ESU quotation and technical specification generation tool – software specification

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Introduction

This document specifies the requirements for software to implement a tool to generate quotations and technical specifications for energy storage units (ESU), shore connections and associated hardware for marine projects. The tool is to permit the user to enter project details and details about the technical requirements and operating profile for these items and it is to calculate all necessary technical specifications and pricing details.

High level options

The user of this tool submits design choices by way of a Word document that is divided into sections relating to the components to be selected. The items specified through this form are:

* DC link voltage and Main Switchboard connection voltage
* Energy storage devices
* Energy storage converter
* Energy storage transformer
* Energy storage switchgear
* Shore connection cabinets
* Shore connection transformers
* Shore connection converters

The user can choose to size batteries either by stating the required power (kW) and capacity (kWh), or by entering cases that are used to establish the largest kW load on the batteries and the total kWh required to fulfil its mission. The user can also state the largest motor starting current that will have to be supplied and the tool can confirm that the selected kW is sufficient to enable the motor to be started.

User inputs

The user of the tool enters all data about the system in a form that is intended to be clear and logical. The form is divided into sections to aid this, and the data should be taken from it and processed. The inputs will either be typed in or selected from drop down menus. Not all boxes will be completed by the user so the system must be able to handle this, where applicable. Table A matches the inputs in the form to what should be in the code for the tool.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | | |
|  | Energy Storage Unit (ESU) – Requirements Description Form |  |  |
|  | | | |
|  | **Section A – Project Details** | |  |
| Quotation Number |  |
| Customer |  |
| Customer Project Number |  |
| Shipyard |  |
| Shipyard Number |  |
| Classification Society |  |
| Required DP Class |  |
| Additional Class Battery Notation |  |
| Revision Number |  |
| Revision Description |  |
| Revision Date |  |
| Author |  |
|  | | | |
|  | **Section B – Energy Storage Sizing Requirements**  ***Enter total required kW and kWh or expected energy storage operating profile cases*** | |  |
| Total power required (kW) |  |
| Total capacity required (kWh) |  |
|  | Required battery lifetime (years) |  |  |
|  | | | |
|  | Case 1 description |  |  |
| Power required in case 1 (kW) |  |
| Duration of required power in case 1 (h) |  |
| Case 2 description |  |
| Power required in case 2 (kW) |  |
| Duration of required power in case 2 (h) |  |
| Case 3 description |  |
| Power required in case 3 (kW) |  |
| Duration of required power in case 3 (h) |  |
| Case 4 description |  |
| Power required in case 4 (kW) |  |
| Duration of required power in case 4 (h) |  |
| Case 5 description |  |
| Power required in case 5 (kW) |  |
| Duration of required power in case 5 (h) |  |
| Case 6 description |  |
| Power required in case 6 (kW) |  |
| Duration of required power in case 6 (h) |  |
|  | | | |
|  | | | |
|  | System Overview Diagram | |  |
|  | | | |
|  | **Section C – Energy Storage Unit Technical Details**  ***Enter technical details as applicable to the vessel power system design and philosophy*** | |  |
| Number of ESU |  |
| Main switchboard AC voltage (V) |  |
| Main switchboard AC frequency (Hz) |  |
| DC link voltage (V) |  |
| Battery type |  |
| Converter control method |  |
| Largest motor starting current (A) |  |
| Number of shore connections |  |
| Shore connection 1 voltage levels: | |
| Level 1 high (V) |  |
| Level 1 low (V) |  |
| Level 2 high (V) |  |
| Level 2 low (V) |  |
| Level 3 high (V) |  |
| Level 3 low (V) |  |
| Shore connection 1 current rating (A) |  |
| Shore connection 2 voltage levels: |  |
| Level 1 high (V) |  |
| Level 1 low (V) |  |
| Level 2 high (V) |  |
| Level 2 low (V) |  |
| Level 3 high (V) |  |
| Level 3 low (V) |  |
| Shore connection 2 current rating (A) |  |
