LINDEMAN GREAT BARRIER REEF RESORT PROJECT

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX M - SOLAR-DIESEL HYBRID FEASIBILITY STUDY

***Addendum:** This EIS was initially prepared assuming that the safe harbour was to be part of the Lindeman Great Barrier Reef Resort Project. With the commencement of the Great Barrier Reef Marine Park Authority's (GBRMPA) Dredging Coral Reef Habitat Policy (2016), further impacts on Great Barrier Reef coral reef habitats from yet more bleaching, and the recent impacts from Tropical Cyclone Debbie, the proponent no longer seeks assessment and approval to construct a safe harbour at Lindeman Island. Instead the proponent seeks assessment and approval for upgrades to the existing jetty and additional moorings in sheltered locations around the island to enable the resort's marine craft to obtain safe shelter under a range of wind and wave conditions. Accordingly, remaining references to, and images of, a safe harbour on various figures and maps in the EIS are no longer current.*

Solar-Diesel Hybrid Feasibility Study – Final Report

HRP15078-001-0140-ELEC-E-RPT-001

Revision: 3 Date: 29/11/16

Prepared for:

White Horse Australia Lindeman Pty Ltd

Lindeman Island Redevelopment Renewable Energy

HRP15078

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Shaping the Future

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1 Introduction

1.1 Redevelopment Plans and Vision

White Horse Australia Lindeman Pty Ltd (WHA) propose to redevelop the existing resort at Lindeman Island into three world class tourist resorts. The proposed design incorporates environmental improvements to protect the values of the Great Barrier Reef World Heritage Area and set new international standards in environmental sustainability and resort design.

Key aspects of the proposed development include:

- Beach Resort - redevelopment of the existing resort to achieve a new 5 star Beach Resort with 136 units, conference centre, beach club and a central facilities building with restaurants, bars and lounges;
- Spa Resort - a new 6 star Spa Resort with 59 units, central facilities, entry lounge, spa, sea view restaurant, pool and a signature rock bar providing spectacular alfresco dining close to the sea;
- Eco resort - a new 5 star Eco Resort near the existing lake consisting of 41 units, a central facility, boathouse and a waterside restaurant;
- Tourist villa precincts - two precincts accommodating 89 tourist villas are proposed to the north-east and north-west of the existing resort;
- Village - a central village precinct comprising restaurants, bar, night club, conference facility buildings, arrival centre, shops, sport and recreation centre and a staff village;
- Services infrastructure precinct - a new precinct with services including power generation (solar with diesel back-up), sewage treatment and water treatment designed to reflect current best practice;
- Airstrip - the existing airstrip is proposed to be upgraded to provide for near all-weather status, capable of landing light aircraft and helicopters;
- Golf course - a recreational golf course is proposed;
- Safe Harbour - a new Safe Harbour is proposed to provide reliable access for the transfer of guests via ferries, luxury vessels and private charters offering greater protection from the prevailing wind direction;
- Ecotourism facilities - a National Park and Great Barrier Reef Educational Centre and 30 glamping facilities are being investigated in consultation with the State Government; and
- Environmental enhancements - native vegetation replanting, improvements to stormwater management and a shift towards renewable energy sources are proposed.

The purpose of this report is to detail the likely demand and the concept plan to supply energy to the development using a combination of solar and diesel generation.

1.2 Power Generation

All power to the existing resort was supplied entirely by diesel generators located at the power-house. Diesel generation numbers were obtained for the existing resort for the period December 2011 to January 2012, before it was closed, as shown in Figure 1.

The diesel generation figure suggest the existing resort had a peak load demand of between 1.0 to 1.2 MW.

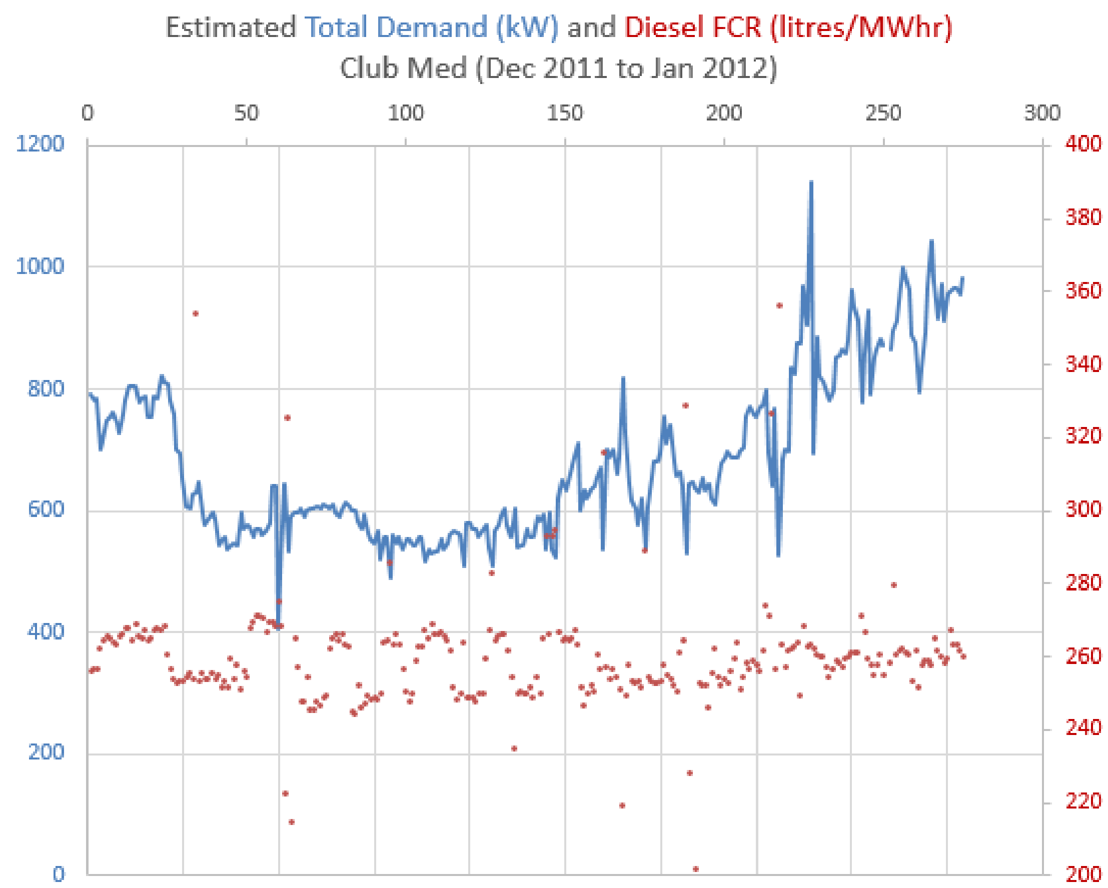

Figure 1: Diesel Generation (Existing Resort)

A previous power study was commissioned by WHA and was undertaken by Perigon Engineering (in October 2015).

Perigon estimated the total load demand for the new development to be ~ **4.1MW**, which is about 4 times the load demand of the existing resort. The existing generators and powerhouse facility would need to be upgraded to cope with the increased power demand of the new resort facilities and additional resort precincts.

