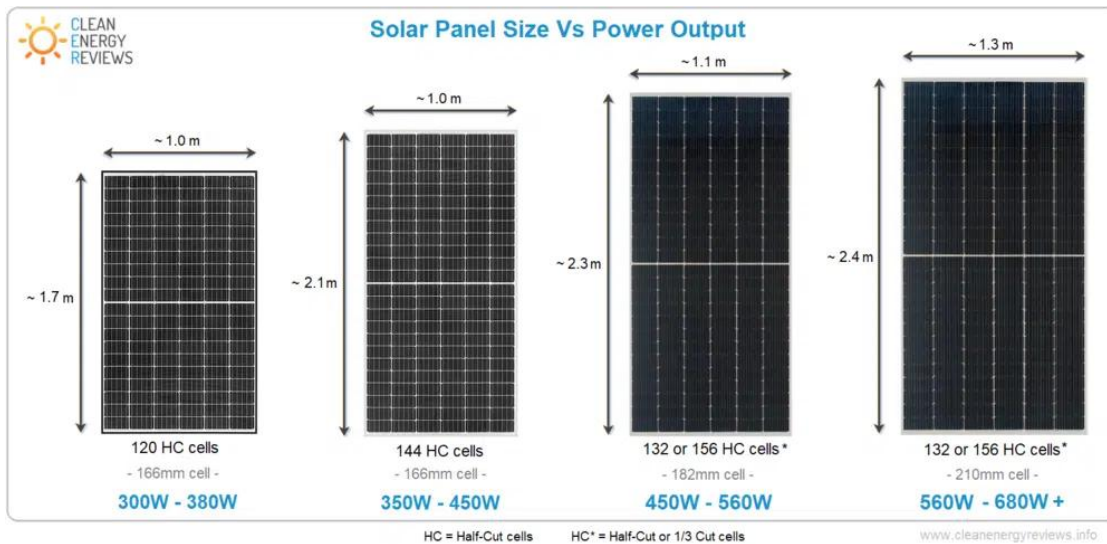
- Residential (houses and out-buildings)
- Schools
- Commercial / Public / Government
- Universities
- Hospitals
- Hotels

5.2 Assigning Rooftop Solar PV to Bright Rooftop Area

5.2.1 Standard Rooftop PV Sizes

Solar PV panels come in different sizes. For the purposes of estimating solar PV potential a standard panel rating of ~330 Watts has been used.

Figure 19 Standard Solar Panel Sizes vs Power Output



Source: Clean Energy Council

In OECD countries, residential PV systems are typically limited at 5 - 6kW. International experience suggests that the maximum size of residential PV system in a developing country is 2kW.



Procurement No. 0002004381
Solar Resource Data & Insights

Larger rooftop PV systems are installed on commercial buildings and light industry factory rooftops. In OECD countries such installations can exceed 500kW. In developing countries however, it is rare to find PV systems rated above 50kW due to the high capital cost.

Table 5-1 Rooftop PV System Sizes

Solar Panel System Capacity	Number of Solar Panels Required	Approximate PV System Area
2kW	6	12 m ²
3kW	9	17 m ²
4kW	12	23 m ²
5kW	15	28 m ²
6.6kW	20	38 m ²
8kW	24	45 m ²
10kW	30	55 m ²
15kW	45	85 m ²
30kW	90	165 m ²
50kW	150	275 m ²

Source: Consultant

5.2.2 Average Rooftop Area Requirements

The ‘bright’ rooftop area is needed for rooftop solar PV systems; this area is much less than total building footprint area. As discussed in Section 4.2 **Error! Reference source not found.**, conservative adjustments of 15% and 30% are appropriate for adjusting residential and non-residential building footprint areas respectively for bright rooftop areas in Timor Leste. These scaling factors have been applied to the standard rooftop PV areas given in Table 5-1. The following tables give the results.

Table 5-2 Minimum Average Building Footprint Required for Households

Solar Panel System Size	Number of Solar Panels Required	Approximate Rooftop Area Required (sq m)	Average Building Footprint area required (sq m)
2kW	6	12	80

Source: Consultant

Table 5-3 Minimum Average Building Footprint Required for Non-Residential Buildings

Solar Panel System Size	Number of Solar Panels Required	Approximate Rooftop Area Required (sq m)	Average Building Footprint area required (sq m)
2kW	6	12	40
3kW	9	17	57
4kW	12	23	77
5kW	15	28	93
6.6kW	20	38	127



Procurement No. 0002004381
Solar Resource Data & Insights

Solar Panel System Size	Number of Solar Panels Required	Approximate Rooftop Area Required (sq m)	Average Building Footprint area required (sq m)
8kW	24	45	150
10kW	30	55	183
15kW	45	85	283
30kW	90	165	549
50kW	150	275	916

Source: Consultant

5.3 Building Footprints

Building footprint areas have been extracted using GIS and the Geofabrik database in line with the above consumer classes. Fully elaborated lists of footprint areas for each building within each building class are provided in the Annexes.

5.3.1 Residential Class Buildings

Table 5-4 Residential Class Building Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu	1,390,987	21,802	64
Ainaro	1,884,370	28,652	66
Baucau	3,418,287	37,913	90
Bobonaro	3,246,094	39,663	82
Covalima	2,218,133	28,002	79
Dili	8,377,157	73,600	114
Ermera	3,397,321	44,589	76
Lautém	1,202,890	14,498	83
Liquiçá	1,134,821	12,693	89
Manatuto	1,357,187	16,435	83
Manufahi	1,918,987	25,770	74
Oecussi	1,132,116	15,488	73
Unkown	513,844	3,730	138
Viqueque	2,661,586	37,676	71
Total	33,853,781	400,511	85

Source: Consultant

The 2022 Census reported that the total number of households is ~250,000. Table 5-4 indicates a building count of ~400,000. This discrepancy arises because Open Street Maps classifies out-buildings such as sheds, carports, etc as residential buildings. It is assumed that most of the 150,000 buildings making up the discrepancy are relatively small in footprint, and so the smallest 150,000 buildings have been removed and a new summary table prepared.



