



Energy3 Services Limited

ZephIR LiDAR Remote Power Supply Rental & Purchase Proposal

At:

Unspecified Site(s)

For:

Unspecified Client(s)

Monday, 25th March 2019



Contents

1. Overview	3
2. Experience & Expertise	4
3. Power Requirements for the ZephIR	5
4. Energy3 ZephIR Remote Power Supply	5
5. Components of the Power Pack	6
6. Remote Communications	10
7. Commissioning, Maintenance and Support	12
8. Photos of Previous Energy3 Constructed Power-Packs & LiDAR Deployments	13



1. Overview

Energy3 can offer a remote power pack system specifically designed to power a ZephIR 300 LiDAR in Australian and New Zealand conditions to provide a robust and reliable power solution. Refinements can be made to the specifications if the power supplies are to be deployed in other countries, or if additional meteorological monitoring or power components are required.

The E3S remote power pack has full remote monitoring and alarming capability via a GSM modem, and can also include additional components such as a separate logging system to monitor parameters such as rainfall and solar radiation if required. Obtaining further meteorological data from the LiDAR monitoring site(s) may be useful for other applications such as recording solar radiation data for potential solar farm development, or rainfall data for construction and environmental compliance.

Energy3 Standard Rates and Charges can be provided on request if initial or ongoing deployments of the power system and LiDAR is desirable. If details of the site location(s) are able to be provided, E3S would be happy to provide definitive quotation, including freight and transportation costs, plus commissioning and training costs if required.

Energy3 field work is spread out over a number of states in Australia and New Zealand. To this end, we regularly have personnel travelling interstate, and are therefore able to assist with deployments, maintenance, site checks if and as required. In particular, the majority of our work is carried out in Victoria and New South Wales in Australia. As such if the proposed deployment location is within reasonable distance from other current projects, costs could be reduced by sharing travel expenses with these projects.

If required, additional data monitoring, validation, and reporting of either the LiDAR data or general metrological data can be provided by Energy3.

2. Experience & Expertise

Energy3 has extensive experience in building, operating, and deploying remote power supplies for LiDAR units, and deploying LiDAR monitoring systems. These power supplies have been built to suit a variety of LiDAR models including the ZephIR 175 and 300, and the Leosphere Windcube v1 and v2.

Earlier generation LiDAR's had significantly greater power requirements, therefore power supplies were typically based on a diesel generation system which ran for a short time each day in conjunction with a large battery bank providing the continual power supply to the LiDAR unit.

Due to the continual advances of LiDAR wind measurement technology, the power consumption requirement for the current model ZephIR LiDAR has been substantially reduced, opening other options for autonomous power supplies. Specifically, those based solely on solar, or integrated solar and wind powered systems with a suitably sized capacity battery bank. Backup internal combustion generation can be used in remote sites to guarantee uptime as an option nevertheless.

Energy3 have also invested in LiDAR and remote power supply trailers for rental arrangements in the Australian market. We would be delighted to provide these units for any projects that may require them, based on availability at the desired time of deployment.



An example of an Energy3 solar-powered remote power supply trailer and LiDAR



3. Power Requirements for the ZephIR

Due to a relatively low overall power consumption, the power supply system for a ZephIR 300 LiDAR can be practically based entirely on a solar (PV) powered system, in conjunction with a battery bank of sufficiently specified capacity.

A detailed power budget has been calculated to ensure the specification of the power pack system will be sufficient to allow the LiDAR to run for a minimum of 5 days, at designed nominal power consumption (69 W) in the event of a total failure of the solar charging system.

The option of adding in a fuel cell or backup generator can be implemented if required to provide for unforeseen downtime of the PV charge system. Additional generation sources should be considered if deployment sites have a risk of snowfall which may cover the solar panels for extended periods, or site with low solar insolation due to shading or other climatic conditions. It is also noted that unattended petrol or diesel generator systems pose an increased fire risk, especially if located in particularly dry areas of Australia during periods of elevated fire risk.

4. Energy3 ZephIR Remote Power Supply

The standalone power system is an autonomous power supply for wind measurement equipment, compatible with the ZephIR 300 LiDAR. The power supply operates in a wide range of climates and is built to ensure easy deployment and operation at the project sites.