The Perigon "Site Investigation Report – Electrical Services" provided both capital and operating cost estimates for the energy supply options which were considered, including:

- Grid Power supply from the mainland
- Continuation of power generation entirely from Diesel Generators
- Hybrid Diesel-Solar generation (utilising Distributed Solar)

Perigon's conclusions are summarised below (reproduced from the report):

Option	Estimated Up-front Capital Cost	Expected Cost / Annum	Notes
HV From Mainland (incl. Powerhouse Cost)	**$108,135,500**	**$3,313,750** (Based on Ergon HV Tariff 47 at time of report)	Assume 50% average loading (2,050kVA) for 24hours/365 days per year = 17,958,000 kWhr/year)
Central Diesel Powerhouse	**$5,550,000**	**$5,256,000**	Assume 50% average loading (2,050kVA) for 24 hours/365 days per year. Consumption for Generators would average approximately 400 litres/hour @ an assumed rate of $1.5/L for Diesel. Generator Maintenance cost and Diesel Fill Labour not included.
Central Diesel Powerhouse with 3.8MW of Solar Dispersed around Development	**$14,100,000**	**$3,604,000**	Based on true historical factor of 22kW/Day return from 5kW System (4.4x Factor). Assume 16MW/Day return from 3.8MW System. 2MW average over 24 Hours = 48MW Total Daily Consumption. Saving is 33% Government Grants could also be sought for this economically sustainable initiative.

1.3 Solar-Diesel Hybrid Feasibility Study

In line with WHA's vision to develop a truly sustainable and world-class eco-resort, the option to further investigate the Hybrid System (i.e. Solar and Diesel) was commissioned with Cardno BEC.

The system which was studied by Cardno comprises a "mini-grid" system of solar generation, large scale battery storage and diesel backup to provide an environmentally friendly, reliable and cost effective energy supply to the island.

Cardno and its specialist solar energy sub-consultants, Conergy conducted a desktop feasibility and preliminary design study on the potential implementation of a solar hybrid "mini-grid" power system based on varying levels of renewable energy from 0% up to 100%.

The concept design of the proposed system, and the outcome of Cardno's modelling (including cost estimates for capital and operating) is provided in the following sections of the report.

2 Site Conditions and Plant Design Philosophy

2.1 Site Suitability

The location of Lindeman Island generally lends itself well to solar power generation, being in a region that enjoys high annual solar irradiation levels, as shown in Figure-2.

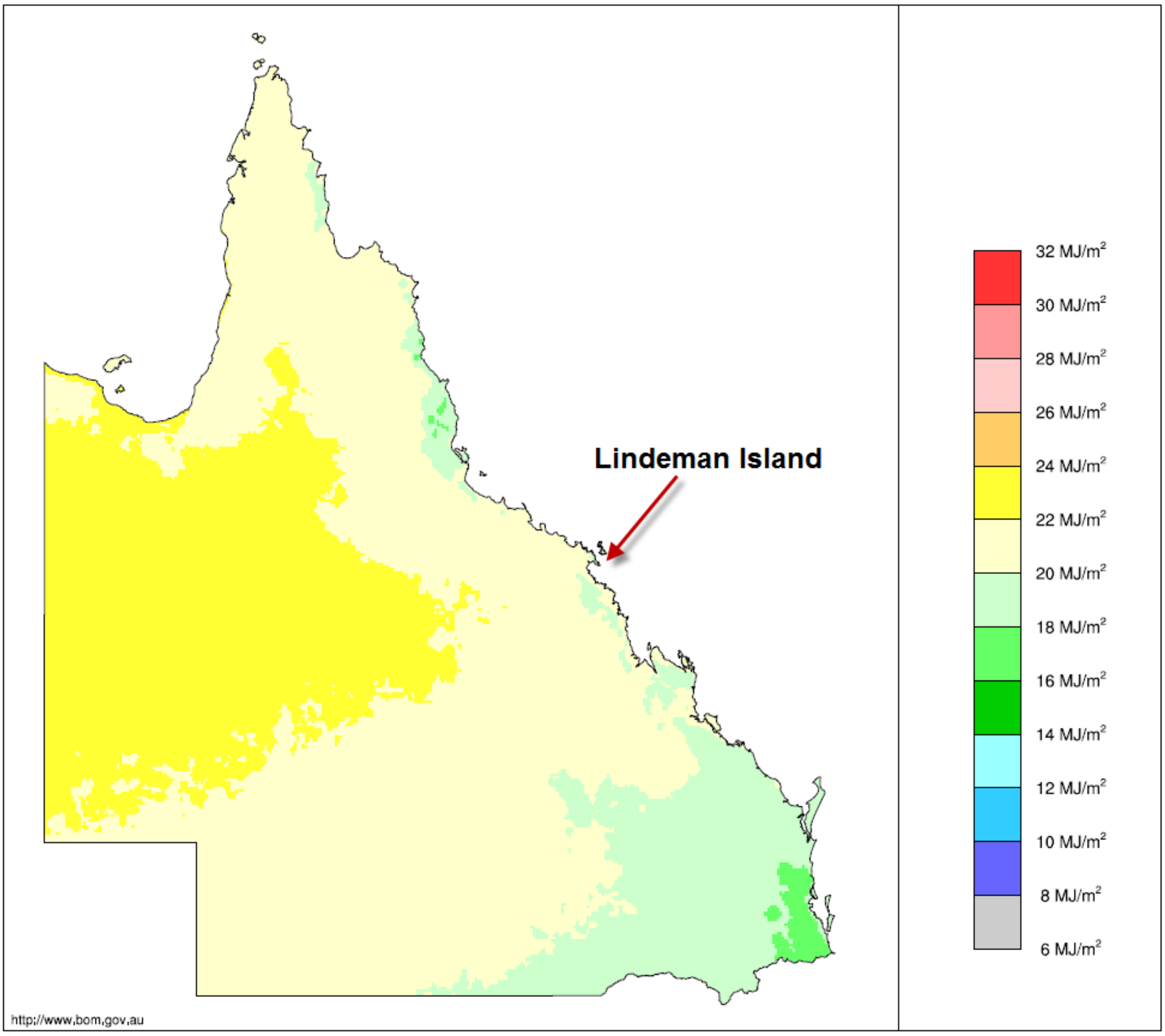

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Figure 2 - Australian Mean Annual Solar Radiation Levels

2.2 Target Locations for Solar Panels

Based on the latest Master-plan from DBI, a number of suitable areas have been identified be Cardno to be considered for the:

- Mounting of solar panels across various roof-tops; and
- Installation of ground-mounted panels in selected land areas around the airport run-way.

2.2.1 Roof-Top Solar Panels

The target buildings for the installation of Roof-Top Solar Panels are located around the central Village / Retail Precinct / Staff Accommodation and the Aircraft Hangers as shown on the extract of the Master-Plan in Figure- 3.

The total available roof-space allows for a minimum of approximately **3MWp** of solar arrays to be installed (based on using the roof-space on buildings No.3, 4, 5, 6 and 7).

If additional and suitable roof-space is available from other buildings in this central area, the solar capacity could be increased slightly above 3MWp.

The density of roof-mounted solar arrays will depend largely on the final designs of the roofs, but as a general guide, the density of roof-mounted systems is higher than ground mounted solar arrays.

