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Lithium-ion Battery Calculator Tool Tutorial

Welcome to the Lithium-ion Battery Calculator Tool tutorial.

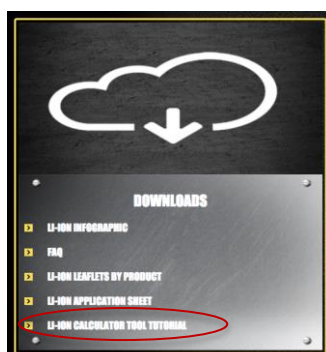
The tool has been designed to check the suitability of Li-ion in a given application, enable the best Li-ion battery and charger configuration and estimate the costs compared to Lead Acid.

The tool can be found in the EMEA Dealer Extranet as shown below (Truck Sales>>Product Information>>Lithium-ion Battery Calculator Tool)



Step 1 – Survey form

In order to use the tool, you need to know the application data from your customer. This data can be collected using the Lithium-ion Application Sheet, a survey form that can be downloaded from the Download section of the Lithium-ion Sales Tool, which can be found in Truck Sales >>Sales Tools.



This one-page form consists of different sections. An example is shown below.

The first section includes the customer details.

The second section includes the list of trucks in the fleet.

For each truck, you need to know:

- Model name
- Brand
- Quantity
- Energy consumption - this should be possibly measured using a battery logging device
- Idle time - the time when the truck should be in use but effectively the energy from the battery is not used, including paper work, loading and unloading, not scheduled breaks etc.

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The forth section is for the Lead Acid battery and includes:

- Time taken to top up the water and the water cost – to estimate the maintenance costs
- Type of charger used for the lead-acid battery - 50 Hz or High Frequency
- Time required to go and come back to and from the charging room
- Time required to exchange the battery
- Is there any employee that takes care of the battery exchange?
- Is it an existing or new facility? If it is a new facility, the cost for a charging room plus the additional equipment should be considered for Lead Acid.

Current Battery Maintenance and Changeover	
Water top up time per battery (mins)	20
Water cost per litre (l)	0.40
Charger type	HF
Travel plus return time to charging station (mins)	10
Battery changeover time (mins)	10
Battery attendant employed?	No Yes/No
Is there an existing charging room?	Yes Yes/No

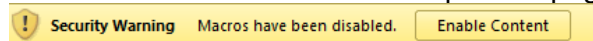
The last section includes:

- Available electrical supply capacity at the site to check the feasibility with Li-ion fast chargers (1 hr chargers) as these might require high power from the mains
- Number of chargers required
- Expire date for current contract if any
- Preferred date for new trucks.

Other	
Available electrical supply capacity at the site (KVA)	500 to check feasibility with fast charging options
Number of chargers required	10
Expire date for current contract	Jun-18
Preferred date for new trucks	Jul-18

Step 2 – Calculator tool (Inputs)

Once you have all these inputs, you can start the simulation using the calculator tool. Macros must be enabled at the top of the page.



In the tool you have to select one truck at a time using the drop down menu.

LITHIUM-ION BATTERY CALCULATOR TOOL	
English	
Truck	
Truck Category	Counterbalance
Truck Model	J1.6-2.0XNT_MWB

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The drop down menu with a 24 hour clock is used for the time, the breaks and the break duration.

It is also possible to select the days per week ranging from 5 to 7.

Application and Daily Schedule						
Start Time	06:00 <small>select</small>					
Break Start Time	Break 1 08:30	Break 2 10:30	Break 3 12:30	Break 4 15:30	Break 5 18:00	Break 6 20:00
Break Duration (mins)	15	15	40	15	15	15
Break Start Time	Break 7 No Break	Break 8 No Break	Break 9 No Break	Break 10 No Break	Break 11 No Break	Break 12 No Break
Break Duration (mins)	0	0	0	0	0	0
Break Start Time	Break 13 No Break	Break 14 No Break	Break 15 No Break	Break 16 No Break	Break 17 No Break	Break 18 No Break
Break Duration (mins)	0	0	0	0	0	0
End Time	22:00 <small>select</small>					
Days per week	6 <small>select</small>					

If you input the working hours per year, the tool will suggest an idle time based on this input as the tool compares the working hours per year with the shift schedule. If you don't have this input, the tool will suggest a value for the idle time based on the type of truck selected, e.g. the tow tractor will have a higher idle time due to the manual loading/unloading required. Your customer might also suggest a different idle time, that needs to be cross-checked with the value based on the working hours per year and/or the value suggested based on the truck type.