|  | Hours to engineer ESU (h) |  |  |
|  | Days to commission ESU (days) |  |  |
|  | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table A – input variables** | | | |
| **Variable name** | **Type** | **How to enter it** | **Item on form** |
| Revision | Number | Typed | Revision Number |
| Revision\_Description | Text | Typed | Revision Description |
| Revision\_Author | Text | Typed | Author |
| Revision\_Date | Date | Typed | Revision Date |
| Quotation\_No | Number | Typed | Quotation Number |
| Customer | Text | Typed | Customer |
| Customer\_project\_no | Text | Typed | Customer Project Number |
| Shipyard | Text | Typed | Shipyard |
| Yard\_No | Text | Typed | Shipyard Number |
| Class | Text | Selected | Classification Society |
| DP\_Class\_Selected | Number | Selected | Required DP Class |
| Class\_Notification\_Additional | Text | Selected | Additional Class Battery Notation |
| Lifetime\_in\_years | Number | Typed | Required battery lifetime |
| Description\_Case\_1 | Text | Typed | Case 1 description |
| Input\_Required\_Power\_in\_kW\_Case\_1 | Number | Typed | Power required in case 1 |
| Input\_Time\_Case\_1 | Number | Typed | Duration of required power in case 1 |
| Description\_Case\_2 | Text | Typed | Case 2 description |
| Input\_Required\_Power\_in\_kW\_Case\_2 | Number | Typed | Power required in case 2 |
| Input\_Time\_Case\_2 | Number | Typed | Duration of required power in case 2 |
| Description\_Case\_3 | Text | Typed | Case 3 description |
| Input\_Required\_Power\_in\_kW\_Case\_3 | Number | Typed | Power required in case 3 |
| Input\_Time\_Case\_3 | Number | Typed | Duration of required power in case 3 |
| Description\_Case\_4 | Text | Typed | Case 4 description |
| Input\_Required\_Power\_in\_kW\_Case\_4 | Number | Typed | Power required in case 4 |
| Input\_Time\_Case\_4 | Number | Typed | Duration of required power in case 4 |
| Description\_Case\_5 | Text | Typed | Case 5 description |
| Input\_Required\_Power\_in\_kW\_Case\_5 | Number | Typed | Power required in case 5 |
| Input\_Time\_Case\_5 | Number | Typed | Duration of required power in case 5 |
| Description\_Case\_6 | Text | Typed | Case 6 description |
| Input\_Required\_Power\_in\_kW\_Case\_6 | Number | Typed | Power required in case 6 |
| Input\_Time\_Case\_6 | Number | Typed | Duration of required power in case 6 |
| Input\_Application\_Name | Text | Selected | Battery type |
| Voltage\_Level\_Switchboard | Number | Selected | Main switchboard AC voltage |
| Input\_Required\_Power\_in\_kW | Number | Typed | Total power required |
| Input\_Required\_Power\_in\_kWh | Number | Typed | Total capacity required |
| Voltage\_Level\_ESU | Number | Selected | DC link voltage (V) |
| Input\_No\_of\_ESU\_units | Number | Typed | Number of ESU |
| Hours\_for\_Engineering\_ESU | Number | Typed | Hours to engineer ESU |
| Commissioning\_Days | Number | Typed | Days to commission ESU |
| Largest\_Motor\_Starting\_Current | Number | Typed | Largest motor starting current |
| Frequency\_Level\_Switchboard | Number | Typed | Main switchboard AC frequency |
| Converter\_Control\_Method | Text | Selected | Converter control method |
| No\_of\_Shore\_Connections | Number | Selected | Number of shore connections |
| Shore\_Connection\_1\_Level\_1\_High | Number | Typed | Level 1 high (V) |
| Shore\_Connection\_1\_Level\_1\_Low | Number | Typed | Level 1 low (V) |
| Shore\_Connection\_1\_Level\_2\_High | Number | Typed | Level 2 high (V) |
| Shore\_Connection\_1\_Level\_2\_Low | Number | Typed | Level 2 low (V) |
| Shore\_Connection\_1\_Level\_3\_High | Number | Typed | Level 3 high (V) |
| Shore\_Connection\_1\_Level\_3\_Low | Number | Typed | Level 3 low (V) |
| Shore\_Connection\_1\_Current | Number | Typed | Shore connection 1 current rating |
| Shore\_Connection\_2\_Level\_1\_High | Number | Typed | Level 1 high (V) |
| Shore\_Connection\_2\_Level\_1\_Low | Number | Typed | Level 1 low (V) |
| Shore\_Connection\_2\_Level\_2\_High | Number | Typed | Level 2 high (V) |
| Shore\_Connection\_2\_Level\_2\_Low | Number | Typed | Level 2 low (V) |
| Shore\_Connection\_2\_Level\_3\_High | Number | Typed | Level 3 high (V) |
| Shore\_Connection\_2\_Level\_3\_Low | Number | Typed | Level 3 low (V) |
| Shore\_Connection\_2\_Current | Number | Typed | Shore connection 2 current rating (A) |