Figure 3: Target Buildings for Roof-top Solar Panels

The concept design by Cardno does not recommend the installation of roof-mounted panels on the roofs of the facilities around the beach resort, spa-villa's, eco-style villas or the tourist villa's precincts, for various reasons:

- Overall preference is for a bulk and centralised installation of roof-moumted solar panels on large and predominantly flat (or slightly angled) and contiguous roof-surfaces - to minimise capital, installation and maintenance costs.
- The central facility buildings are well away and hidden from the general view of the guest living, recreational and accommodation areas, and does not detract from the owner's vision of having minimal impact both visually and environmentally (with regards to clearance of natural vegetation).
- The central areas identified are not as 'architecturally sensitive' relative to the villa's or main buildings (e.g. signature restaurant in the 6-star spa-precinct, or main restaurant in the beach-precinct, or the guests welcome centre).
- The central facility location is more cleared of trees and hence less impacted by any shading from tall trees as it is close to the airport runway (compared to the eco-villa's which are in more heavily wooded areas).
- The panels on the roof-space of the central facilities can be more easily aligned with the ideal NW-N-NE facing orientation, compared to the smaller roof-spaces of the eco-villa's and spa-villa's (which would only be scarcely aligned with the ideal NW-N-NE facing orientation, and would necessitate additional mounting brackets and create visual impact).

Facilities in Main Beach Precinct – not preferred for roof-mounted solar panels (architecturally sensitive)

Eco-resort villas – not preferred for roof-mounted solar panels (heavily shaded)

Central Spa Facility – not preferred for roof-mounted solar panels (visual impact and architecturally sensitive)

Guest Welcome Centre – not preferred for roof-mounted solar panels (architecturally sensitive)

2.2.2 Ground Mounted Panels

In addition to the centralised roof-mounted solar panels, Cardno's concept design requires the installation of ground-mounted solar panels to provide the necessary and additional solar generation capacity to displace the amount of diesel usage.

The land area which is required varies and depends on the amount of diesel fuel usage which is intended to be displaced by solar generation:

Diesel Displacement (%)	**Roof Mounted Solar** (MWp) based on available roof area in central facility	**Ground Mounted Solar** (MWp)	**Approximate Land Area required** (note 1)
35%	3.0	1.5	18,000 m²
50%	3.0	3.5	42,000 m²
75%	3.0	7.0	84,000 m²

Note 1: As a rule of thumb, the solar capacity from ground mounted arrays is ~ 1.2 Ha per MWp based on today's high efficiency panels.

In reference to the latest master plan, the available land areas which Cardno recommends would be suitable for the installation of ground-mounted solar arrays, are as shown in Figure 4.

- **Location 1**

  This area is immediately north of the run-way, total area ~ 1.74Ha, and is estimated to yield ~ 1.5MWp.

- **Location 2**

  This area is to the north-west of the aircraft hangars, total area ~ 0.78Ha and is estimated to yield ~ 0.7MWp

- **Location 3**

  This area is to the south of the run-way, total area ~ 0.72Ha, and is estimated to yield ~ 0.5MWp

Based on the above land areas, the estimated percentage of diesel savings will be:

Land Area (in addition to roof-space of central facility buildings)	**Total Solar Capacity** (MWp) [Roof Mounted] + Ground Mounted	**Approximate Diesel Usage savings**
Location 1	[3.0] + 1.5 = 4.5	35 %
Location 1 + Location 3	[3.0] + 1.5 + 0.5 = 5.0	38 %
Location 1 + Location 2	[3.0] + 1.5 + 0.7 = 5.2	40 %
Location 1 + Location 2 + Location 3	[3.0] + 1.5 + 0.7 + 0.5 = 5.7	44 %

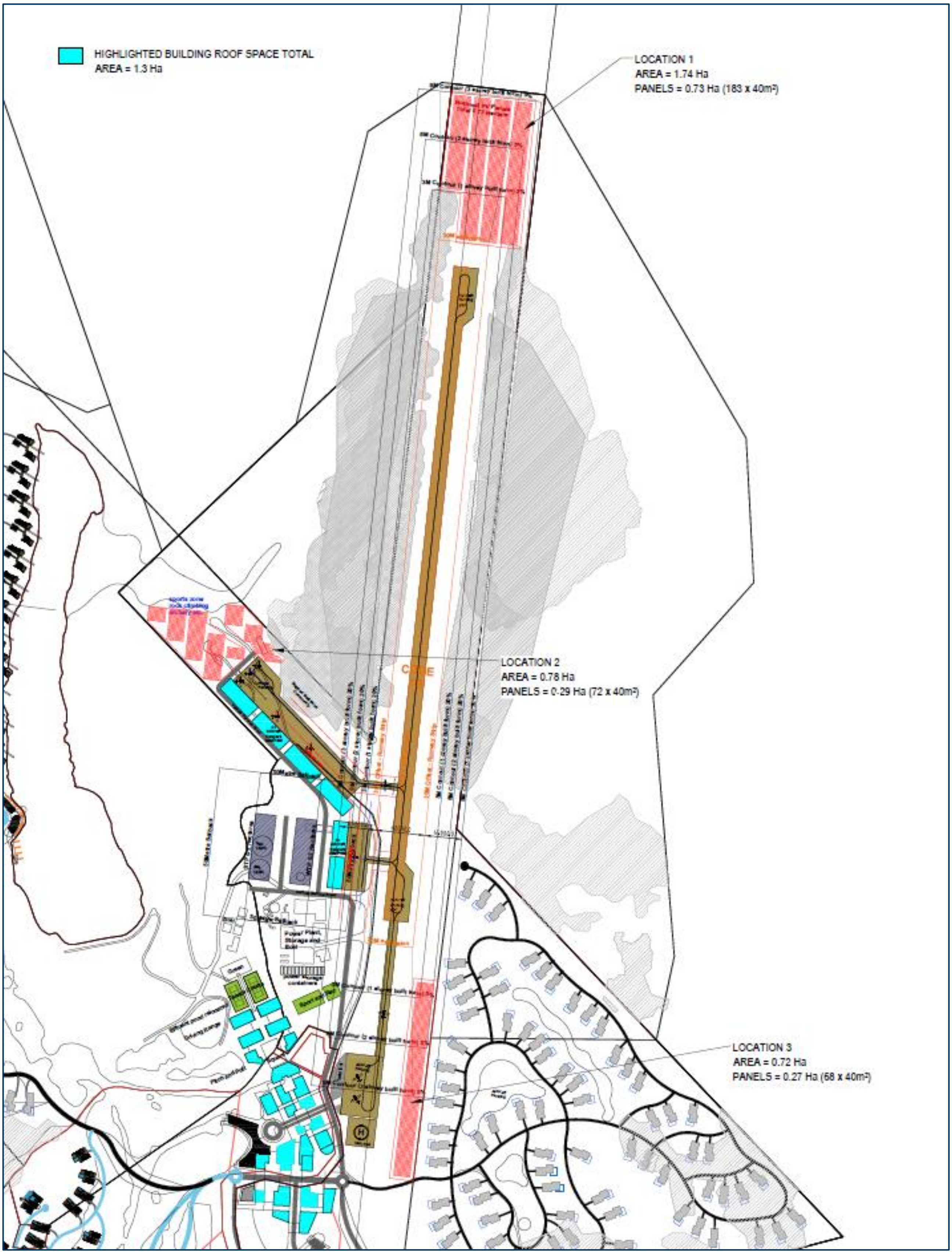


Figure 4 – Recommended Land Areas for Ground Mounted Solar Panels (Red)

The recommended land areas for the installation of ground mounted solar arrays are well hidden from the general view of the guest living and accommodation areas, and does not detract from the owner's vision of having minimal impact both visually and environmentally (with regards to clearance of natural vegetation).