Procurement No. 0002004381
Solar Resource Data & Insights

Table 5-5 Adjusted Residential Class Building Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu	1,032,053	10,946	94
Ainaro	1,371,816	14,421	95
Baucau	2,583,196	22,991	112
Bobonaro	2,448,977	23,911	102
Covalima	1,709,858	16,955	101
Dili	6,124,725	55,242	111
Ermera	2,496,642	25,987	96
Lautém	852,881	8,482	101
Liquiçá	818,444	8,166	100
Manatuto	1,007,924	9,717	104
Manufahi	1,454,369	14,940	97
Oecussi	729,003	7,311	100
Unkown	251,296	2,457	102
Viqueque	2,033,863	21,085	96
Total	24,915,048	242,611	103

Source: Consultant

5.3.2 Schools

Table 5-6 School Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu	25,794	80	322
Ainaro	3,377	11	307
Baucau	19,474	43	453
Bobonaro	23,342	23	1,015
Covalima	2,756	10	276
Dili	39,428	67	588
Ermera	6,038	16	377
Lautém	15,252	84	182
Liquiçá	14,373	5	2,875
Manatuto	7,209	20	360
Manufahi	754	2	377
Oecussi	3,313	4	828
Unkown	1,865	6	311
Viqueque	21,994	9	2,444
Total	184,969	380	487



Source: Consultant

5.3.3 Commercial Sector

Table 5-7 Commercial Sector Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu	527	3	176
Baucau	1,470	5	294
Dili	6,392	9	710
Ermera	94	1	94
Lautém	335	1	335
Liquiçá	1,729	2	865
Manatuto	739	4	185
Oecussi	64	1	64
Total	11,350	26	437

Source: Consultant

5.3.4 Public / Government Buildings

Table 5-8 Public / Govt Building Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu			
Ainaro			
Baucau	78	1	7
Bobonaro			
Covalima			
Dili	2,956	2	225
Ermera			
Lautém			
Liquiçá			
Manatuto			
Manufahi	98	1	8
Oecussi			
Unkown	2,259	1	150
Viqueque	883	3	70
Total	6,274	8	460

Source: Consultant



5.3.5 Universities

Table 5-9 University Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu			
Ainaro			
Baucau			
Bobonaro			
Covalima			
Dili	26,918	13	1,070
Ermera	919	2	60
Lautém			
Liquiçá	5,599	1	150
Manatuto			
Manufahi			
Oecussi			
Unkown	782	1	50
Viqueque			
Total	34,218	17	1,330

Source: Consultant

5.3.6 Hospitals

Table 5-10 Hospital Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu	980	5	65
Ainaro	1,111	3	75
Baucau	319	2	19
Bobonaro	834	1	75
Covalima			
Dili	2,055	3	180
Ermera	545	1	30
Lautém	1,612	7	116
Liquiçá			
Manatuto	308	1	15
Manufahi			
Oecussi			
Unkown			



Procurement No. 0002004381
Solar Resource Data & Insights

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Viqueque			
Total	7,765	23	575

Source: Consultant

5.3.7 Hotels

Table 5-11 Hotel Footprints by Area, Count

Municipality	Sum of Building Footprints (m2)	Count of Residential Class Buildings	Average Footprint (m2 / Bldg)
Aileu			
Ainaro			
Baucau			
Bobonaro			
Covalima			
Dili	7,823	27	461
Ermera			
Lautém	827	3	52
Liquiçá			
Manatuto			
Manufahi			
Oecussi			
Unkown			
Viqueque			
Total	8,650	30	513

Source: Consultant

5.4 Quality of Housing

The residential building footprint areas have been adjusted to exclude houses of poor-quality construction (refer Section 3.2.3).

5.4.1 Household Rooftop Solar PV

Table 5-12 Households Solar PV Potential (kWp)

	Sum of Building Footprint Area (m2)	Building Quality Adjustment Factor	Quality Adjusted Sum of Building Footprint Area (m2)
Aileu	1,390,987	64.7%	899,969
Ainaro	1,884,370	51.1%	962,913



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of Building Footprint Area (m2)	Building Quality Adjustment Factor	Quality Adjusted Sum of Building Footprint Area (m2)
Baucau	3,418,287	52.6%	1,798,019
Bobonaro	3,246,094	59.8%	1,941,164
Covalima	2,218,133	43.3%	960,452
Dili	8,377,157	94.8%	7,941,545
Ermera	3,397,321	57.4%	1,950,062
Lautém	1,202,890	69.8%	839,617
Liquiçá	1,134,821	56.6%	642,309
Manatuto	1,357,187	65.9%	894,386
Manufahi	1,918,987	42.4%	813,650
Oecussi	1,132,116	50.9%	576,247
Unknown	513,844	55.0%	282,614
Viqueque	2,661,586	45.6%	1,213,683
Total	33,853,781		21,716,631

Source: Consultant

5.5 Solar Technical Potential

The rooftop solar PV technical potential is estimated by applying the minimum rooftop PV required areas to the building footprints.

5.5.1 Household Rooftop Solar PV

Table 5-13 Households Solar PV Potential (kWp)

	Sum of Building Footprint Area (m2)	Solar PV Potential (MWp)	Building Quality Adjustment Factor	Adjusted Solar PV Potential (MWp)
Aileu	1,390,987	21.8	64.7%	14.1
Ainaro	1,884,370	28.7	51.1%	14.6
Baucau	3,418,287	37.9	52.6%	19.9
Bobonaro	3,246,094	39.7	59.8%	23.7
Covalima	2,218,133	28.0	43.3%	12.1
Dili	8,377,157	73.6	94.8%	69.8
Ermera	3,397,321	44.6	57.4%	25.6
Lautém	1,202,890	14.5	69.8%	10.1
Liquiçá	1,134,821	12.7	56.6%	7.2
Manatuto	1,357,187	16.4	65.9%	10.8
Manufahi	1,918,987	25.8	42.4%	10.9
Oecussi	1,132,116	15.5	50.9%	7.9
Unknown	513,844	3.7	55.0%	2.1



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of Building Footprint Area (m2)	Solar PV Potential (MWp)	Building Quality Adjustment Factor	Adjusted Solar PV Potential (MWp)
Viqueque	2,661,586	37.7	45.6%	17.2
Total	33,853,781	400.5		246.1

