## Sub Working Group: Power Systems (5.1.2.) – ENG2

## Task Register Reference

* 5.1.2 - Review of IALA documents (ref ENG1 input paper on document ownership).

## Summary

During the ENG2 and ENG3 meetings a review of the IALA solar model has been completed with a goal to validate it as a suitability ongoing IALA tool. A number of input papers were reviewed, each providing the results from a solar sizing model.

The review confirmed that for both Large (lighthouse) and small (buoys) solar sizing designs, the IALA model provided similar answers to that of other models. It was therefore felt that the IALA solar model should have some small improvement implemented, but that it should remain a simple dedicated solar calculator.

Some additional design hints are to be added to the guideline 1039 to aid the user in achieving an effective design and interpreting the results.

### Introduction

During ENG1, Task Group 2 identified that a review and combining of a number of guidelines on power systems is needed. This was to start with a comparison of solar sizing techniques with the goal of considering updating the IALA model. Members were requested to use their own models and submit the results for comparisons and discussion. Trinity House was to provide the load, location, battery and solar module data. Two different comparison were done. The first being a large lighthouse and the second being a small buoy system.

## Activity at ENG2 – Lighthouse comparison

### Input papers used for the comparison

ENG2-10.3, ENG2–10.9, ENG2–10.12

### Variation in Design Strategy

Trinity House, RET & IALA

* Need to meet the day’s reserve.
* Increase the battery capacity and balance this against the number of solar panels
* Balance solar panel count and battery size to physical site constraints.

IALA

* 1 Hour switch level: exhibit the light 1 hour before sun set and 1 hour after sun rise.

Trinity House

* The goal is to have no more than 60% discharged (40% remaining) with a recovery charge of about 3 months.
* If a fault occurs only 90% capacity of the battery is used as the load is disconnected.

CEREMA

* In normal operation, the batteries are only discharged to a maximum of 50%
* All solar gain calculation for the whole year is based on the worst month’s irradiance (Jan).
* The total nightly energy consumption is recharged each day.
* Need to have sufficient solar panels to recover the battery discharge within a minimal time.

RETScreen

* The goal is to have a maximum discharge of 80% and recovery within 3 months.
* Always use the minimum historical level of solar irradiance
* 7 Days of no sun or reserve
* If a fault occurs the full 100% capacity of the battery is used

### Results

Comparison of fixed sites

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Batteries** | **Solar Modules** | **Autonomy** | **Comments** |
| IALA | 1 x 1363 Ah | 12 | 21 |  |
| Trinity House | 1 x 1363 Ah | 14 | 23 |  |
| CEREMA | 1 x 1363 Ah | 17 | 21 | Designed for the worst period of the year, but if designed for spring, then 10 panels. |
| RETScreen | 1 x 655Ah | (14) 6.4m2 | 21 | Variation is due to solar irradiance and strategy |

Table - Comparison of results

### Observations

In completing and comparing the approaches to solar modelling a number of key factors need to be considered and included within any calculations to ensure effective performance at the end of life.

|  |  |
| --- | --- |
| **Batteries** | **Panels** |
| * Minimal battery capacity * Battery capacity de-rating due to temperature * Aging factor for batteries | * Aging of solar panel * PV array losses due to high temperature. * Bird fowling de-rating |

Table - Factors

In addition, there are a number of other observations that have been identified that should be encompassed within the IALA solar model:

* The ability to include equipment that is operational during low visibility
* Seasonal loads e.g. Racon operational during summer months only
* Use of new technology such as Maximum Power Point Tracking (MPPT) regulators and their impact on solar calculations.

## Activity at ENG3 – Buoy comparison

### Input papers used for the comparison

ENG3-10.3, ENG3–10.4, ENG3–10.16, ENG3-10.17, ENG3-10.18, ENG3-10.??

### Design Strategy

Trinity House, RET & IALA

* Determine daily load demand
* Calculate the battery sizing to meet the reserve requirement
* Calculate the solar size to meet the daily load demand based on the irradiance.

IALA

* There is an empirical figure used for orientation based on historical measurement – 0.7 for 4 cardinal direction, unclear if only 3 or 2 modules
* Irradiance is based on the mean figure for each month.
* The further away from the equator the more uncertainty there is to the night hours calculated figure.