These land areas are also reasonably flat, and largely devoid of natural vegetation and/or are outside of the protected vegetation areas, as shown on the master plan.

With careful planning during the detailed design stages, it is possible to maximise the solar generation from the limited land areas surrounding the airport run-way, through compact array designs and low profile layouts which comply with the Civil Aviation requirements as well as manage any glare-risks from the solar panels.

Solar PV panels are designed to absorb, not reflect, irradiation. However the sensitivities associated with glint and glare, and the landscape/visual impact and the potential impact on aircraft safety, must be a consideration during the detailed design stages – no different from glare sources from e.g. tarmac surface or water on tarmac, building roofs, nearby body of water, etc.

Examples of ground mounted systems installed elsewhere in the world adjacent to airports, are shown below, for comparison:

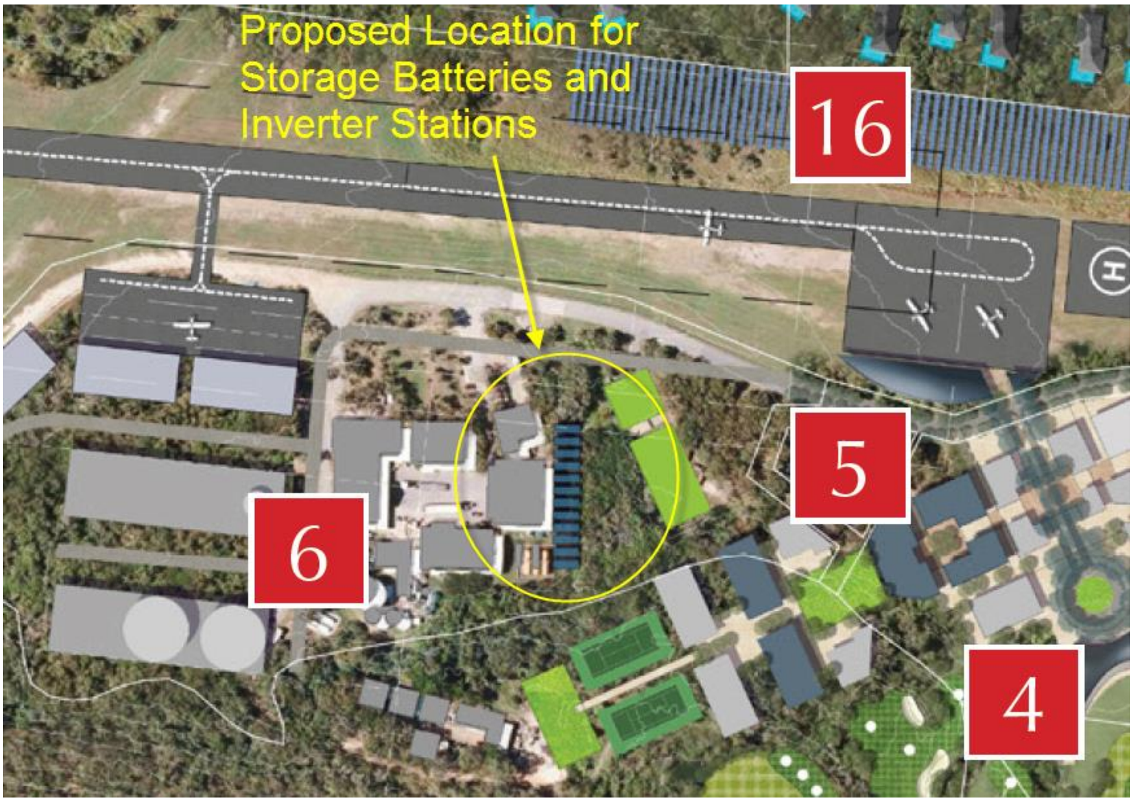
Thunder Bay Airport, Ontario Canada

Dusseldorf International Airport, Germany

V.C. Bird International Airport, Antigua

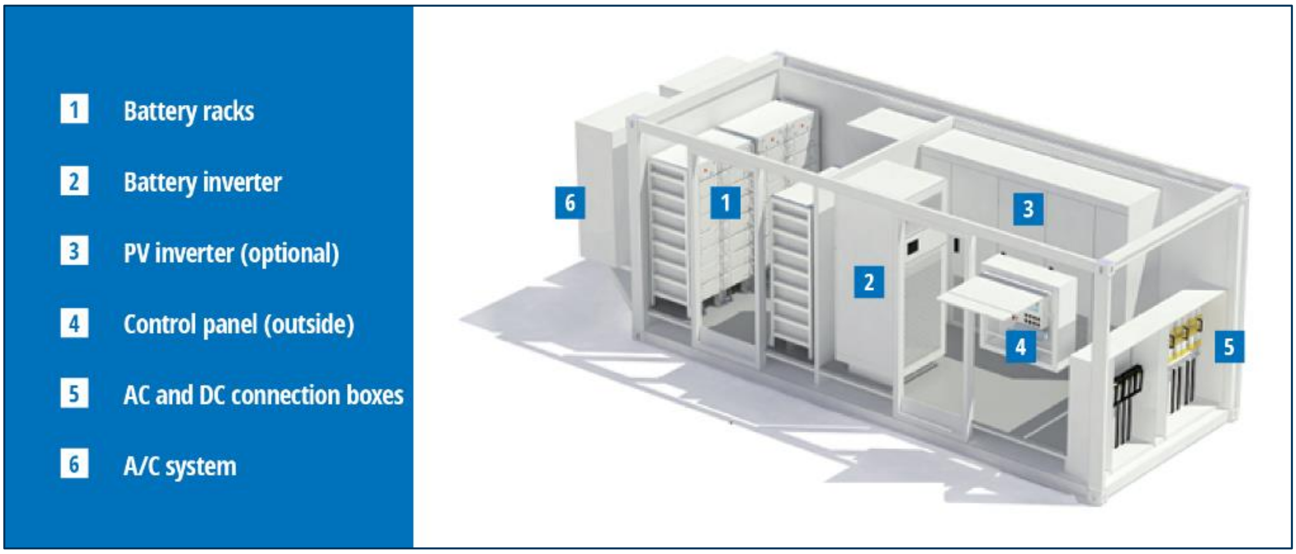
2.3 Target Location for Centralised Energy Storage

The existing powerhouse area (which is in-between the Retail Precinct / Commercial Centre and the Aircraft Hangers, shown circled below) is ideally suited to house the central energy storage system, power management and “mini-grid” control systems.



This location was previously used for the diesel generators to power the island from its central location and has been preserved for the same intention in the latest Master-Plan.

Example Storage Battery and Inverter Units (modular)



3 Solar-Diesel Hybrid Mini-Grid Concept

The proposed Hybrid System is illustrated as in Figure-5, which shows the contribution of both roof-top and ground mounted solar generation (through inverters) to a commonly connected Electrical Distribution System, into which the power generated from Diesel Generators is also fed (as is required to meet load demand), and any excess power from all generation sources (solar and/or diesel) is stored in centralised storage systems (batteries with inverters).

The entire system is seamlessly integrated, managed and controlled using the proprietary controls system, with local and remote 'on-line' monitoring abilities.

The power-house is also the location where the battery storage and system control / monitoring equipment would be located.