Source: Consultant

5.5.2 Non-Residential Rooftop Solar PV

Table 5-14 Non-Residential Solar PV Potential (kWp)

	Schools	Commercial	Public / Govt	Universities	Hospitals	Hotels	Total
Aileu	1,736	42			65		1,843
Ainaro	228				75		303
Baucau	884	105	7		19		1,015
Bobonaro	495				75		570
Covalima	170						170
Dili	1,837	291	225	1,070	180	461	3,603
Ermera	334	8		60	30		432
Lautém	1,055	30			116	52	1,201
Liquiçá	150	80		150			380
Manatuto	465	58			15		538
Manufahi	60		8				68
Oecussi	145	5					150
Unkown	105		150	50			305
Viqueque	294		70				364
Total	7,958	619	460	1,330	575	10,942	7,958

Source: Consultant

5.5.3 Total Rooftop Solar PV Potential

Table 5-15 Total Solar PV Technical Potential (MWp)

	Household	Schools	Commercial	Public / Govt	Universities	Hospitals	Hotels	Total
Aileu	6.0	1.7	0.0	0.0	0.0	0.1	0.0	7.8
Ainaro	6.3	0.2	0.0	0.0	0.0	0.1	0.0	6.6
Baucau	12.4	0.9	0.1	0.0	0.0	0.0	0.0	13.4
Bobonaro	13.3	0.5	0.0	0.0	0.0	0.1	0.0	13.9
Covalima	6.7	0.2	0.0	0.0	0.0	0.0	0.0	6.9
Dili	53.1	1.8	0.3	0.2	1.1	0.2	0.5	57.2
Ermera	12.9	0.3	0.0	0.0	0.1	0.0	0.0	13.3
Lautém	5.3	1.1	0.0	0.0	0.0	0.1	0.1	6.6



Procurement No. 0002004381
Solar Resource Data & Insights

	Household	Schools	Commercial	Public / Govt	Universities	Hospitals	Hotels	Total
Liquiçá	4.2	0.2	0.1	0.0	0.2	0.0	0.0	4.6
Manatuto	6.0	0.5	0.1	0.0	0.0	0.0	0.0	6.5
Manufahi	5.6	0.1	0.0	0.0	0.0	0.0	0.0	5.6
Oecussi	3.3	0.1	0.0	0.0	0.0	0.0	0.0	3.5
Unkown	1.2	0.1	0.0	0.2	0.1	0.0	0.0	1.5
Viqueque	8.4	0.3	0.0	0.1	0.0	0.0	0.0	8.7
Total	144.7	8.0	0.6	0.5	1.3	0.6	0.5	156.2

Source: Consultant

5.6 Rooftop Solar PV Energy Production

Rooftop PV electricity production is an important input to net metering policy. A rooftop PV system could be sized to supply only self-consumption of a consumer, or over-sized to facilitate export of surplus electricity.

The maximum annual rooftop PV electricity production is simply determined as the Installed Capacity (kW) x Solar PV Capacity Factor (17%) x 8760 hours. The estimation of self-consumption, and therefore the net electricity available for export, is complicated because different consumer classes have different electricity demand profiles. Moreover, the peak demand varies by consumer within each consumer class as some consumers are 'larger' than others in terms of their personal and business activities. In practice, assumptions are needed regarding the shape of electricity demand profiles of each consumer class, and regarding the driving factors of peak electricity demand, before self-consumption can be estimated.

The maximum solar PV technical potential was given above as Table 5-15. This may not be the same as the Installed Capacity. The Installed Capacity depends on financial considerations within the context of net metering policy. For example, it may be that the Installed Capacity is lower than the maximum technical potential because the benefits associated with selling surplus electricity to the grid are not sufficient to justify the cost of the largest technically feasible PV system.

However, ahead of completion of net metering analyses to determine installed capacities, PV electricity production has been computed based on the maximum technical potential of rooftop PV as follows.

Table 5-16 Maximum Solar PV Electricity Production Technical Potential (MWh)

	Household	Schools	Commercial	Public / Govt	Universities	Hospitals	Hotels	Total
Aileu	8,854	2,570	62	0	0	96	0	11,582
Ainaro	9,315	338	0	0	0	111	0	9,763
Baucau	18,378	1,309	155	10	0	28	0	19,879
Bobonaro	19,681	733	0	0	0	111	0	20,525
Covalima	9,916	252	0	0	0	0	0	10,168
Dili	78,669	2,719	431	333	1,584	266	682	84,684



Procurement No. 0002004381
Solar Resource Data & Insights

	Household	Schools	Commercial	Public / Govt	Universities	Hospitals	Hotels	Total
Ermera	19,108	494	12	0	89	44	0	19,748
Lautém	7,914	1,561	44	0	0	172	76	9,768
Liquiçá	6,178	222	118	0	222	0	0	6,741
Manatuto	8,893	688	86	0	0	22	0	9,690
Manufahi	8,229	89	0	12	0	0	0	8,330
Oecussi	4,896	215	7	0	0	0	0	5,118
Unknown	1,841	155	0	222	74	0	0	2,293
Viqueque	12,369	435	0	104	0	0	0	12,908
Total	214,242	11,780	915	680	1,969	851	759	231,197

Source: Consultant



6 Community-Owned Solar PV

6.1 Concept

Community solar is defined as any solar project or purchasing program, within a geographic area, in which the benefits flow to multiple customers such as individuals, businesses, nonprofits, and other groups. Electricity consumers benefit from energy generated by solar panels at an off-site array.

Figure 20 Community PV Solar Array



Source: PLN Persero, Indonesia

Community solar customers typically subscribe to—or in some cases own—a portion of the energy generated by a solar array and receive an electricity bill credit for electricity generated by their share of the community solar system.

There are potential benefits in deploying community solar PV systems.

- Consumers may not be able to afford rooftop solar PV
- Consumers may not have the knowledge to be confident in purchasing rooftop solar PV
- Off-site systems can be rolled out faster than rooftop solar PV
- Operations and maintenance can be carried out by skilled technicians, ensuring highest possible efficiency of PV generation



- No changes are required at consumers premises i.e. wiring / fuse upgrades are avoided, special metering is not required

The administration of the scheme is only slightly more involved than the administration of billing and revenue collection for energy wheeled over the distribution network.