Choices for the selectable inputs:

|  |  |
| --- | --- |
| **Table B – available options for selectable inputs** | |
| **Input:** | **Required options:** |
| Class | * ABS * BV * CCS * DNV-GL * GL * IRS * KR * LR * NK * Rina * RS |
| DP\_Class\_Selected | * 0 * 1 * 2 * 3 |
| Class\_Notification\_Additional | * Battery Power * Battery Safety |
| Input\_Application\_Name | * High power batteries * High energy batteries |
| Voltage\_Level\_Switchboard | * 110 * 120 * 208 * 230 * 380 * 400 * 440 * 450 * 480 * 690 |
| Voltage\_Level\_ESU | * 750 * 1000 |
| Converter\_Control\_Method | * Virtual Generator * Peak shaving |
| No\_of\_Shore\_Connections | * 0 * 1 * 2 * 3 |

Fixed battery calculation data

The fixed data required to carry out the calculations is listed in Table B. The data will vary depending on whether the calculation is being done to size high energy batteries or high power batteries, and hence the table has columns for each.

|  |  |  |
| --- | --- | --- |
| **Table C – fixed data** | | |
| **Variable** | **Values when sized based on high energy batteries** | **Values when sized based on high power batteries** |
| Nominal\_Energy\_in\_kWh\_High\_Power\_Batteries | 49.16 |  |
| Nominal\_Energy\_in\_kWh\_High\_Energy\_Batteries |  | 68.47 |
| Maximum\_charge\_A\_1C\_One\_String\_High\_Energy\_Batteries | 80 |  |
| Maximum\_charge\_A\_3\_3C\_One\_String\_High\_Power\_Batteries |  | 200 |
| Maximum voltage | 1000 | 1000 |
| Minimum\_voltage\_1C\_discharge\_at\_20%\_SOC | 830 |  |
| Minimum voltage\_2C\_discharge\_at\_20%\_SOC |  | 830 |
| Maximum\_discharge\_A\_2C\_One\_String\_High\_Energy\_Batteries | 160 |  |
| Maximum\_discharge\_A\_3\_3C\_One\_String\_High\_Power\_Batteries |  | 200 |
| Continuous\_rms\_charge\_discharge\_A\_ΔT\_25°C | 40 | 120 |
| ESU\_Dimensions\_D | 800 | |
| ESU\_Dimensions\_H | 2040 | |
| Price\_in\_€\_Per\_Unit | 58611 | |
| Labour\_Cost\_Project\_Management\_Engineering\_in\_Norway | 1300 | |
| Labour\_Cost\_Service\_Commissioning\_Test | 1050 | |
| Cost\_Commissioning\_Travel | 25000 | |
| Cost\_Hotel | 2500 | |
| Cost\_Transport | 660 | |

Variables to be calculated during execution

Table D lists the variables that are to be calculated during execution of the tool and the formulae to be applied to calculate them. There are two columns of calculations: one is for calculations based on capacity (kWh); the other is for calculations based on power (kW).

Note: Required\_power\_in\_kW and Required\_power\_in\_kWh will either be entered by the user or calculated from the cases, as described in table D.