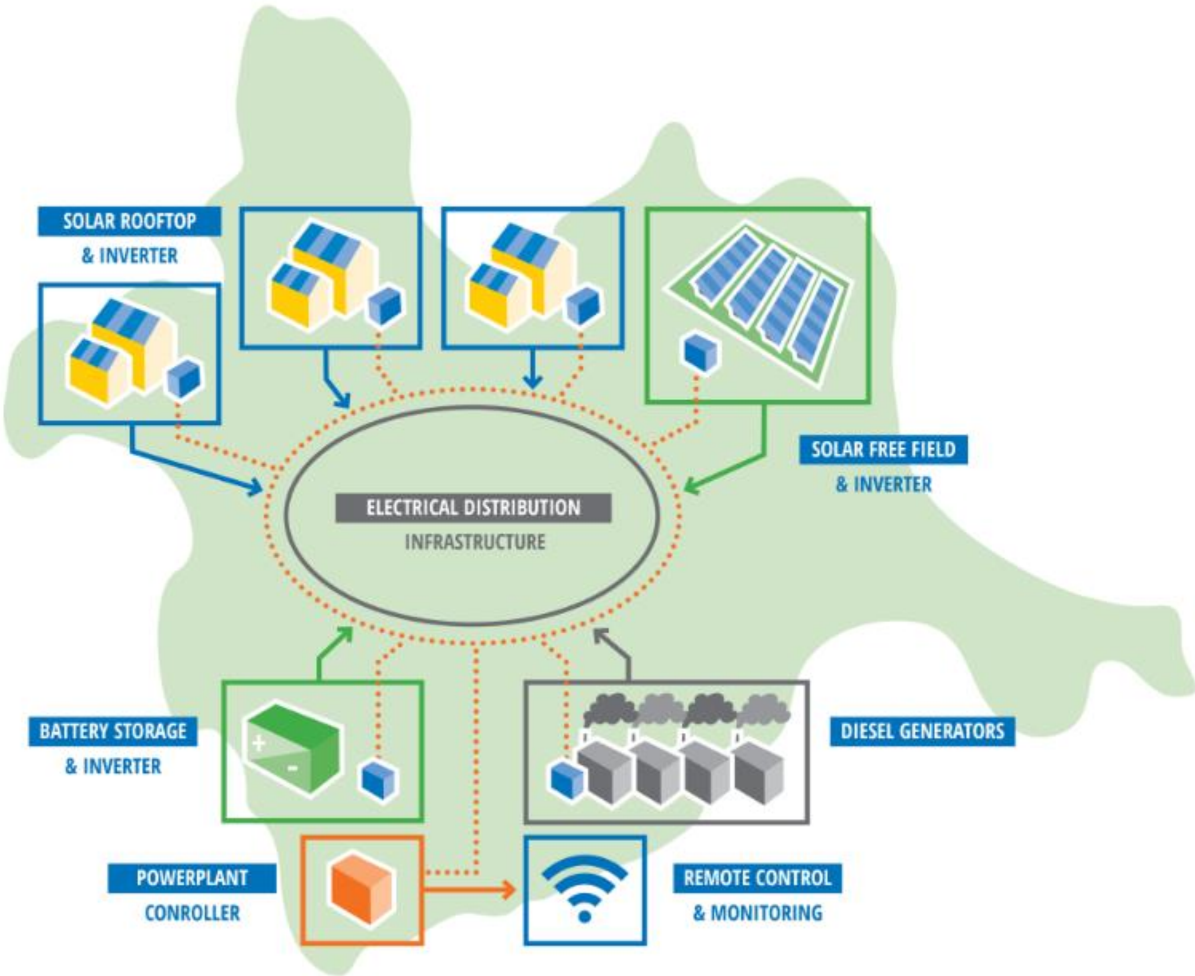


Figure 5 - Hybrid Solar-Diesel "Mini Grid" System

If the resort wished to raise the profile of the renewable power generation on site, this can even be facilitated via animated live screen displays in selected prominent positions around the resort and at various locations in the resort.

3.1 Design Approach

Cardno considered both 'distributed (solar) generation' and 'centralised (solar) generation' options in its design approach to the study, each with the following merits:

- Distributed generation would entail the deployment of solar panels, inverter systems and potentially smaller energy storage units right across the island, allowing various sectors of the resort to effectively self-consume the energy generated by their 'local' energy generation units on the rooftops.
- Centralised generation would entail the deployment of solar panels and their corresponding inverter systems strategically across selected, larger rooftops and land areas. This design would then feed back into a centralised power house, housing a single large scale energy storage and monitoring/control system.

Fundamentally, whether distributed or centralised, all energy supplied to the respective areas of the island would still be supplied via a common and interconnected electricity distribution/reticulation system across the proposed development. Hybrid centralised-distributed systems are also viable.

In the case of Lindeman Island, it was deemed by Cardno that a 'centralised power system' would provide a superior solution, taking into account:

- the environmentally sensitive design constraints of the island accommodation / villa sectors;
- limitations in vegetation clearing;
- lower expected operation and maintenance costs associated with fewer,but larger solar plants;
- ability to locate the solar plants in unshaded and largely vegetation-free spaces (around the Airport Hangar, run-way and Retail / Commercial precinct) to maximise solar generation yield; and
- availability of an existing central power house facility with the diesel generators.

The further advantage of the choice of the centralised model for Lindeman Island is that both the solar panel deployment and energy storage capacity is fully modular and easily scalable, allowing the resort to adapt the system to any future increased energy demand.

This scalable flexibility allows WHA to begin with a smaller portion of renewable generation, which can then be increased in power and energy storage over time, without the need to develop any further significant infrastructure across the island. The future staging would also cause minimal disruption to the resort's operations.

Furthermore, and more importantly, the benefits of a centralised model represent a superior financial benefit as well as a lower operational risk, since all plant can be centrally managed and maintained, rather than being distributed across the island in smaller clusters.

4 Key Assumptions of the Study

Key Assumptions in modelling the Hybrid Solar-Diesel system are outlined in the following sections.

4.1 Cost of Large Generation Certificates (LGCs)

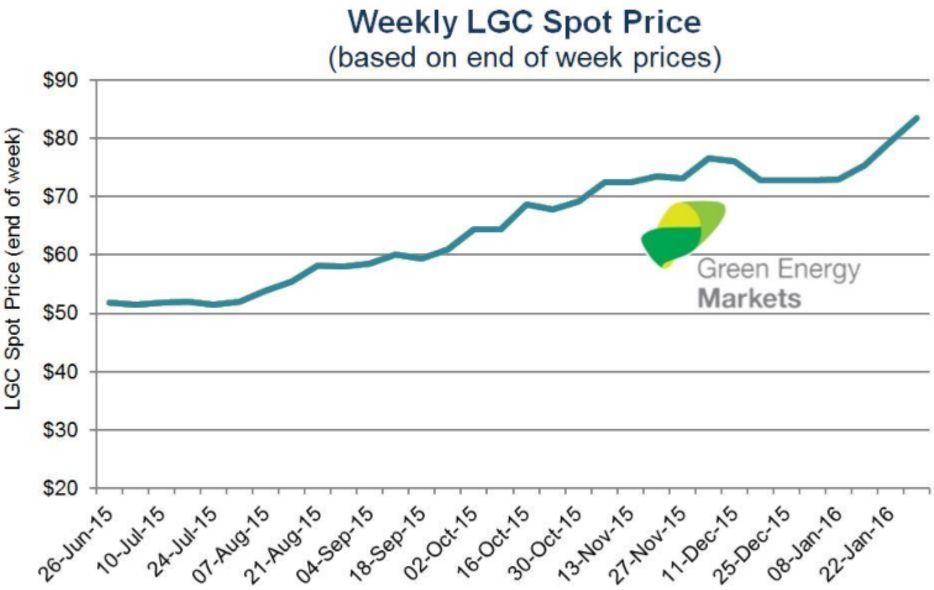
LGCs – or 'Large Generation Certificates' are created on a yearly basis based on the actual amount of power generated by an accredited and registered renewable energy power station.