In Timor Leste, outside of Dili, the radial nature of the distribution network with loads near the end of the 22kV lines results in high electrical losses. This makes community owned off-site PV systems a particularly attractive option for supplying municipality load during the day, thereby reducing the power flow over the 22kV lines.

6.2 Site Selection

It was observed during the field visits, and confirmed from satellite images, that there are ample flat, open land areas that can accommodate PV systems of the typical size of community schemes.

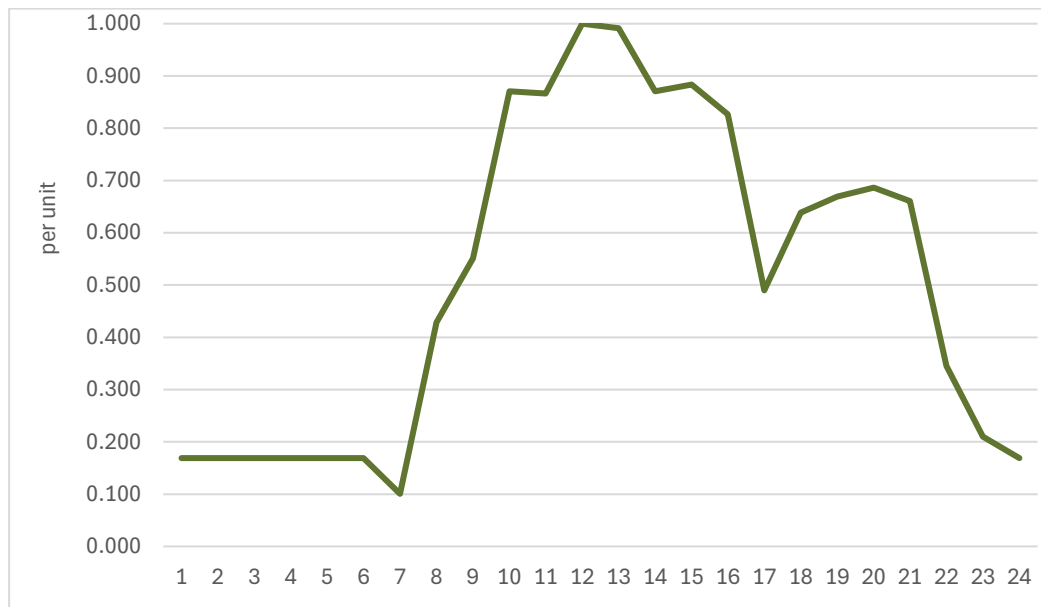
6.3 Electricity Demand

A normalized electricity daily demand profile for a large settlement in Timor Leste is given as Figure 21. The load profile exhibits are peak demand during the day, that is coincident with solar PV electricity production.

The per unit base of the load profile is 85 Watts per household. This specific consumption rate is a proxy rate in that it includes all other consumer classes, i.e. schools, retail businesses, etc.

The load profile can be scaled up by simply multiplying 85 Watts by the number of households to be supplied. This sets the peak demand to be met by a solar PV system.

Figure 21 Normalized Demand Profile (per unit basis)



Source: Consultant



6.4 Large Rural Towns by Household Counts & kWpeak Demand

The Consultant has estimated the peak demands of large rural towns.

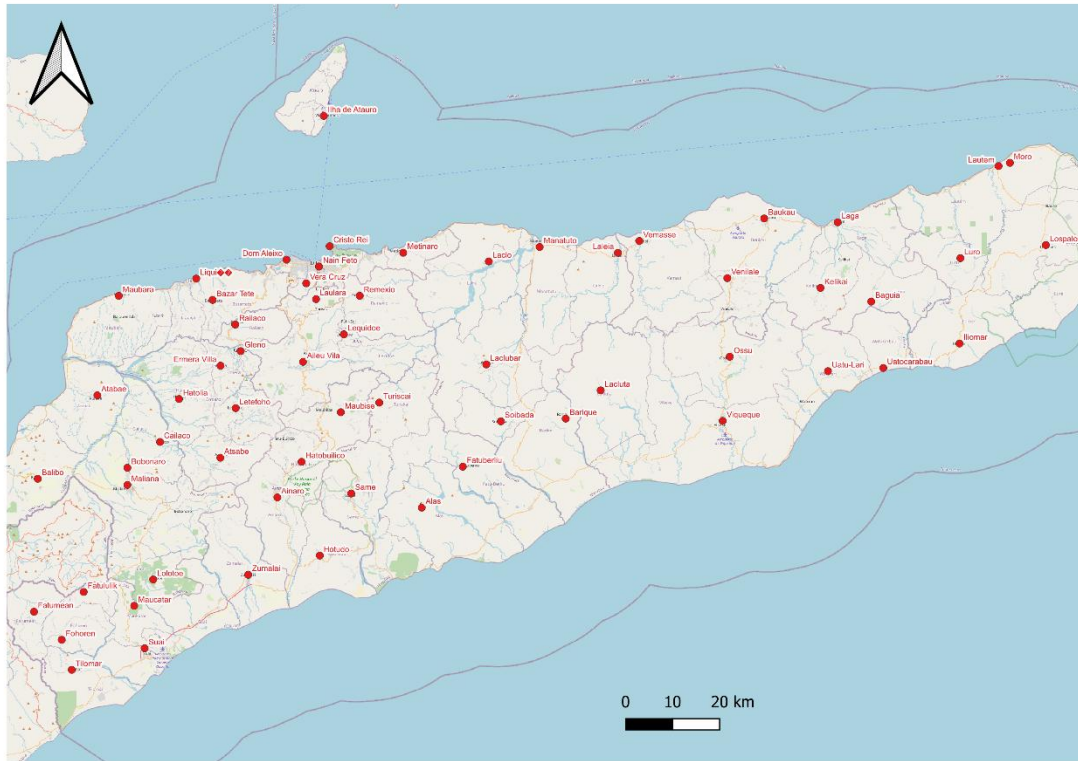
Table 6-1 Large Rural Town HH Counts and Peak Demands