|  |  |  |
| --- | --- | --- |
| **Table D – battery variables to be calculated during execution** | | |
| **Variable** | **Calculations when sized using high energy batteries** | **Calculations when sized using high power batteries** |
| No\_of\_ESU\_units | =Input\_No\_of\_ESU\_units | =Input\_No\_of\_ESU\_units |
| Required\_power\_in\_kWh | =Input\_Required\_power\_in\_kWh |  |
| Required\_power\_in\_kW |  | =Input\_Required\_power\_in\_kW |
| Application\_name | =Input\_application\_name | =Input\_application\_name |
| ESU\_Application\_Type | If Input\_Application\_Name = High power batteries; then ESU\_Application\_Type = VL30PFe | If Input\_Application\_Name = High energy batteries; then ESU\_Application\_Type = VL41MFe |
| Energy\_Start\_of\_Life\_in\_kWh | =Nominal\_Energy\_in\_kWh\_High\_Power\_Batteries\*0.8 | =Nominal\_Energy\_in\_kWh\_High\_Energy\_Batteries\*0.8 |
| Energy\_End\_of\_Life\_in\_kWh | = Energy\_Start\_of\_Life\_in\_kWh\*0.8 | = Energy\_Start\_of\_Life\_in\_kWh\*0.8 |
| Maximum\_charge\_kW\_3\_3C\_One\_String\_High\_Power\_Batteries |  | =(Maximum\_charge\_A\_3\_3C\_One\_String\_High\_Power\_Batteries\* Minimum voltage\_2C\_discharge\_at\_20%\_SOC)/1000 |
| Maximum\_charge\_kW\_1C\_One\_String\_High\_Energy\_Batteries | =(Maximum\_charge\_A\_1C\_One\_String\_High\_Energy\_Batteries\* Minimum\_voltage\_1C\_discharge\_at\_20%\_SOC)/1000 |  |
| Maximum\_discharge\_kW\_3\_3C\_One\_String\_High\_Power\_Batteries |  | =(Maximum\_discharge\_A\_3\_3C\_One\_String\_High\_Power\_Batteries\* Minimum voltage\_2C\_discharge\_at\_20%\_SOC)/1000 |
| Maximum\_discharge\_kW\_2C\_One\_String\_High\_Energy\_Batteries | =(Maximum\_discharge\_A\_2C\_One\_String\_High\_Energy\_Batteries\* Minimum\_voltage\_1C\_discharge\_at\_20%\_SOC)/1000 |  |
| Continuous\_rms\_charge\_discharge\_kW\_ΔT\_25°C | =Continuous\_rms\_charge\_discharge\_A\_ΔT\_25°C\*Minimum voltage\_2C\_discharge\_at\_20%\_SOC)/1000 | =Continuous\_rms\_charge\_discharge\_A\_ΔT\_25°C\* Minimum\_voltage\_1C\_discharge\_at\_20%\_SOC)/1000 |
| Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Required\_power\_in\_kWh/Energy\_End\_of\_Life\_in\_kWh | =Required\_power\_in\_kW/Maximum\_charge\_kW\_3\_3C\_One\_String\_High\_Power\_Batteries |
| Total\_Installed\_Energy\_Start\_of\_Life | =Nominal\_Energy\_in\_kWh\_High\_Power\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Nominal\_Energy\_in\_kWh\_High\_Power\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| Total\_Usable\_Energy\_Start\_of\_Life | =Energy\_Start\_of\_Life\_in\_kWh\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Energy\_Start\_of\_Life\_in\_kWh\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| Total\_Usable\_Energy\_End\_of\_Life\_20%\_Reduction | =Energy\_End\_of\_Life\_in\_kWh\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Energy\_End\_of\_Life\_in\_kWh\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| ESU\_Total\_Continuous\_Maximum\_charge\_Amp | =Maximum\_charge\_A\_1C\_One\_String\_High\_Energy\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Maximum\_charge\_A\_3\_3C\_One\_String\_High\_Power\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| ESU\_Total\_Continuous\_Maximum\_charge\_kW | =Maximum\_charge\_kW\_1C\_One\_String\_High\_Energy\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Maximum\_charge\_kW\_3\_3C\_One\_String\_High\_Power\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| ESU\_Total\_Continuous\_Maximum\_discharge\_Amp | =Maximum\_discharge\_A\_2C\_One\_String\_High\_Energy\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Maximum\_discharge\_A\_3\_3C\_One\_String\_High\_Power\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| ESU\_Total\_Continuous\_Maximum\_discharge\_kW | =Maximum\_discharge\_kW\_2C\_One\_String\_High\_Energy\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Maximum\_discharge\_kW\_3\_3C\_One\_String\_High\_Power\_Batteries\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| ESU\_Total\_Continuous\_rms\_charge\_discharge\_kW\_ΔT\_25°C | =Continuous\_rms\_charge\_discharge\_kW\_ΔT\_25°C\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Continuous\_rms\_charge\_discharge\_kW\_ΔT\_25°C\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| ESU\_Total\_Continuous\_rms\_charge\_discharge\_Amp\_ΔT\_25°C | =Continuous\_rms\_charge\_discharge\_A\_ΔT\_25°C\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Continuous\_rms\_charge\_discharge\_A\_ΔT\_25°C\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| Price\_in\_€\_Total | =Price\_in\_€\_Per\_Unit\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit | =Price\_in\_€\_Per\_Unit\*Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| Price\_in\_€\_Per\_Installed\_kWh | =Price\_in\_€\_Total/Total\_Installed\_Energy\_Start\_of\_Life | =Price\_in\_€\_Total/ Total\_Installed\_Energy\_Start\_of\_Life |
| ESU\_Dimensions\_W | Where ‘Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit’ is an odd number:  =(Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit – 1)\*900  Where ‘Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit’ is an even number:  =(Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit\*900) + 1200 | Where ‘Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit’ is an odd number:  =(Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit – 1)\*900  Where ‘Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit’ is an even number:  =(Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit\*900) + 1200 |
| ESU\_Dimensions\_m2 | =(ESU\_Dimensions\_D\* ESU\_Dimensions\_W)/1000000 | =(ESU\_Dimensions\_D\* ESU\_Dimensions\_W)/1000000 |
| ESU\_Dimensions\_m3 | =(ESU\_Dimensions\_H\* ESU\_Dimensions\_D\* ESU\_Dimensions\_W)/1000000000 | =(ESU\_Dimensions\_H\* ESU\_Dimensions\_D\* ESU\_Dimensions\_W)/1000000000 |
| ESU\_Total\_Units\_Weight\_in\_kg | =Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit\*1000 | =Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit\*1000 |
| Total\_Price\_Engineering\_ESU | = Hours\_for\_Engineering\_ESU \* Labour\_Cost\_Project\_Management\_Engineering\_in\_Norway | = Hours\_for\_Engineering\_ESU \* Labour\_Cost\_Project\_Management\_Engineering\_in\_Norway |
| Total\_Price\_Included\_Engineering\_in\_NOK\_Without\_Commisioning | = Total\_Price\_Engineering\_ESU | = Total\_Price\_Engineering\_ESU |
| Commissioning\_Days\_@10\_Hours | =Commissioning\_Days\*10\*Labour\_Cost\_Service\_Commissioning\_Test | =Commissioning\_Days\*10\*Labour\_Cost\_Service\_Commissioning\_Test |
| Hotel\_and\_Diet | =Commissioning\_Days\*Cost\_Hotel | =Commissioning\_Days\*Cost\_Hotel |
| Transport | =Commissioning\_Days\*Cost\_Transport | =Commissioning\_Days\*Cost\_Transport |
| Total\_Price\_Commisioning\_Energy\_Storage\_in\_NOK | =Commissioning\_Days\_@10\_Hours+Hotel\_and\_Diet+Transport+Cost\_Commissioning\_Travel | =Commissioning\_Days\_@10\_Hours+Hotel\_and\_Diet+Transport+Cost\_Commissioning\_Travel |
| Total\_Price\_in\_NOK\_Included\_Commisioning | =Total\_Price\_Included\_Engineering\_in\_NOK\_Without\_Commisioning+Total\_Price\_Commisioning\_Energy\_Storage\_in\_NOK | =Total\_Price\_Included\_Engineering\_in\_NOK\_Without\_Commisioning+Total\_Price\_Commisioning\_Energy\_Storage\_in\_NOK |