LGCs form part of the Federal Government Renewable Energy Target (RET) and sit within the Large-scale Renewable Energy Target (LRET), which is due to run until the end of 2030.

An LGC represents one megawatt hour (MWh) of net renewable energy generated by a solar PV system of more than 100kW capacity, or which generates over 250MWh each year. The generation can include anything which is consumed on the premises or exported to a distribution or transmission network. This network does not need to be grid-connected to qualify, so even a locally operated and islanded grid system such as that proposed for Lindeman Island, would qualify for the LGCs.

The creation of renewable energy certificates (large-scale and small-scale) creates the 'supply' side of the market. The *Renewable Energy (Electricity) Act 2000* requires liable entities (mainly electricity retailers) to source renewable energy certificates. This creates the 'demand' side of the market.

To meet their obligation, liable entities purchase and surrender a certain number of renewable energy certificates to the Clean Energy Regulator each year based on annual percentages set in the regulations.



As at early 2016, Cardno's solar specialist sub-consultant (Conergy) has advised that LGC traders are locking in values at as much as $85 per LGC for "Megawatt scale projects" out until the year 2019. It is also Conergy's opinion that the LGC value is set to stay at the "upper-level" for at least the next 3-4 years as the certificate creation targets may not be achieved and there will be a shortfall of certificates in the market.

Conergy also advises that a reasonable ceiling to the LGCs is at the high $80's mark, as liable parties who do not achieve the required targets under the Renewable Energy Act are required to pay a penalty of $92.50 per MWh shortfall.

The downside risk is that the Federal Government may step in at some point in the future to review and potentially reduce the target. In this scenario, there could be a fall back down to the $30-40's mark.

For this study, Cardno has used and assumed an **LGC value of $55 per Certificate** based on advice from Conergy and on historical data and indicative forecasts by its own trading partners and advisors.

Whilst the value of the LGCs can fluctuate according to the supply and demand side of the market, Cardno has applied the above key assumption to the financial models as a reasonable average until the end of 2030.

4.2 Cost of Diesel Fuel

Cardno recognises that the cost of diesel continuously fluctuates, based on global market conditions such as supply and demand. The general long term trend, however, is still rising costs.

The reliance on diesel fuel for the entire energy supply to the island can represent significant long term financial exposure risks to the resort owner.

Cardno has used and assumed a delivered cost of diesel of **$1.80/Litre** to the island.

This key assumption is considered to be a fair and reasonable average to apply, taking into account risk factors such as security of supply and adverse short-term price fluctuations, but also some short term price advantages.

4.3 Diesel Generator Maintenance Costs

In the absence of historical maintenance costs, but using industry recognised bench-mark figures, Cardno has used and assumed an average diesel generator maintenance cost of **$1.00/hour** of operation, based on a 25,000 hour generator life.

4.4 Load Profile

One of the most sensitive parameters which could affect the sizing of any proposed solar system is the correlation of the solar generation with the load consumption. The solar generation profile must be carefully balanced with the load profile, in order to most effectively size any solar system (including the storage system).

In lieu of actual historical load profile data from the previous Club Med resort, the load profile used in the Cardno models has been based on load profile data obtained from Ergon Energy, for similar resort islands in the Whitsundays.

Load metering information was formally obtained from Ergon Energy's Shutehaven and Mt. Rooper zone substations (*which supplies other resort islands such as Hayman, Hamilton, South Molle, Long and Day-Dream Islands*). The profile was assumed to be comparable and representative of the profile of Lindeman Island when the development is fully realised.

The Ergon substation load profiles were scaled to match a 4.1MVA peak load estimated form the development, during the summer months.

Cardno utilised the load profile as shown in Figure-6 in the models.

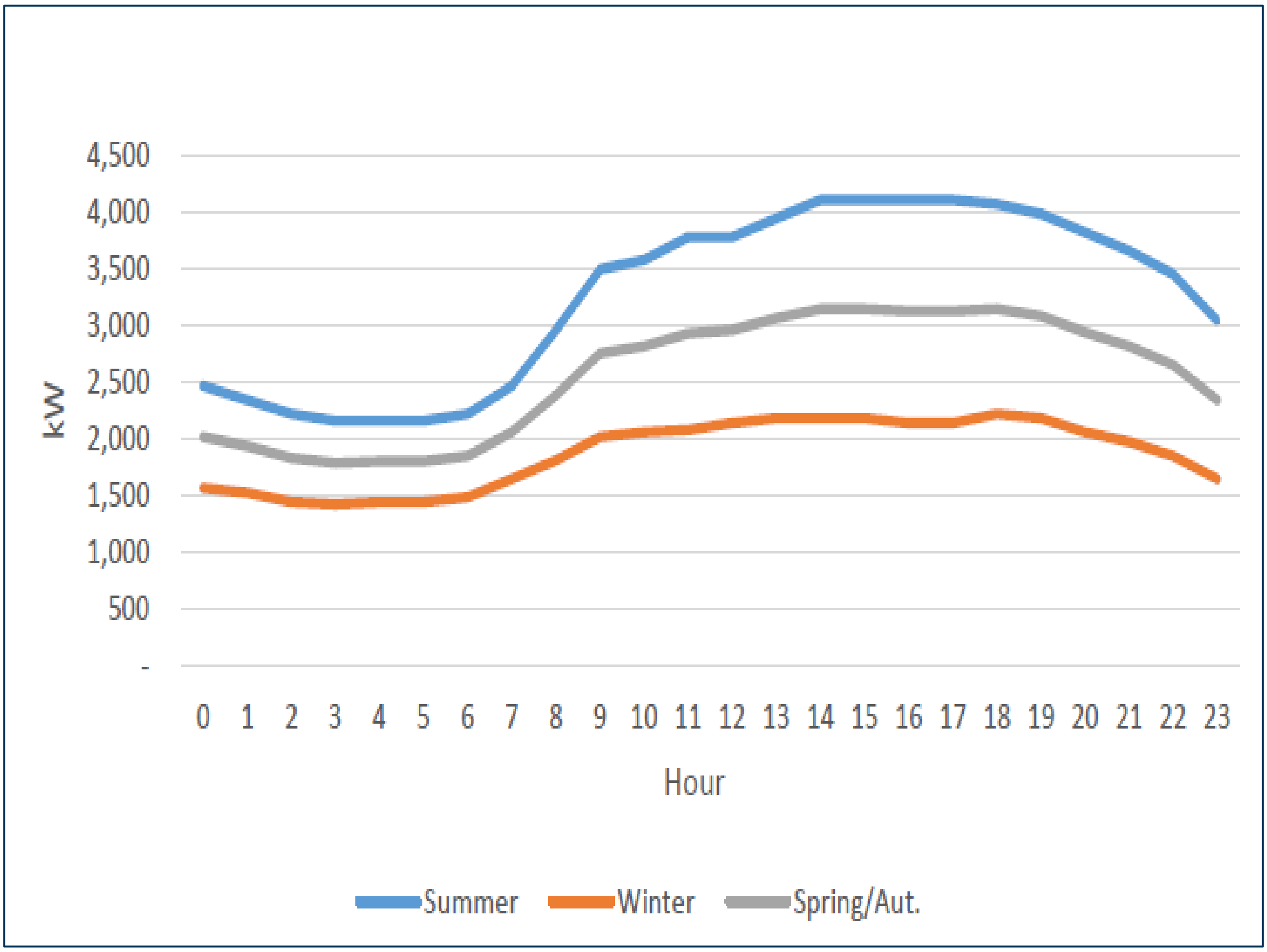


Figure 6 - Load Profile assumed for Lindeman Island

Seasonal variations have been considered by Cardo in its models. Using this load profile, the following applies:

- Average daily consumption: 62,000kWh
- Average annual consumption: 22,350MWh

Note: For any final system design, it is absolutely essential to have a load profile as accurate as possible. Therefore, any recommendation given in this report must be reviewed once information on real expected load profile is available.