Large Town	Household counts	kWpeak Demand	Large Town	Household counts	kWpeak Demand
Aileu Vila	26,208	2,228	Atsabe	19,826	1,685
Laulara	7,022	597	Ermera Villa	40,294	3,425
Lequidoe	7,800	663	Gleno	4,583	390
Remexio	13,294	1,130	Hatolia	15,134	1,286
Ainaro	17,786	1,512	Letefoho	22,064	1,875
Hatobuilico	15,134	1,286	Railaco	13,802	1,173
Hotudo	21,479	1,826	Iliomar	6,569	558
Maubise	23,798	2,023	Lautem	7,022	597
Baguia	11,718	996	Lospalos	30,044	2,554
Baukau	54,964	4,672	Luro	8,381	712
Kelikai	6,569	558	Tutuata	3,659	311
Laga	19,781	1,681	Bazar Tete	54,964	4,672
Vemassee	11,206	953	Liquiçá	26,418	2,246
Venilale	18,765	1,595	Maubara	23,798	2,023
Atabae	12,938	1,100	Barique	6,164	524
Balibo	17,619	1,498	Laclo	9,856	838
Bobonaro	25,374	2,157	Laclubar	12,173	1,035
Cailaco	10,328	878	Laleia	4,192	356
Lolotoe	7,691	654	Manatuto	15,197	1,292
Maliana	32,689	2,779	Soibada	3,277	279
Fatululik	2,178	185	Alas	9,532	810
Fatumean	3,648	310	Fatuberliu	8,490	722
Fohoren	4,583	390	Same	34,843	2,962
Maucatar	10,793	917	Turiscail	7,800	663
Suai	26,644	2,265	Nitibe	13,496	1,147
Tilomar	9,977	848	Oesilo	12,637	1,074
Zumalai	16,110	1,369	Pante Makasar	45,415	3,860
Ilha de Atauro	21,479	1,826	Ossu	9,137	777
Metinaro	7,169	609	Uatocarabau	6,695	569
Moro	7,169	609	Uatu-Lari	18,787	1,597
Nain Feto	33,528	2,850	Viqueque	3,659	311
Vera Cruz	41,873	3,559			
			Total	1,081,457	91,924

Source: Consultant



Figure 22 Large Towns



Source: Consultant

6.5 Simulation Model

A simulation model has been used to simulate dispatch of a community-based PV system. The simulation model includes a battery storage option.

The steps to run the simulation model are straightforward.

- Step 1 – Download PVGIS data, compute solar PV kWh / kW
- Step 2 – Enter a per unit demand profile
- Step 3 – Scale by the number of households
- Step 4 – Run the dispatch to size the PV system and battery

The simulation model produces a cost-benefit analysis. However, financial and economic results fall outside an analysis of technical potential and are not presented in this report.

6.6 Community Solar PV Sizing

With reference to Table 6-1 above, a small and large town has been selected for PV system sizing. The two towns selected are Bacau and Fatululic.

A simulation model has been used to simulate the dispatch of a community-based PV system. Two cases have been considered, with- and without-battery storage.



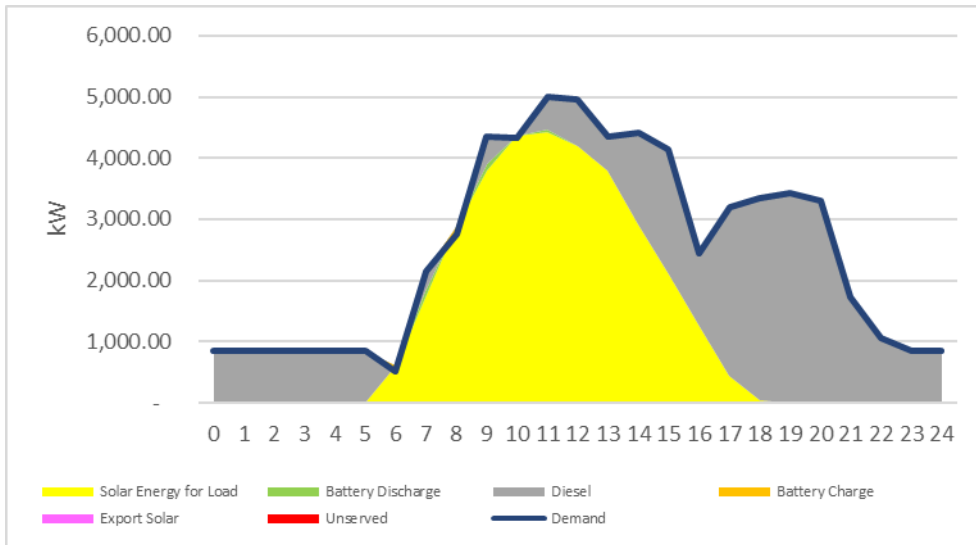
Procurement No. 0002004381
Solar Resource Data & Insights

It remains to conduct a cost benefit analysis as part of the development of a broad Renewable Energy policy and roadmap.

6.6.1 Bacau

Case 1 - Demand 5,000 kW, Solar PV 4,300 kW, Battery Storage 0 kW, Diesel (Balancing) 3,500 kW

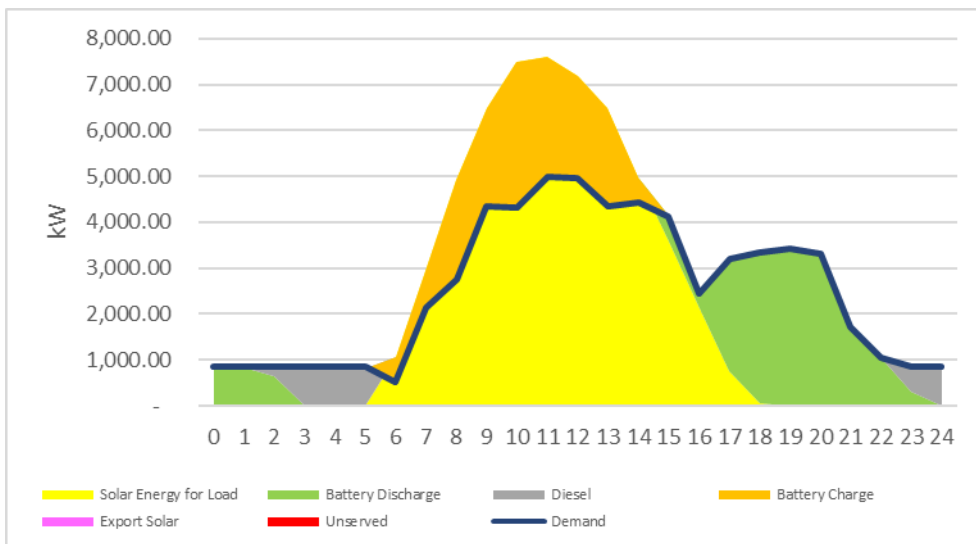
Figure 23 Dispatch - Bacau without Battery Storage