For the energy consumption, you should use the real value if possible as shown in this example. If not provided, you can use the VDI energy consumption suggested, based on the truck selected, but it should be considered that this value is usually higher than in real applications.

You can lower this value or increase the idle time to offset it.

There is also a simple formula reported here in grey that will help you estimate the battery consumption based on the duration of the current battery.

Operator hourly rate and electricity cost are simply copied from the survey form.

Working hours p.a.	3200	input	
% Working time that truck is idle (excl. scheduled breaks)	21 %	input	<i>Suggested value based on working hours p.a. = 21%</i>
Energy consumption rate during use (kWh/h)	3.50 kW	input	<i>VDI value for selected truck is = 4.20</i>
Operator hourly rate (€)	€ 30.00	input	<i>Default = 30.00</i>
Electricity cost (€/kWh)	0.12	input	<i>Default = 0.12</i>

Energy consumption = change in battery state of charge (%) / 100 × nominal battery voltage (V) × battery capacity (Ah) / duration of use (hours)

Same comment for the inputs in the next section, the one dedicated to Lead Acid.

The tool will suggest some default values if you don't know the actual ones.

The battery and charger prices are left blank and you should fill in these fields with the net prices, considering the discount and the margin. Please note that the prices shown in this example are approximate.

Lead Acid Battery and Charger			
Battery capacity (Ah)	575 Ah	select	
Water top up time per battery (mins)	20	input	<i>Default = 20</i>
Water cost per litre (€)	0.40	input	<i>Default = 0.40</i>
Charger type	High Frequency	select	
Travel plus return time to charging station (mins)	10	input	
Battery changeover time (mins)	10	input	
Battery attendant employed?	No	select	
Is there an existing charging room?	Yes	select	
Lead Acid battery price (€)	€ 3,500.00	input	
Charger price (€)	€ 1,000.00	input	

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The last section is about Li-ion.

The drop down menu shows the list of battery capacities and charger available for the truck selected.

You should start always with the smallest battery capacity and charger and upgrade them if the tool gives you a warning message that tells you that this battery and charger configuration is not suitable for the application.

If you select the fastest charger, your customer should be aware that a connector upgrade may be necessary as well as a suitable electrical infrastructure in case many trucks are charged at the same time.

For the 2017 range available with Li-ion, the prices of batteries and chargers are available on the Warehouse Price List/Counterbalance SPED Price List. For the 2018 range, please contact the SPED team.

Please note that the prices in this example are approximate.

Lithium-ion Battery and Charger			
Battery capacity (Ah)	450 Ah	select	<i>Maximum DOD has been exceeded, Please check energy consumption, choose a larger Lithium battery or charger or change shift pattern</i>
Charger (A)	150 A	select	
Lithium-ion battery price (€)		input	
Charger price (€)		input	