|  |  |
| --- | --- |
| **Table E – other variables to be calculated during execution** | |
| **Variable** | **Calculation** |
| Required\_power\_in\_kWh | =(Input\_Required\_Power\_in\_kW\_Case\_1\*Input\_Time\_Case\_1)+ (Input\_Required\_Power\_in\_kW\_Case\_2\*Input\_Time\_Case\_2)+ (Input\_Required\_Power\_in\_kW\_Case\_3\*Input\_Time\_Case\_3)+ (Input\_Required\_Power\_in\_kW\_Case\_4\*Input\_Time\_Case\_4)+ (Input\_Required\_Power\_in\_kW\_Case\_5\*Input\_Time\_Case\_5)+ (Input\_Required\_Power\_in\_kW\_Case\_6\*Input\_Time\_Case\_6) |
| Required\_power\_in\_kW | =Largest value of:   * Input\_Required\_Power\_in\_kW\_Case\_1 * Input\_Required\_Power\_in\_kW\_Case\_2 * Input\_Required\_Power\_in\_kW\_Case\_3 * Input\_Required\_Power\_in\_kW\_Case\_4 * Input\_Required\_Power\_in\_kW\_Case\_5 * Input\_Required\_Power\_in\_kW\_Case\_6 * (Voltage\_Level\_Switchboard \*√3\*Largest motor starting current) |
| Energy\_Storage\_Converter\_kW | = Required\_power\_in\_kW |
| Energy\_Storage\_Converter\_Current | = Energy\_Storage\_Converter\_kW/Voltage\_Level\_ESU |
| Energy\_Storage\_Transformer\_kW | = Required\_power\_in\_kW |
| EST\_Secondary\_Voltage | = Voltage\_Level\_ESU/√2 |
| Energy\_Storage\_Switchgear\_Current | = Energy\_Storage\_Transformer\_kVA/( Voltage\_Level\_Switchboard \*√3) |
| Shore\_Connection\_1\_Max\_Voltage | =Largest of:   * Shore\_Connection\_1\_Level\_1\_High * Shore\_Connection\_1\_Level\_2\_High * Shore\_Connection\_1\_Level\_3\_High |
| Shore\_Connection\_2\_Max\_Voltage | =Largest of:   * Shore\_Connection\_2\_Level\_1\_High * Shore\_Connection\_2\_Level\_2\_High * Shore\_Connection\_2\_Level\_3\_High |
| Shore\_Connection\_1\_kVA | =Shore\_Connection\_1\_Max\_Voltage\*√3\*Shore\_Connection\_1\_Current |
| Shore\_Connection\_2\_kVA | =Shore\_Connection\_2\_Max\_Voltage\*√3\*Shore\_Connection\_2\_Current |