Source: Consultant

Case 2 - Demand 5,000 kW, Solar PV 7,500 kW, Battery Storage 5,000 kW, Diesel (Balancing) 800 kW

Figure 24 Dispatch - Bacau with Battery Storage



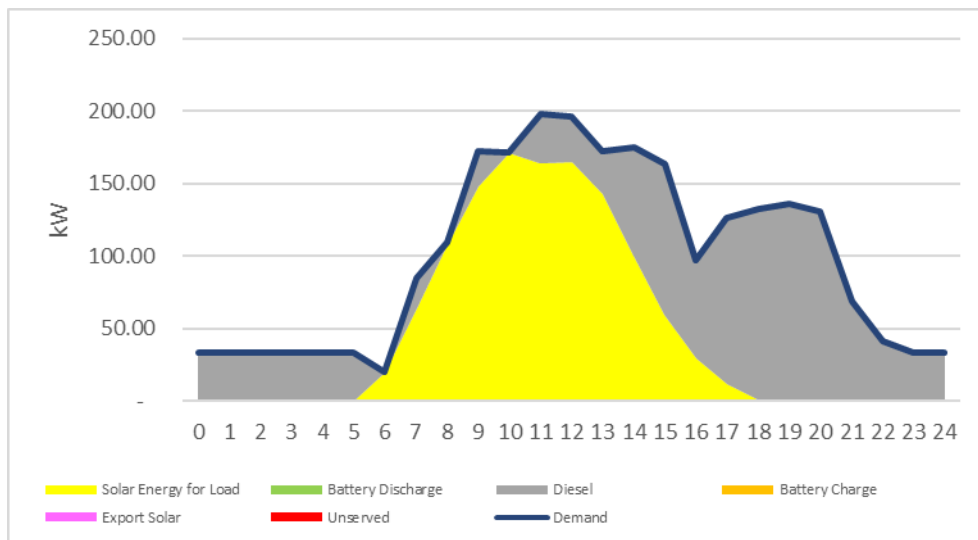
Source: Consultant



6.6.2 Fatululic

Case 1 - Demand 200 kW, Solar PV 180 kW, Battery Storage 0 kW, Diesel (Balancing) 140 kW

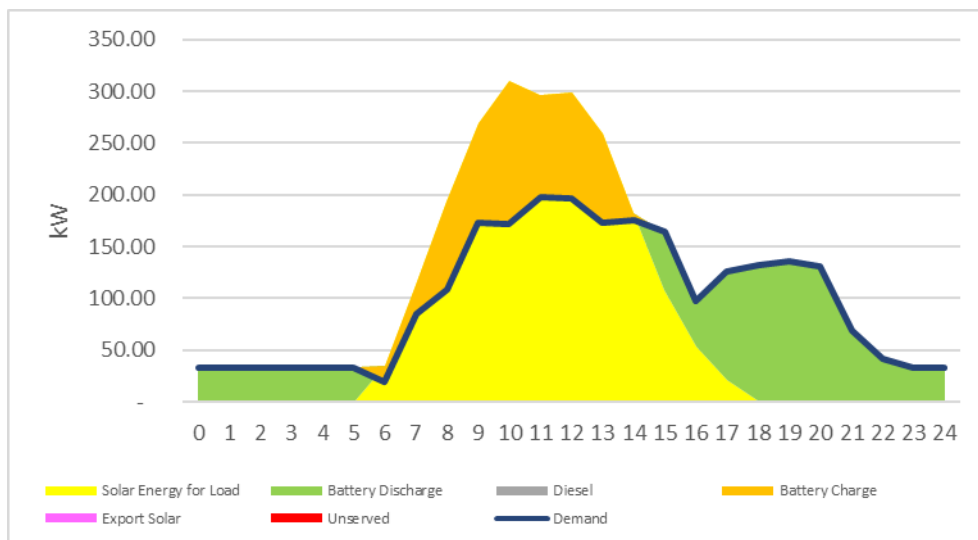
Figure 25 Dispatch - Fatululic without Battery Storage



Source: Consultant

Case 2 - Demand 200 kW, Solar PV 300 kW, Battery Storage 260 kW, Diesel (Balancing) 0 kW

Figure 26 Dispatch - Fatululic with Battery Storage



Source: Consultant



ANNEXES



Households

	Sum of kW Potential	Count of kW Potential2
Aileu Vila	5,613	6,547
Ainaro	3,179	3,481
Alas	1,979	2,316
Atabae	2,919	3,101
Atauro	1,907	2,118
Atsabe	3,310	3,770
Baguia	1,088	1,150
Balibo	3,538	3,883
Barique/Natarbora	1,196	1,318
Baucau	11,651	10,483
Bazartete	2,862	2,754
Bobonaro	5,060	5,207
Cailaco	2,055	2,343
Cristo Rei	12,849	12,731
Dom Aleixo	27,596	27,187
Ermera	7,955	8,504
Fatubertiu	1,722	1,998
Fatululic	419	447
Fatumean	634	733
Forohem	1,005	1,056
Hatolia	5,780	7,091
Hatu-Builico	2,756	3,059
Hatu-Udo	2,330	2,718
Iliomar	211	243
Laclo	1,451	1,741
Laclubar	1,360	1,584
Lacluta	1,028	1,303
Laga	2,331	2,349
Laleia	1,113	1,089
Laulara	828	904
Lautém	2,478	3,058
Letefoho	4,135	5,212
Liquiçá	1,568	1,554
Liquidoe	1,404	1,731
Lolotoe	1,425	1,719
Lospalos	4,307	4,361
Luro	181	215
Maliana	7,232	7,658