Trinity House

* The autonomy is based on the response by a buoy tender. This has resulted in a figure of 30 days minimum.
* Irradiance is based upon historical weather data.
* The goal is to have no more than 60% discharged (40% remaining) with a recovery charge of about 3 months.
* Irradiance is based on the mean figure for each month

CEREMA

* Use of standardised batteries of 60Ah and standardised panels of 50W
* For afloat a figure of 2 is used to the solar panels facing South
* For sizing purposes, the use of the worst case (minimum) irradiance in the winter for the site is used.
* For solar only the top 50% of the capacity is used before entering the reserve.
* Reserve varies by location from 20 days to 5 days due to the certainty of solar performance.
* The sizing of the solar system is based on the nightly load / the minimal irradiance x 0.7. The 0.7 is an empirical figure.

### Results from the solar models

Comparison of floating sites

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Batteries** | **Solar Modules** | **Autonomy**  **In days** | **Comments** |
| IALA | 2 x 70 Ah | 2 x 25W | 43 | The key factor used due to the solar modules being all around and not facing South is 1.7, but 4 modules required. |
| Trinity House | 3 x 63Ah | 3 x 25W | 34 | The average irradiance from all cardinal directions |
| CEREMA | 3 x 60 Ah (155Ah) | 4 x 25W (90W) | 30 | For all round distribution of panels a factor of 2 is used. |
| RETScreen | 1 x 70Ah | 3 x 25W | 35 | The RETScreen solutions are optimistic, but WG were unable to determine why as the author was not available. |
| RETScreen | 2 x 70Ah | 2 x 25W | 61 |  |

Table - Comparison of results

### Observations

The solar models for small systems is very susceptible to small variation have a significant impact. The cost of increasing the batteries or number of panels is small relative to the cost of failure.

In completing and comparing the approaches to solar modelling a number of key factors need to be considered and included within any calculations to ensure effective performance at the end of life.

* When considering a design solution, where an extra battery or solar module is added for comfort, consideration of the cost of implementing this across all of the buoys needs to be balanced against the cost of failure at sea.
* The addition of new loads e.g. AIS as a retrofit to an existing buoy solar system, can have a significant detrimental effect and needs to be done with care.

## Conclusions of comparisons

The review and comparison of the above solar models has indicated that although there are areas of improvement in the IALA model, the solution that the model provides is in line with that of other models.

## Other observations

It was noted that all of the solar models use are reliant upon irradiance data that has been gathered over an extended period and is quite old. It may be useful to investigate the impact of climate change on the data set.

## Summary of areas of improvement

1. Update Guideline 1039 to make the user aware of the limitation of the Excel solar model. This is to be achieved by discussion on:
   1. Clarity over the limitation to load profiles. The model is only able to deal with night and day loads.
   2. When sizing small solar systems, they are very susceptible to small variation that have a significant impact. The cost of increasing the batteries or number of panels is small relative to the cost of failure.
   3. It is critical to consider how the solar panels are distributed when the panels are orientated all round for afloat. This is particularly critical if there are only 3 or 2 modules
2. Update the IALA model in the following areas:

|  |  |  |
| --- | --- | --- |
| **Load** | **Batteries** | **Panels** |
| * Daytime on loads | * Include a level of capacity that remains following a load disconnect * Battery capacity de-rating due to temperature * Aging factor for batteries | * PV array losses due to high temperature. – Guidance required in the instructions * Bird fowling de-rating |

1. Future potential areas of improvement to the IALA solar model
   1. Seasonal loads e.g. Racon operational during summer months only
   2. Use of new technology such as Maximum Power Point Tracking (MPPT) regulators and their impact on solar calculations.
   3. The ability to include equipment that is operational during low visibility

## Action timeline

Action 1 – Update Guideline 1039 – Jorg Unterderweide & Peter Dobson to write draft additions detailed above as an input paper for ENG4

Action 2- Update the IALA model – Jorg Unterderweide to update as an input paper for ENG4

Action 3 – Future potential areas of improvement to the IALA solar model - To be deferred.

The above actions to be reviewed and approved at ENG 4

## Sub Working Group: Power Systems (5.1.2.) – ENG3

## Task Register Reference

* 5.1.2 - Review of IALA documents (ref ENG1 input paper on document ownership).

## Summary

Follow a review of the input documents at ENG3 on solar sizing, the results of the models based on a buoy solution were compared and contrasted. The differences were identified leading to further actions intercessionally and possible activities for the IALA LITE and BATT workshop.

### Introduction

During ENG2, Task Group 2 identified that a review and combining of a number of guidelines on power systems is needed. As part of this review focus was given to reviewing the IALA solar model and guideline 1039.

This was progressed with a comparison of solar sizing techniques based around a buoy design. This was following the work done at ENG2, based around a lighthouse design. This comparison from the various members will inform improvements in Guideline 1039.