- Modular, easily transportable system (trailer mounted)
- Solar panel (PV) array as prime power source (1.4kW array, 4 x 350W Panels in series parallel arrangement), arranged on tilting frame with selectable plane angles to maximise energy yield in winter;
- 48V 400Ah sealed lead acid battery bank (8 x 200Ah 12V SLA batteries in 48V arrangement)
- Remote communications (cellular) for full monitoring and control / alarming
- Trailer (tandem axle) configured to transport solar panels, and optional stock fencing for LiDAR site security



5. Components of the Power Pack

Key Components

Key components of the power-pack are as follows:

- 4 X 350W LG Solar PV Array
- Folding PV array racking with quick release panel clamps
- Internal panels storage racking
- Morningstar TriStar 600V MPPT Solar Regulator with MODBUS networking
- 8 x Vision FM 12V 200Ah SLA Battery array (Arranged in 48V array)
- 48/12 SMPS DC converter to power ZephIR LiDAR with stabilised voltage and isolated output protection from the solar circuit
- Batteries permanently installed inside trailer (so no need for heavy lifting)
- Remote SCADA system for monitoring key variables and email alarms (ChIoT)
- Customised Tandem Axle covered and braked trailer for ease of transportation, and deployment
- Fencing components for stock security

The power supply is a fully self-contained, modular system, capable of being deployed by two people, without the use of any mechanical lifting devices.

Solar Array

The solar array consists of a total of four LG 350W modules, which are high quality Tier 1 modules.

The solar panel array is mounted on a custom-built frame which can be quickly deployed in its operational position at the monitoring site. The PV panels are connected in 2 strings of 2 panels to provide the most effective charging voltage for a 48V system.

Once the solar panels have been positioning and clamped on the array frame, they can be collectively set to the required winter plane angle and locked in place using the quick-locking mechanism. For summer months, and the shoulder periods when solar insolation is high, the panels can be left in the horizontal position.

For transportation, the array frame is locked in its horizontal position for easy transportation, the panels are removed by releasing the catches and placed in the internal panel racks. The internal transport and storage of the panels mitigates the possibility of stone chip damage while on the road and reduces the chance of theft in longer term storage situations.



A Morningstar TriStar MPPT Solar Regulator is used to maximise yield from the solar panels, and to manage battery charging effectively. This regulator uses Maximum Power Point Tracking (MPPT) technology to ensure the most efficient use of incoming solar radiation. The TriStar regulator supports MODBUS communications over TCP-IP, allowing the system to be monitored remotely, and has email alarming capability. Energy3 have developed the ChIoT monitoring system which will provide 24/7 monitoring, data storage, and alarming.

The solar charging system will provide 100% of the energy requirements, and in addition provides a significant capacity overhead, even in winter conditions (assuming no snow cover or shading on the panels). The power budget for the system is based on a conservative model and will ensure the ZephIR LiDAR can run for up to 5-days without any incoming charge due to an unforeseen issue with the solar array, or solar controller. If a longer period of operation with no incoming solar charge is required, please contact E3S for a customised trailer design and proposal. Parallel operation of the solar array means that if one circuit is damaged, then the other can still provide energy.

The main circuit from the battery is protected by an HRC fuse system, and the individual solar and load circuits are protected by DC circuit breakers. These are contained within a custom enclosure in conjunction with the charge regulator, switch mode power supply, and communications system.

Battery Bank

A sealed battery bank is housed within the trailer; this is configured in a 48V array, consisting of two parallel banks of four batteries connected in series (a total of 8 x 200 Ah SLA 12V batteries). This configuration is used to maximise the efficiency of the charge system, and prolong battery life by reducing the number of battery strings to two. The batteries are manufactured by Vision, are of the SLA type to prevent electrolyte spillage, and have an individual rated capacity of 200Ah, providing a total storage of 400Ah at 48V, or 19.2kWh of energy.

The battery bank has been sized to power the LiDAR unit for at least 5 days (to a calculated 70% depth of discharge) without any incoming solar charge. This allows maintenance logistics to be planned well in advance without the risk of data loss when a problem is signalled by the on-board monitoring system.

Daily depth of discharge has been calculated at approximately 5-10% depending on daily solar contribution, a low level of discharge is important in order to maximise battery lifetime and conserve total available capacity. Please note however that total actual capacity and



timeframes are based on new batteries, temperature and load variations can affect these variables.

Monitoring System

The monitoring system is based around a TCP-IP based GSM cellular router, which allows MODBUS over TCP connection to the Tristar MPPT 600 solar charge controller. Email alerts and status updates are configurable by Energy3 personnel. This system provides warnings of any abnormalities, alarms, and faults that may arise in the system. A daily “watchdog” email is also sent out to inform of the previous days charge statistics, as well as current statistics on state of charge, voltage, and output current. All data is recorded in a database for later analysis if necessary. This data can be viewed on a real-time basis on the ChIoT monitoring system, a 10 second refresh period is available for real time variable display, data is collected on a 10-minute basis otherwise. Further details on the ChIoT monitoring system can be found in the Remote Commutations section (Section 6).