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
Manatuto	3,550	3,508
Maubara	2,948	3,858
Maubisse	4,053	5,163
Maukatar	1,501	1,690
Metinaro	1,469	1,412
Nain Feto	5,180	4,821
Nitibe	201	252
Oesilo	267	366
Ossu	4,120	4,253
Pante Macassar	5,909	6,522
Passabe	117	171
Quelicai	1,204	1,298
Railaco	1,308	1,410
Remexio	1,398	1,764
Same	7,972	8,815
Soibada	440	477
Suai	6,695	7,080
Tilomar	2,132	2,563
Turiscai	1,441	1,811
Tutuala	478	605
Uato-Lari	4,993	5,820
Uatucarbau	2,003	2,171
Unkown	2,261	2,457
Vemasse	2,936	3,107
Venilale	4,395	4,604
Vera Cruz	7,029	6,973
Viqueque	6,176	7,538
Zumalai	3,069	3,386
Grand Total	225,702	242,611

Schools

	Sum of kW Potential	Count of kW Potential2
Aileu Vila	856	40
Biblioteca do Cospepal	15	1
Cospepal	209	11
EBF Hlalameta	15	1
EBF No.2 Fatuk-Hun	60	2
EBF Tabulasi	15	1



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
Ensino Secundaria Geral Aileu Malere	80	2
Escola Basica Filial de Mantane	30	1
Escola Basico Central Seloï Craic	50	1
Escola Filial Ensino Primaria Seloï Craic	50	1
Escola Referência Café Aileu Villa	68	3
Escola Secundária Cristal	58	2
Escola secundaria Geral Seloï kraik	50	1
Escola Tecnico Vocacional Aileu	60	3
Ainara	93	5
Ebc Sao Paulo	30	1
Alas	30	1
Escola EBF 1,2 Colocau.	30	1
Atauro	45	2
Atsabe	40	3
Escola EBC Lacao	15	1
Escola EBF Lacao	15	1
Baguia	135	7
28 de Agustus	15	1
28 de Augustus	30	2
EP Chatolica São João Bosco Samalari	30	1
Escola Pre-Secundaria	15	1
Escola Primaria Lebenei	45	2
Barique/Natarbora	165	9
EBC-filial uma boco	60	4
EBC-Natarbora	90	4
Baucau	230	8
Area eskola SD 11	50	1
Centro Regional de Formacao de Professores Baucau	15	1
EBF Gologota	50	1
Youth Vision Centre	30	1
Bazartete	100	2
Colegio Santo Inacio de Loiola	50	1
Bobonaro	130	8
EBF Soilesu	30	1
EBF Woalgomo	15	1
Escola Basica Filial Mazop, Ai-Assa	15	1
Cailaco	75	4
EBC Samutaben	45	2
EBC Tatelori	15	1
Cristo Rei	355	11



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
EBC Laulara	10	1
EBC Pe. Monteiro	30	1
Escola Basica MUI	30	1
Escola Primaria No. 3 Acanuno	15	1
escola secundaria s. João Paulo II	50	1
Eskola Primaria No.3 Akanuno	30	1
ESTV- Economia e Comercio Becora	30	1
ESTV-IT 28 de Novembro	50	1
pre-escolar Santjes	50	1
Dom Aleixo	759	30
EBC 13 Fatumeta	53	4
EBC Sao Mateus Maloa	15	1
EBF Fatumeta	30	1
Escola 10 de Dezembro	50	1
Escola An'nur	50	1
Escola Canossa	50	1
Escola ETI	50	1
Escola São Carlos	50	1
Eskola Tais	50	1
pre escolar irman carmelita	30	1
Pre-secondary number 4 Bairo Pite	50	1
Timor-Leste Adventist International School	15	1
Ermera	264	12
ES Nino Konis Santana Gleno	165	7
Fatuberliu	30	1
EBC Ailalek	30	1
Fatululic	120	7
Escola EBF 1 2 Fatuloro	45	2
Escola EBF Maco'us	30	2
Escola EBF Taroman	45	3
Hatolia	30	1
Hatu-Udo	135	6
Laclo	50	1
Escola Sao Joao Paulo II de Laclo	50	1
Laga	203	8
Escola Larifanu	30	1
Laleia	105	4
Laulara	200	8
EBF Darlau	60	2
Escola Basica Central de Bessilau	20	2



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
Escola Pre-Secundaria de Bessilau	90	3
Lautém	260	13
EBC	30	1
EBC Com	75	3
EBF, Maina I	45	2
Ensino Basico Central No. 1 Lautem	15	1
EP Sao Jose Pitileti	15	1
Escola Basica 13 Soiquili	20	2
SDK SJP	30	2
Liquiçá	50	3
EBC Loidahar	45	2
Liquidoe	205	8
EBF Faturilau	50	1
ESC NOSCAL	80	3
Eskola Lequidoe	15	1
pre-Secundaria	30	1
Lolotoe	115	6
EBF AMES	30	1
Lospalos	575	61
Ensino Filian de Tilitary	30	1
Escola Basica Numero 3 de Lospalos	15	1
Escola Pre-secundaria Centro Lospalos	30	1
Luro	75	3
Escla Filial no 2 De Alahira	30	1
Escola Primaria no 3 de Cotamuto	15	1
Maliana	175	5
Escola Cafe Maliana	80	2
ESTV Malibaca, Yamato	50	1
Seminarion Menor de São José de Malian	30	1
Manatuto	145	6
Eskola Basika Filial Rentau	30	1
Eskola Kafe	30	1
Eskola TK Sau	55	3
Nain Feto	328	9
EBC Catolica 3 Ciclo São José Operario	50	1
EBC Nu'u Laran	30	1
ES Catolica São José Operario	30	1
Escola Café de Dili	50	1
Escola Duque de Caxias	50	1
Escola Nobel da Paz	10	1