Look-up Table Selections

Table F lists the variables that are to be assigned a value from a look up table based on the value of another variable. For now, temporary values should be put in for the entry, which will later be replaced with real data.

|  |  |  |
| --- | --- | --- |
| **Table F – variables to be assigned a value from a look-up table** | | |
| **Variable** | **Selection criteria** | **Look-up Table Data** |
| Energy\_Storage\_Converter\_kVA | =Closest match above:  Energy\_Storage\_Converter\_kW | 1000 – 10000 in steps of 1000 |
| Energy\_Storage\_Converter\_Cost | Corresponds to converter kVA | 10000 - 100000 NOK in steps of 10000 |
| Energy\_Storage\_Transformer\_kVA | =Closest match above:  Energy\_Storage\_Transformer\_kW | 1000 – 10000 in steps of 1000 |
| Energy\_Storage\_Transformer\_Cost | Corresponds to ES transformer kVA | 10000 - 100000 NOK in steps of 10000 |
| Shore\_Connection\_1\_Transformer\_kVA | =Closest match above:  Shore\_Connection\_1\_kVA | 50 – 500 in steps of 50 |
| Shore\_Connection\_1\_Transformer\_Cost | Corresponds to shore connection 1 transformer kVA | 10000 - 100000 NOK in steps of 10000 |
| Shore\_Connection\_2\_Transformer\_kVA | =Closest match above:  Shore\_Connection\_2\_kVA | 50 – 500 in steps of 50 |
| Shore\_Connection\_2\_Transformer\_Cost | Corresponds to shore connection 1 transformer kVA | 10000 - 100000 NOK in steps of 10000 |
| Shore\_Connection\_1\_Converter\_kVA | =Closest match above:  Shore\_Connection\_1\_kVA | 50 – 500 in steps of 50 |
| Shore\_Connection\_1\_Converter\_Cost | Corresponds to shore connection 1 transformer kVA | 10000 - 100000 NOK in steps of 10000 |
| Shore\_Connection\_2\_Converter\_kVA | =Closest match above:  Shore\_Connection\_2\_kVA | 50 – 500 in steps of 50 |
| Shore\_Connection\_2\_Converter\_Cost | Corresponds to shore connection 1 transformer kVA | 10000 - 100000 NOK in steps of 10000 |

Output data

Table G lists the variables that have to be written to a Word document as the output from this tool. The data should be written to a table. The left-hand side of table D gives the label that should be put in the left column of the table in the report produced by the tool, and the right-hand side of the table contains the variable name that has to be put in the right column of the table in the report.