4.5 Electricity Distribution / Reticulation System Works

Cardno has only allowed for the costs of the electrical works associated with the installation and connection of the supply of electricity from the solar plants (roof mounted as well as ground mounted) to the central powerhouse, and for the connection of the energy storage system and inverters to a point of common coupling.

In its financial modelling assumptions, Cardno has not specifically costed any additional electrical works associated with the capital costs of establishing an electricity distribution and reticulation network around the island, as this is part of the overall island development costs (including sewerage, water, civil, buildings and other infrastructure).

It has therefore been assumed that the electricity distribution/reticulation infrastructure costs will already be provided by others.

4.6 Government Grants and Incentives

The federal government's *Australian Renewable Energy Agency (ARENA)* provides grants / funding to projects of "particular value or significance in the field of renewable energies" and supports the more rapid deployment of renewable energy in situations which may otherwise take longer to realise, either due to new technology risk or financial hurdles.

Having recently been through a similar process for a project in far north Queensland - and subsequently achieving ARENA award approval for its project – our solar specialist Conergy believes that the Lindeman Island opportunity could be a strong contender for the ARENA application process.

Cardno has however not factored in any Government Grants or Incentives in its financial models.

5 System Options and Indicative Costs

5.1 Model Scenarios and Conditions

Cardno has analysed and modelled the Hybrid System based on the following scenarios:

- 20 year system life
- Base case of diesel-only (for comparison)
- Renewable energy ratios of 35%, 50%, 75% and nearly 100% (i.e. 93%)

Note:

While 100% renewable is technically possible to achieve, there is very limited available land area for the purpose of installing ground mounted PV arrays. Examination of available land area suggests a diesel substitution level of between 35% and 44% could be achieved, on a staged basis.

The 'base case' (with 0% renewable) reflects the diesel-only generation scenario, and provides a comparison for all of the different renewable energy ratios.

The 'base case' is not recommended under any circumstance, as it presents the highest operating cost option for the resort owners, and it is Cardno's opinion that this option is un-sustainable.

5.2 Results and Comparison of Scenarios

The following tables provide a summary of the following, for each renewable energy ratio scenario:

- Estimated Capital and Operating costs
- Recommended System sizes (MWp) – both roof-top and ground mounted Solar Arrays
- Recommended Storage battery sizing (MVA and MWh)
- Diesel generator sizing (MVA and quantity)
- Estimated Solar System Generation (MWh)
- Estimated levelised Cost of Energy ($/kWhr)
- Estimated total annual operating cost
- Estimated diesel usage and savings (litres)
- Indicative Pay-back period (in years) for the capital investment

Table-1: System Configuration

SYSTEM DESIGN								
Scenario	**Renewable Energy**	**Diesel Gen #1 (kVA)**	**Diesel Gen #2 (kVA)**	**Diesel Gen #3 (kVA)**	**Solar PV Rooftop (MWp)**	**Solar PV Ground Mounted (MWp)**	**Battery capacity (MWh)**	**Battery Power (MVA)**
1	0%	3000	1000	1000	NA	0	NA	NA
2	35%	3000	1000	750	3	1.5	2.5	4.5
3	50%	3000	1000	1000	3	3.5	16.7	4.5
4	75%	3000	1000	1000	3	7	33.2	4.5
5	95%	3000	750	-	3	15	46.2	4.5

Table-2: Estimated Energy Production

ENERGY PRODUCTION					
Scenario	**Renewable Energy**	**Annual Total System Generation (MWh)**	**Annual Solar Generation (MWh)**	**Excess Production (%)**	**Diesel Displacement (Litres)**
1	0%	22,352	NA	NA	NA
2	35%	22,625	8,072	1.01%	1,926,738
3	50%	22,695	11,803	1.20%	2,843,794
4	75%	23,663	18,331	1.80%	4,249,394
5	95%	34,272	33,252	30.85%	5,342,462

Table-3: Financial Modelling Results

FINANCIALS (excl. GST)									
Costs						**Revenues**		**Savings**	
Scenario	**Renewable Energy**	**Cost of Energy ($/kWh)**	**Indicative Outlay/Capex ($)**	**Total Annual OPEX – Diesel and O&M ($)**	**Annual Diesel Usage (L)**	**Annual LGCs (QTY)**	**Annual LGCs (at $55/LGC)**	**Annual Diesel Savings ($)**	**Estimated Payback (Years)**
1	0%	0.49	2,775,000	10,754,490	5,599,271	NA	NA	NA	NA
2	35%	0.35	14,735,250	7,147,906	3,672,533	8,072	443,960	3,468,128	5
3	50%	0.30	28,162,000	5,347,586	2,755,477	11,802	649,110	5,118,829	6
4	75%	0.22	45,962,000	2,646,223	1,349,877	18,330	1,008,150	7,648,909	7
5	95%	0.19	69,800,250	634,526	256,809	33,252	1,828,860	9,616,433	8

Table-4: Breakdown of Component Costs (Capital)

COMPONENT COSTS ($ excl GST)							
Scenario	**Renewable Energy**	**PV Rooftop**	**PV Ground Mounted**	**Battery System**	**Battery Converter**	**Diesel Generators**	**Total**
1	0%	0	0	0	0	2,775,000	2,775,000
2	35%	3,000,000	5,400,000	1,620,000	2,079,000	2,636,250	14,735,250
3	50%	7,000,000	5,400,000	10,908,000	2,079,000	2,775,000	28,162,000
4	75%	14,000,000	5,400,000	21,708,000	2,079,000	2,775,000	45,962,000
5	95%	30,000,000	5,400,000	30,240,000	2,079,000	2,081,250	69,800,250

Notes:

The rows highlighted in Blue reflect the 'practical' option, of:

- using the roof-spaces in the central retail precinct / village / staff accommodation and aircraft hangar areas for roof-mounted solar panels, and
- only using the land area shown as Location 1 in Figure 4 (to the North of the Run-way) for ground mounted solar panels.

The maximum Renewable Energy percentage (diesel usage substitution) that can be achieved by utilising all of the available land areas (shown as Locations 1, 2 and 3 in Figure 4) is ~ 44%.

6 Conclusions

6.1 General

The higher the renewable ratio, the lower the cost of energy per kWh will be to the resort owner, in comparison to the diesel-only scenario.

