ESU quotation and technical specification generation tool – software specification

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Author: Gary Wilson

Introduction

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

High level options

There are two high level options that the user has when using the tool and its structure is to ensure it operates in the correct mode for the selected option. The first high level option is to choose if the energy storage sizing is to be done for a required energy storage capacity (sized in kWh) or a required power rating (sized in kW). The second high level option is the choice of batteries that will be used in the ESU: high power batteries of high energy batteries. These high level options should be the first two items specified by the user of the tool and they should be defined as variables that are used during the execution of the tool.

User inputs

Table A sets out the inputs that the user is to be able to enter. These specify the technical details of the installation and its operating profile. This data is used by the tool to calculate the outputs. Table A provides the name of each variable and a short description of what it is. The variables can either be typed in by the user (typed) or selected from a drop-down list (selected), as specified in the table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table A – input variables** | | | |
| **Variable name** | **Type** | **How to enter it** | **Description** |
| Revision | Number | Typed | Quotation / technical specification revision number |
| Revision\_Description | Text | Typed | User comments to describe the revision |
| Revision\_Author | Text | Typed | Name of the user who created the revision |
| Revision\_Date | Date | Typed | The date the revision was made |
| Quotation\_No | Number | Typed | Reference number for the quotation |
| Customer | Text | Typed | Name of the customer being provided the quotation |
| Customer\_project\_no | Text | Typed | The project number the customer has assigned to it |
| Shipyard | Text | Typed | The name of the shipyard involved in the project |
| Yard\_No | Text | Typed | The number the shipyard has assigned to this ship |
| Class | Text | Selected | The Classification Society involved in the project |
| DP\_Class\_Selected | Number | Selected | The dynamic position (DP) required for the ship |
| Class\_Notification\_Additional | Text | Selected | Additional Class Notations for the ship |
| Lifetime\_in\_years | Number | Typed | The required lifetime of the batteries |
| Description\_Case\_1 | Text | Typed | Description of the 1st operating profile case |
| Input\_Required\_Power\_in\_kW\_Case\_1 | Number | Typed | The power required during case 1 |
| Input\_Time\_Case\_1 | Number | Typed | The duration of case 1 |
| Description\_Case\_2 | Text | Typed | Description of the 2nd operating profile case |
| Input\_Required\_Power\_in\_kW\_Case\_2 | Number | Typed | The power required during case 2 |
| Input\_Time\_Case\_2 | Number | Typed | The duration of case 2 |
| Description\_Case\_3 | Text | Typed | Description of the 3rd operating profile case |
| Input\_Required\_Power\_in\_kW\_Case\_3 | Number | Typed | The power required during case 3 |
| Input\_Time\_Case\_3 | Number | Typed | The duration of case 3 |
| Description\_Case\_4 | Text | Typed | Description of the 4th operating profile case |
| Input\_Required\_Power\_in\_kW\_Case\_4 | Number | Typed | The power required during case 4 |
| Input\_Time\_Case\_4 | Number | Typed | The duration of case 4 |
| Description\_Case\_5 | Text | Typed | Description of the 5th operating profile case |
| Input\_Required\_Power\_in\_kW\_Case\_5 | Number | Typed | The power required during case 5 |
| Input\_Time\_Case\_5 | Number | Typed | The duration of case 5 |
| Description\_Case\_6 | Text | Typed | Description of the 6th operating profile case |
| Input\_Required\_Power\_in\_kW\_Case\_6 | Number | Typed | The power required during case 6 |
| Input\_Time\_Case\_6 | Number | Typed | The duration of case 6 |
| Input\_Application\_Name | Text | Selected | Selection of high power/energy batteries |
| Input\_Required\_Power\_in\_kWh\_or\_kW? | Text | Selected | Selection of capacity (kWh) or power (kW) |
| Voltage\_Level\_Switchboard | Number | Selected | The switchboard connection voltage |
| Input\_Required\_Power\_in\_kW | Number | Typed | The required battery power in kW |
| Input\_Required\_Power\_in\_kWh | Number | Typed | The required battery power in kWh |
| Voltage\_Level\_ESU | Number | Selected | The ESU voltage level |
| Input\_No\_of\_ESU\_units | Number | Typed | The required number of ESU on the ship |
| Hours\_for\_Engineering\_ESU | Number | Typed | Hours required to engineer ESU |
| Commissioning\_Days | Number | Typed | The number of commissioning days required |

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 |
| Input\_Required\_Power\_in\_kWh\_or\_kW? | * Required power in kWh * Required power in kW |
| Voltage\_Level\_Switchboard | * 110 * 120 * 208 * 230 * 380 * 400 * 440 * 450 * 480 * 690 * 750 * 1000 |
| Voltage\_Level\_ESU | * 750 * 1000 |

Fixed 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 |
| 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).

|  |  |  |
| --- | --- | --- |
| **Table D – variables to be calculated during execution** | | |
| **Variable** | **Calculations when sized based on capacity** | **Calculations when sized based on power** |
| 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 |
| Required\_power\_in\_kWh\_or\_kW? | =Input\_Required\_power\_in\_kWh\_or\_kW? | =Input\_Required\_power\_in\_kWh\_or\_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\_in\_NOK\_Included\_Commisioning | =Total\_Price\_Included\_Engineering\_in\_NOK\_Without\_Commisioning+ Total\_Price\_in\_NOK\_Included\_Commisioning |

Output data

Table E 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 E - 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 |