|  |  |
| --- | --- |
| **Table G - outputs** | |
| **Label** | **Variable** |
| Quotation no. | Quotation\_No |
| Revision | Revision |
| Date | Revision\_Date |
| Author | Revision\_Author |
| Application Type | Application\_name |
| Customer | Customer |
| Customer project | Customer\_project\_no |
| Shipyard | Shipyard |
| Yard No. | Yard\_No |
| Class | Class |
| Total Price of ESU | Total\_Price\_Engineering\_ESU |
| Total Price Commissioning | Total\_Price\_Commisioning\_Energy\_Storage\_in\_NOK |
| Total Price Including Commissioning | Total\_Price\_in\_NOK\_Included\_Commisioning |
| No. of ESU | No\_of\_ESU\_units |
| ESU Application Type | Application\_name |
| Total no. of battery strings for each ESU unit | Total\_no\_of\_battery\_strings\_for\_each\_ESU\_unit |
| Maximum voltage | Maximum\_voltage |
| Minimum voltage (1C discharge at 20 % SOC) | Minimum\_voltage\_1C\_discharge\_at\_20%\_SOC |
| Maximum charge current (1C) | ESU\_Total\_Continuous\_Maximum\_charge\_Amp |
| Maximum charge kW (1C) | ESU\_Total\_Continuous\_Maximum\_charge\_kW |
| Maximum discharge current (2C) | ESU\_Total\_Continuous\_Maximum\_discharge\_Amp |
| Maximum discharge kW (2C) | ESU\_Total\_Continuous\_Maximum\_discharge\_kW |
| Continuous (rms) charge/discharge current ΔT 25°C | ESU\_Total\_Continuous\_rms\_charge\_discharge\_Amp\_ΔT\_25°C |
| Continuous (rms) charge/discharge kW ΔT 25°C | ESU\_Total\_Continuous\_rms\_charge\_discharge\_kW\_ΔT\_25°C |
| Total installed start of life energy | Total\_Installed\_Energy\_Start\_of\_Life |
| Total usable energy at end of life (100 – 20 %) | Total\_Usable\_Energy\_Start\_of\_Life |
| Total usable energy end of life (20 % reduction) | Total\_Usable\_Energy\_End\_of\_Life\_20%\_Reduction |
| Weight approx. | ESU\_Total\_Units\_Weight\_in\_kg |
| Dimensions (H\*W\*D) | ESU\_Dimensions\_H\*ESU\_Dimensions\_W\* ESU\_Dimensions\_D  [Note: this is to display the data in H\*W\*D format, not to multiply the values |
| Switchboard AC voltage (V) | Voltage\_Level\_Switchboard |
| Required power (kW) | Required\_Power\_in\_kW |
| Required capacity (kWh) | Required\_Power\_in\_kWh |
| ESU DC link voltage (V) | Voltage\_Level\_ESU |
| Number of ESU | Input\_No\_of\_ESU\_units |
| Switchboard AC frequency (Hz) | Frequency\_Level\_Switchboard |
| Converter control method | Converter\_Control\_Method |
| Number of shore connections | No\_of\_Shore\_Connections |
| Energy storage converter rating (kVA) | Energy\_Storage\_Converter\_kVA |
| Energy storage converter cost (NOK) | Energy\_Storage\_Converter\_Cost |
| Energy storage transformer rating (kVA) | Energy\_Storage\_Transformer\_kVA |
| Energy storage transformer cost (NOK) | Energy\_Storage\_Transformer\_Cost |
| Shore connection 1 transformer rating (kVA) | Shore\_Connection\_1\_Transformer\_kVA |
| Shore connection 1 transformer cost (NOK) | Shore\_Connection\_1\_Transformer\_Cost |
| Shore connection 2 transformer rating (kVA) | Shore\_Connection\_2\_Transformer\_kVA |
| Shore connection 2 transformer cost (NOK) | Shore\_Connection\_2\_Transformer\_Cost |
| Shore connection 1 converter rating (kVA) | Shore\_Connection\_1\_Converter\_kVA |
| Shore connection 1 converter cost (NOK) | Shore\_Connection\_1\_Converter\_Cost |
| Shore connection 2 converter rating (kVA) | Shore\_Connection\_2\_Converter\_kVA |
| Shore connection 2 converter cost (NOK) | Shore\_Connection\_2\_Converter\_Cost |