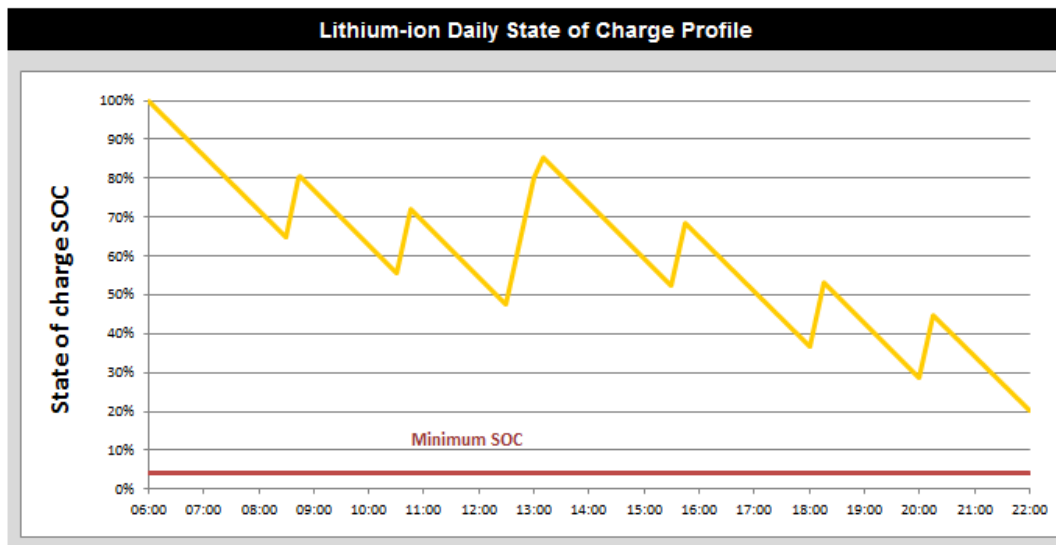
Lithium-ion Battery and Charger			
Battery capacity (Ah)	450 Ah	select	
Charger (A)	250 A	select	
Lithium-ion battery price (€)	€ 20,000.00	input	
Charger price (€)	€ 3,000.00	input	

SUBMIT

Step 3 – Calculator tool (Outputs)

After checking that all the values have been selected or inserted, pressing the Submit button will generate the outputs in the lower part of the page.

The graph shows the state of charge of the Li-ion battery during the discharging and charging phases. The battery and charger configuration is suitable if the yellow line is well above the red line, which indicates the minimum state of charge.



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The estimated costs per truck are also listed.

The investment costs include the purchase costs and the cost of the charging room and equipment if required for Lead Acid in a new facility.

Usually the investment cost is higher for Lithium-ion.

The annual cost per year includes:

- The energy cost, usually lower for Li-ion due to the higher efficiency of the battery and charger
- The battery handling cost, usually lower for Li-ion as the travel to the charging room and battery exchange is not required
- Battery maintenance cost, usually lower for Li-ion as water top up is not required.

Investment Costs per truck		
	Lead Acid	Lithium-ion
Batteries required per truck (integer)	2	1
	€	€
Total battery cost	7,000.00	20,000.00
Charger cost	1,000.00	3,000.00
Charging room and equipment cost	0.00	0.00
Total	8,000.00	23,000.00

Annual Costs per truck		
	Lead Acid	Lithium-ion
	€	€
Energy cost	2,471.94	1,574.01
Battery handling cost	5,079.18	756.00
Battery maintenance cost	725.38	50.00
Total	8,276.50	2,380.01

The last part of the outputs is about the savings and the payback period, if the customer chooses Li-ion.

The savings are cumulative and it is possible to convert them into a currency different from Euro. The currency desired can be selected in the drop down menu.

Payback in appropriate applications is as low as 2-3 years.

Also the savings in terms of carbon emissions are estimated due to the higher Li-ion efficiency and are calculated using the standard EN 16796, based on a mix of the German different electricity generation systems.

Savings per truck				
	Costs		Cumulative Savings (Lithium-ion vs Lead Acid)	
	Lead Acid	Lithium-ion	€	Select Currency (EUR)
	€	€		
y1	16,277	25,380	-9,104	-9,104
y2	8,277	2,380	-3,207	-3,207
y3	8,277	2,380	2,689	2,689
y4	8,277	2,380	8,586	8,586
y5	8,277	2,380	14,482	14,482

Payback Time	2.5 years
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Estimated CO ₂ emissions savings p.a.	4.0 Tonnes
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Moving to the next sheet of the tool, the outputs are ready to be printed in 2 pages and presented to your customer to complement the discussion about the best power choice for that specific application.