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
Escola Portuguesa	50	1
Nitibe	15	1
Ossu	200	4
EBC 1 e 2 Ciclo Santa Teresinha Ossu	50	1
EBC 3 Ciclo Santa Teresinha	50	1
ESG. Canossa Ossu	50	1
Pante Macassar	130	3
CAFE de Oé-Cusse	50	1
EBC Santo Antonio	50	1
EBF 28 de Agosto	30	1
Quelicaí	75	3
Remexio	476	24
EBF Aco-Mau, Remexio	60	3
Ensino Basico Filial katiloka Sao Jose operation Remexio	50	1
Escola Basico Filial Likisa	45	2
Escola Basico Filial Mautoba	30	1
Escola Pre-Secundaria Aco-Mau	100	5
Escola pre-Secundaria Roluli	30	1
Escola Primaria Publica No.6 Hau-toho	71	6
pre sesundaria Tuque Maumeta	30	2
Suai	50	3
Eskola Primaria 5 Suai Loro	15	1
Eskola primaria Audian, Suai Covalima	35	2
Tutuala	145	7
Escola Presecudaria Mehara	70	4
Unknown	105	6
Cospedal	15	1
EBC-Natarbora	30	2
EBC-Natarbora antigo	15	1
Uma laku Cospedal	30	1
Vemasse	226	16
EBC de Vemasse Clase 1	30	1
EBC de Vemasse Clase 2	15	1
ESG de Vemasse Clase 1	30	1
ESG de Vemasse Clase 2	30	1
ESG de Vemasse Clase 3	15	1
Kantor EBC Filial Vemasse	15	1
Venilale	15	1
EBC Publico Venilale	15	1
Vera Cruz	350	15



Procurement No. 002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
ABUT Timor - Actividade Centro Educativo	15	1
Cosafar Dare	80	2
EBF Memoria dos Herois Fatunaba	15	2
EBF No.5 Payol	15	1
EBF Taur Matan Ruak	30	1
EBF Tuana Laran	15	1
Escola 4 de Setembro	50	1
Escola Basica Filial Kasnafar	20	2
Escola Infantil Sagrada Familia	15	1
Escola Pre Escolar Assisi	15	1
International Eagle School	50	1
St. Jude Thaddeus International School	30	1
Viqueque	94	5
EBC Beobe	30	1
Escola Cafe De Viqueque	30	1
Grand Total	7,957	380

Commercial

	Sum of kW Potential	Count of kW Potential2
Aileu Vila	30	1
Loja Nusabe	30	1
Baucau	30	1
Lisun-Depo Baucau	30	1
Dom Aleixo	100	2
Laga	74.6	4
Mercado Laga	74.6	4
Lospalos	30	1
Manatuto	58	4
Huntasingkong	30	1
Jofra Ar-Li, Ennjofra Ar-Li, ENN	18	2
Supermerkadu	10	1
Maubara	80	2
Fort Restaurant	30	1
Nain Feto	41	4
Dtpsc Balide	30	1
Pante Macassar	5	1
Tempat pelelangan ikan	5	1
Railaco	8	1



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of kW Potential	Count of kW Potential2
Tilofe Compost Place	8	1
Remexio	11.6	2
Loja	11.6	2
Vera Cruz	150	3
ETO Halilaran	50	1
Port Centre Shopping	50	1
Grand Total	618.2	26

Public/Government

	Sum of area1	Sum of kW Potential
Fatuberliu	98	8
Sede Aldeia Sukaer Oan	98	8
Laga	78	6.6
Nain Feto	867	75
Ossu	883	70
Administrasaun Posto Ossu	331	30
Esquadra PNTL Ossu	429	30
Sede Suco Ossu de Cima	123	10
Unknown	2,259	150
PLBN Terpadu Montaaain	2,259	150
Vera Cruz	2,089	150
Ministérios	2,089	150
Grand Total	6,274	459.6

Universities

	Sum of area1	Sum of kW Potential
Bazartete	5598.973	150
Cristo Rei	18065.559	430
Departamento Geodesia	397.624	30
Faculdade Engenharia UNTL	4695.152	150
Kampus Agrikultura Hera	1081.124	100
Universidade Oriente Timor Lorosa'e	11891.659	150
Dom Aleixo	6243.57	410
Insitut Of Business	541.78	30
Instituto Ciências da Saúde	334.588	30



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of area1	Sum of kW Potential
IPDC	1396.565	100
Isfit D. Jaime Garcia Goulart	554	50
Sao Fransico de Sales	717.507	50
Seminario Maior Fatumeta	2699.13	150
Ermera	919.142	60
ETCI	791.117	50
Nain Feto	1674.295	150
Universidade Catolica São João Paulo II Dili	1674.295	150
Unknown	782.485	50
Universidade de Díli	782.485	50
Vera Cruz	934.473	80
ICR-São Tomas de Aquino	590.758	50
UNTL Faculdade Ciencia de Saude Lahane	343.715	30
Grand Total	34218.497	1330

Hospitals

	Sum of area1	Sum of kW Potential
Aileu Vila	255.431	15
Centro de Saúde Aileu Kota	255.431	15
Ainaro	642.477	50
Baguia	265.678	15
Cristo Rei	965.301	80
Capela HNGV	398.309	30
ICU Room	566.992	50
Dom Aleixo	1089.29	100
Kampun Baru	1089.29	100
Hatu-Udo	323.052	15
Laclo	308.232	15
Letefoho	545.138	30
Klinika Santa Bakhita Eraulo	545.138	30
Lolotoe	834.219	75
Centro de saúde Opa	834.219	75
Lospalos	1233.089	93
Luro	379.364	23
Centro Saude Luro	287.28	15
Maubisse	145.391	10
klinika	145.391	10
Remexio	724.523	50



Procurement No. 0002004381
Solar Resource Data & Insights

	Sum of area1	Sum of kW Potential
Centro Maternidade	257.881	20
Centro Saude	228.214	15
Centru Saude Tulatageu	238.428	15
Vemasse	53.374	4
Grand Total	7764.559	575

Hotels

	Sum of kW Potential	Count of kW Potential2
Cristo Rei	30	1
Sakura Tower	30	1
Dom Aleixo	351	24
Hotel Malinamoc	7	1
Tutuala	52	3
Vera Cruz	80	2
Hotel Colmera	30	1
Hotel Timor	50	1
Grand Total	512	30