Meteorological Monitoring System

Energy3 can offer an additional meteorological datalogging system which is built into the trailer power supply system. This includes a high quality rain gauge and pyranometer to collect additional meteorological data. In accompaniment to the external Pressure, Temperature, and Humidity (PTH) Sensor data that is collected by the ZephIR 300, the additional rainfall and solar radiation data can be extremely useful for correlating periods of heavy rainfall, and / or cloud cover with the rare periods of lower data availability from the LiDAR. The additional data is also useful for general project development, or even solar farm prospecting.

The specifications of the additional meteorological monitoring system can vary depending on client requirements. For example, if a detailed study of the solar resource is desired, a higher quality pyranometer can be specified, or an additional pyranometer can be include (e.g. mounted on the plane of array in addition to a horizontal mounted pyranometer).

It should be noted that a power supply trailer hired from E3S will include the meteorological monitoring system as standard, however; for the purchase of a system, these meteorological components are an additional cost to the purchase price given in this document.



An Optional Pyranometer and Rain Gauge Sensors can be Included in Trailer Power Supply Package

Optional Components

As well as the optional meteorological monitoring suite, Energy3 can provide additional optional components such as:

- **High current DC battery charger**, this allows the client to take a standard 230V petrol or diesel-powered generator to site, and plug it directly in to the battery charger, thus allowing a top-up charge in the case of a PV charging failure.
- **Mini Wind Turbine**, a turbine can be provided with associated mounting hardware and cabling. E3S have generally not included a mini-wind turbine as standard due to cost & maintenance considerations, however; we would be happy to provide a mini wind turbine as part of the trailer power supply package based on customer requirements. Please contact E3S if the inclusion of a mini wind turbine would be of interest for your system
- **Diesel or Petrol-Powered generator**, this option can be provided in conjunction with the high-current DC battery charger if required due to client specifications. This would be a manually (electrically) started generator, as due to considerations previously



mentioned, we would not recommend having an autonomous fuel powered generator left to operate in remote areas of Australia. An autonomous system can nevertheless be provided if required.

- **Fuel Cell**, the provision of a fuel cell is a viable option in place of a traditional generator.

6. Remote Communications

Remote communications for the ZephIR 300 are obtained from an internal GSM modem, which is provided as standard in the purchase price of the ZephIR 300. Included in the GSM modem is a SIM supplied by ZephIR, which can be activated, and the ownership transferred to the customer at the time of purchase. This means that the remote communications of the ZephIR are completely removed from Energy3, and thus E3S have no control over, or ability to obtain data from the ZephIR.

A separate 3G GSM modem is used to remotely monitor the Power Supply system, providing an optional redundancy in remote communications, as well as removing Energy3 from any remote communication with the ZephIR 300. This cellular modem is used in conjunction with the MPPT solar controller to enable remote monitoring and alarming functionality. The SIM card and associated data costs for the trailer monitoring are included in the monthly trailer rental costs. If a purchase of the power supply is required, an ongoing monthly charge for the SIM card and ChIoT monitoring system will apply.

A daily “watchdog” email will be sent out to a specified set of recipients to advise the current status of the power pack (system voltage, power used and charge obtained in the past 24 hours). If any fault was to occur e.g. low battery voltage an email alarm will be sent out to a pre-defined list of people to enable a site visit in a timely manner, thereby assuring maximum uptime and avoiding data loss.