Lithium-ion Battery Calculator Tool Output Page 15-Nov-17

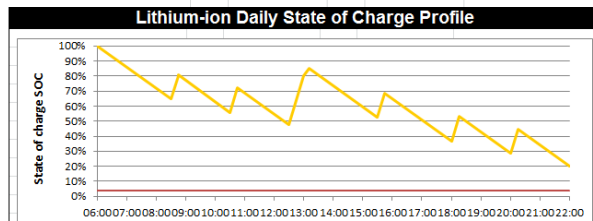
Truck type	J1.6-2.0NNT_MWB	
Start Time	07:00	
End Time	22:00	
Operating time per day (hh:mm)	14:05	
Idle time (hh:mm)	02:57	
Number of breaks per day	6	
Break time during shift per day (hh:mm)	01:55	
Operator hourly rate (€)	30.00	
Electricity cost (€/kWh)	0.12	

Energy	Lead Acid	Lithium-ion
Voltage (V)	48	51
Capacity (Ah)	575	450
Charge rate (kWh/hour)	n/a	12.80
Useable energy per battery (kWh)	22.08	18.80
Used energy per day (kWh)	38.94	38.94
Energy consumption rate (kWh/h)	3.50	3.50
Mains Energy per day (kWh)	71.53	45.54
Energy cost p.a. (€)	2,471.94	1,574.01
Estimated CO₂ emissions savings p.a. (tonnes)	4.04	

Battery Handling	Lead Acid	Lithium-ion
Number of batteries per truck (integer)	2	1
Number of battery cycles per day	1.76	7
Driver recharging time per annum (hours)	169	25
Battery attendant time per annum (hours)	0	0
Battery handling cost p.a. (€)	5,079.18	756.00

Battery Maintenance	Lead Acid	Lithium-ion
Water cost p.a. (€)	111.03	0
Water top up time p.a. (mins)	1129	0
Top up labour cost p.a. (€)	564.35	0
Annual inspection cost (€)	50.00	50.00
Battery maintenance cost p.a. (€)	725.38	50

Infrastructure	Lead Acid	Lithium-ion
Charging room and charging equipment (€)	0.00	0.00



Investment Costs per truck			
	Lead Acid	Lithium-ion	
Total battery cost	€ 7,000	€ 20,000	
Charger cost	€ 1,000	€ 3,000	
Charging room and equipment cost	€ 0	€ 0	Difference
Total	€ 8,000	€ 23,000	-15,000

Annual Costs per truck			
	Lead Acid	Lithium-ion	
Energy cost	€ 2,472	€ 1,574	
Battery handling cost	€ 5,079	€ 756	
Battery maintenance cost	€ 725	€ 50	Difference
Total	€ 8,277	€ 2,380	5,896

Savings per truck				
	Costs		Total Savings	
	Lead Acid	Lithium-ion	Lithium-ion vs Lead Acid	Select Currency (EUR)
y1	€ 16,277	€ 25,380	-9,104	
y2	€ 8,277	€ 2,380	-3,207	
y3	€ 8,277	€ 2,380	2,689	
y4	€ 8,277	€ 2,380	8,586	
y5	€ 8,277	€ 2,380	14,482	

Payback Time	2.5 years
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Estimated CO₂ emissions savings p.a.	4.0 Tonnes
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THIS HYG BATTERY CALCULATOR TOOL USES GENERIC DATA AND TECHNICAL DATA FROM HYSTER-YALE GROUP (HYG) AND ITS SUPPLIERS TO MODEL THE PERFORMANCE OF LITHIUM ION EQUIPMENT SUPPLIED BY HYG. BASED ON USER INPUTS IT CALCULATES THE PERFORMANCE OF THE EQUIPMENT IN TYPICAL MATERIALS HANDLING APPLICATIONS. WHILE HYG HAS ENDEAVOURED TO ENSURE ITS ACCURACY, HYG CANNOT GUARANTEE THAT THE RESULTS GENERATED WILL BE ACCURATE OR CORRECT FOR A SPECIFIC CUSTOMER OR APPLICATION. FURTHER, THE PERFORMANCE OF THE TOOL RELIES ON THE USER PROVIDING COMPLETE AND ACCURATE INPUTS. RESULTS GENERATED BY THE TOOL MAY BE COMPROMISED IF INCOMPLETE OR INACCURATE INPUTS ARE USED. THE TOOL PROVIDES ESTIMATES ONLY, AND SHOULD NOT BE RELIED UPON TO ACCURATELY FORECAST OR PREDICT RESULTS IN ACTUAL USE OF MATERIALS.

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