The savings results as shown in Figure 7 provides an estimate of the payback periods for different levels of renewable energy ratios (from 35% up to 95%), which vary from ~ 3 years up to ~ 8 years.

Over a 20 year operating period, the 75% and 95% Hybrid Systems have the highest Return on Investment (ROI) when compared to the Diesel Only / Base case system (shown as the horizontal blue line). However, the limited available land area for the installation of ground mounted PV arrays will restrict the maximum level of diesel substitution to ~ 44%.

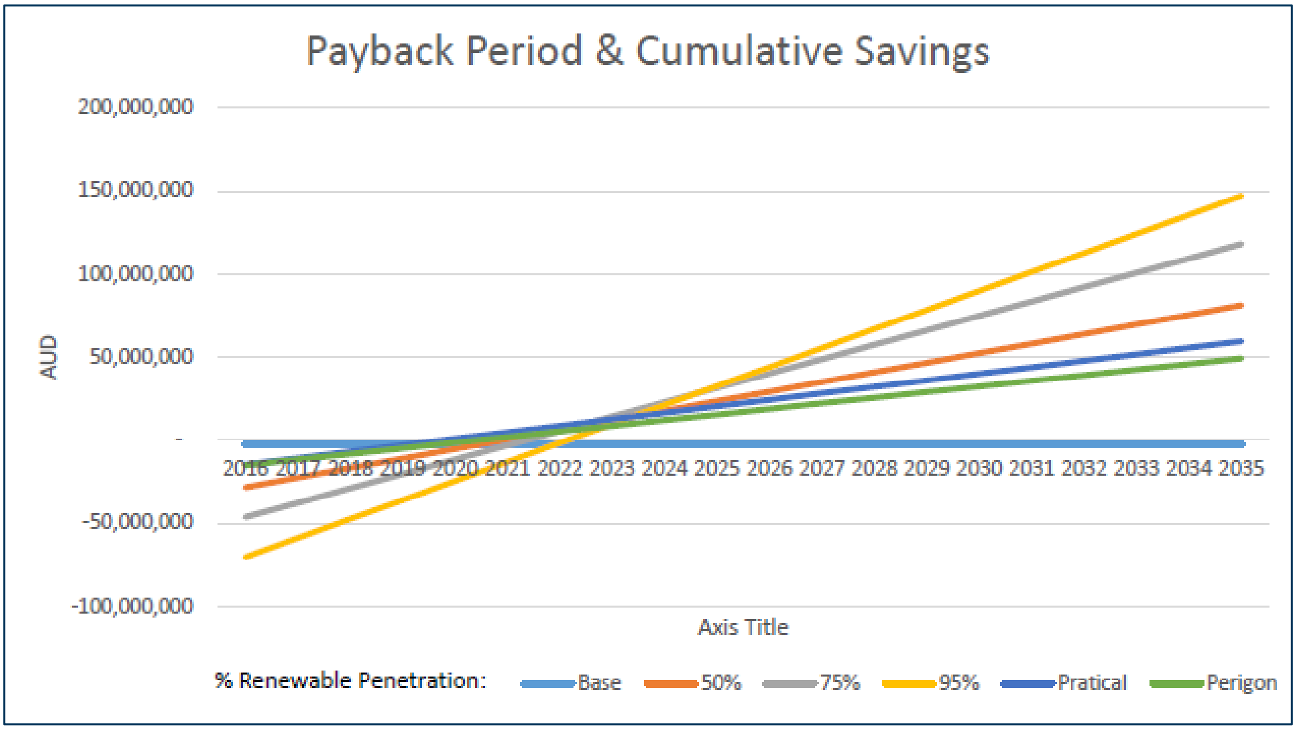


Figure 7 - Comparison of Pay-Back Periods

Note: The comparison in payback period is based on non-levelised costs (i.e. not applying any discount rates).

6.2 Excess Energy

Systems with a higher renewable ratio will naturally have a higher amount of excess energy.

This is because the renewable generation has to be sized to account for the worst case scenario (with no diesel generation). Whilst technically possible, it currently makes less financial sense to size and install a system to provide complete substitution of diesel from the start. Land area limitation restricts this anyway.

The graph shown in Figure-8 shows the significant increase in excess energy for systems larger than 70% renewable ratios. Since the limitation in available land restricts the maximum substitution to ~ 44%, the amount of excess energy will be minimal.

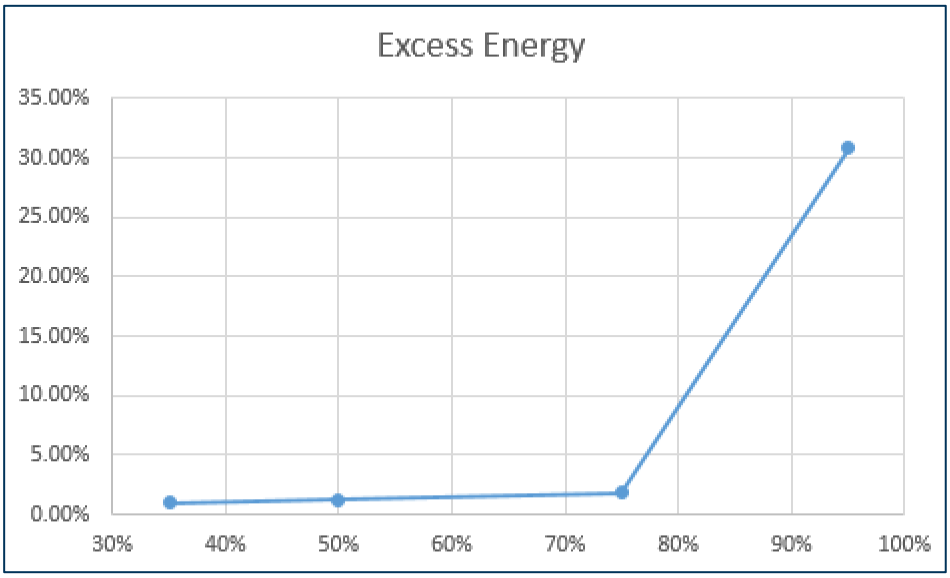


Figure 8: Excess Energy levels for Different Renewable Energy Ratios

6.3 Recommendation

Based on Cardno's study and models, a system with a target of ~75% renewable ratio provides the best theoretical financial and risk balance for the owner, with regard to fuel savings, cost of energy and risk mitigation for the island's ultimate development.

This is certainly true as energy storage costs come down even further in future.

However, with the limited available land area for ground-mounted solar arrays, the level of renewable energy which is likely to be achieved is between 35% to 44% based on the latest Masterplan (as at November 2016).

The estimated capital investment for this level of renewables is between $15M to $25M, with an estimated payback period between 3 to 8 years, depending on the pace of development, timing of investment and load demand/energy consumption.

The exact level of renewable energy investment will largely depend on the owners views on capital costs, return on investment, sustainable operating costs as well as land area which is available for the installation of ground mounted solar arrays. While the last item may be ameliorated partially by installing additional solar panels on roof-spaces of villa's and other buildings in the various resort precincts, in practice this will require very careful consideration during the detailed design stages of the villas and facilities to ensure that civil, architectural and solar system designs inputs are carefully coordinated.

In any case, the scalability of the Hybrid Solution as proposed by Cardno allows the resort to 'grow into' the technology whilst it learns more about its actual consumption patterns, and upscale the renewable energy ratio even further in future years, and especially as the cost of the renewable energy systems are expected to drop in future years.