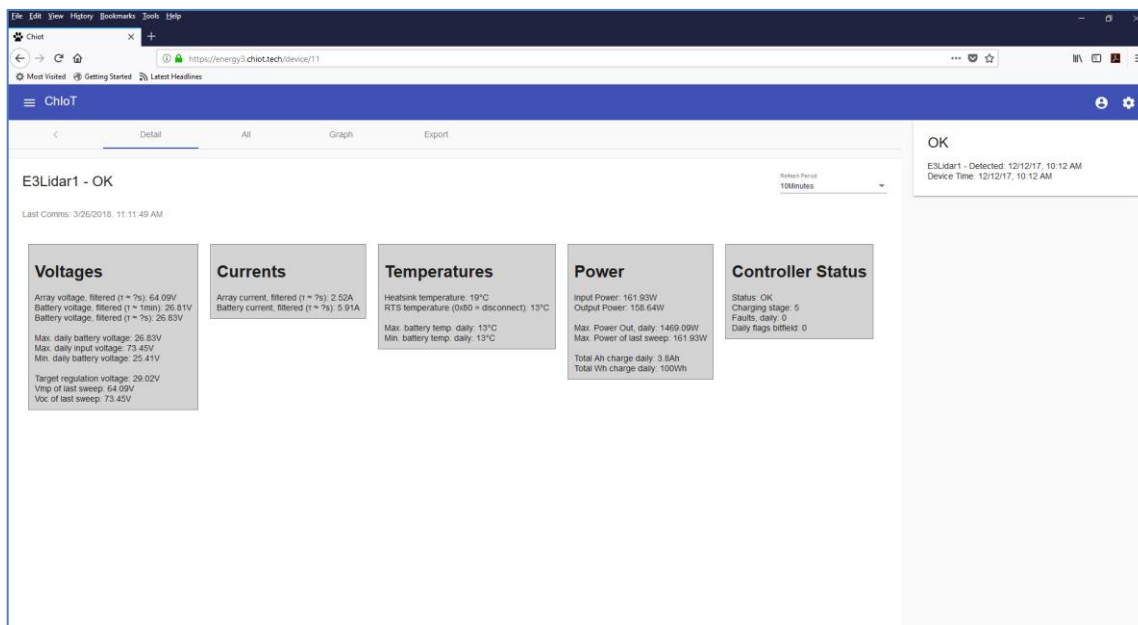
The ChIoT monitoring system is web-based and can be accessed from any PC browser. The system also has graphing functionality, as well as the ability to export historic data from the power system in Excel format. Both these features can be very useful for monitoring of the system, as well as providing information on potential faults, and diagnosing historic trends or issues.

If required, due to lack of sufficient GSM signal at the monitoring site(s), a satellite-based communications system can be supplied for both power supply and ZephIR remote

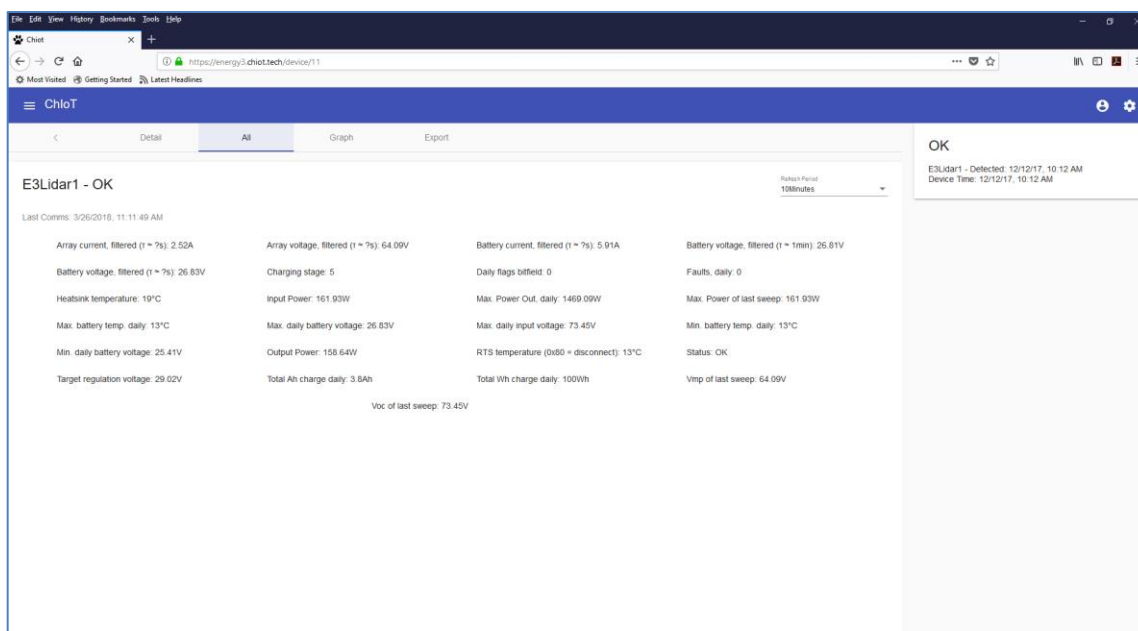


communication capabilities. Please get in touch if you would like further details and pricing on the satellite remote communications option.

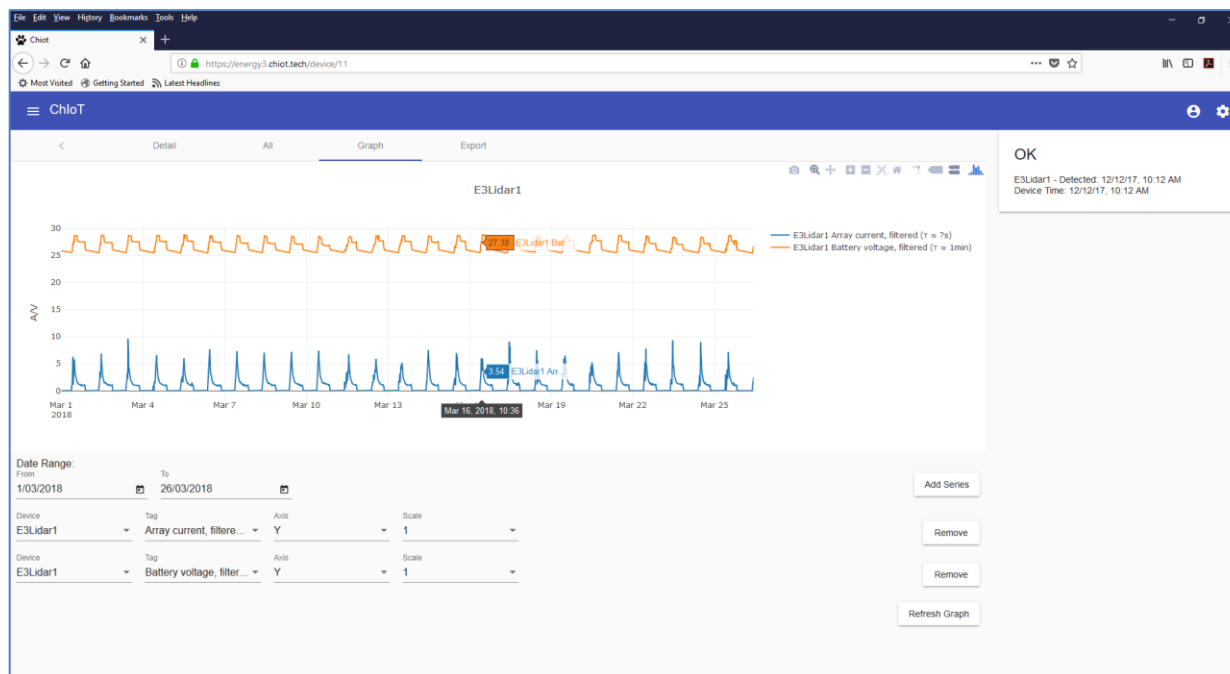
Please see screenshots from the ChIoT monitoring system below:



Screenshot of System Overview from Energy3 ChIoT Monitoring System



Screenshot of All Monitored Parameters from Energy3 ChIoT Monitoring System



Screenshot of Example Plots from Energy3 ChIoT Monitoring System

7. Commissioning, Maintenance and Support

Whether for rental or purchase, a remote power supply trailer will be provided with a full operational and deployment instruction manual. Energy3 can also provide services for the initial installation and commissioning of the power supply and / or ZephIR, thereafter Energy3 can arrange relocation of the LiDAR and power supply as required. Please get in touch to get further information about further details and pricing.

At the time of commissioning, Energy3 personnel can also train personnel on the operation and maintenance of the power supply unit (if required).

Energy3 will provide technical support for both the ZephIR LiDAR and the power supply via phone or email as required. The cost of this technical support is included in the monthly rental costs. Energy3 will provide technical support free of charge for the lifetime of any remote power supply systems if purchased outright.

8. Photos of Previous Energy3 Constructed Power-Packs & LiDAR Deployments



Energy3 Power Supply Trailer – Internal Racking for Solar Panel Transportation



Complete Modular Power Pack System for a ZephIR



Energy3 Power Supply Trailer – Stock Fencing Transported in Custom Racking on top of Trailer



Optional Additional Meteorological Monitoring System



Example of Rain Gauge for Optional Meteorological Monitoring System



Example of Power Supply Trailer with Custom Solar Panel Mountings – Foldable for Transportation



Internal Solar Panel Racking above Battery Bank for Ease of Transportation



Typical Control Cabinet inside Trailer – Tristar MPPT Solar Charge Controller



Typical Control Cabinet inside Trailer – Circuit Breakers, Fuses, and Remote Communications System



Trailer Mounted Power Pack for ZephIR V1



Trailer as Left in Commission with ZephIR V1



Complete Modular Power Pack System (in 2009)



Internals of Optional Generator Enclosure (2 x Diesel engines for Customer Specified 98% Availability and Reliability)



Satellite Communications Module (If No Cellular Reception Available at Site)