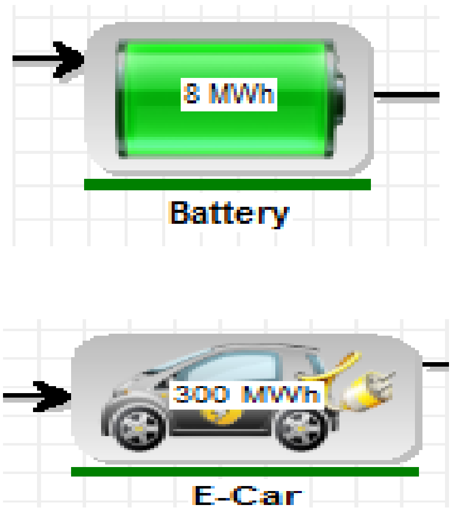
HOW TO GUIDE

Batteries and E-cars as a storage opportunity in energyPRO



Software for techno-economic analyses of energy projects

EMD
www.emd.dk

Preface

energyPRO is a Windows-based modeling software package for combined techno-economic analysis and optimisation of complex energy projects with a combined supply of electricity and thermal energy from multiple different energy producing units.

The unique programming in energyPRO optimises the operations of the plant including energy storage (heat, fuel, cold and electrical storages) against technical and financial parameters to provide a detailed specification for the provision of the defined energy demands, including heating, cooling and electricity use.
energyPRO also provides the user with a detailed financial plan in a standard format accepted by international banks and funding institutions. The software enables the user to calculate and produce a report for the emissions by the proposed project.
energyPRO is very user-friendly and is the most advanced and flexible software package for making a combined technical and economic analysis of multi-dimensional energy projects.
For further information concerning the applications of energyPRO please visit www.emd.dk.

Terms of application

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EMD International A/S, November 2013

Content

1. Introduction

With energyPRO it is possible to simulate energy storages other than a hydro pumping station by the use of batteries and E-cars.

A battery in energyPRO is regarded as a typical battery and thus purely functioning as an electricity storage. With E-cars you can state a driving demand and a battery capacity and let the e-cars participate on the electricity market.

2. Batteries

Battery is an electricity storage and can in energyPRO be found under "storage" as shown on Figure 1.

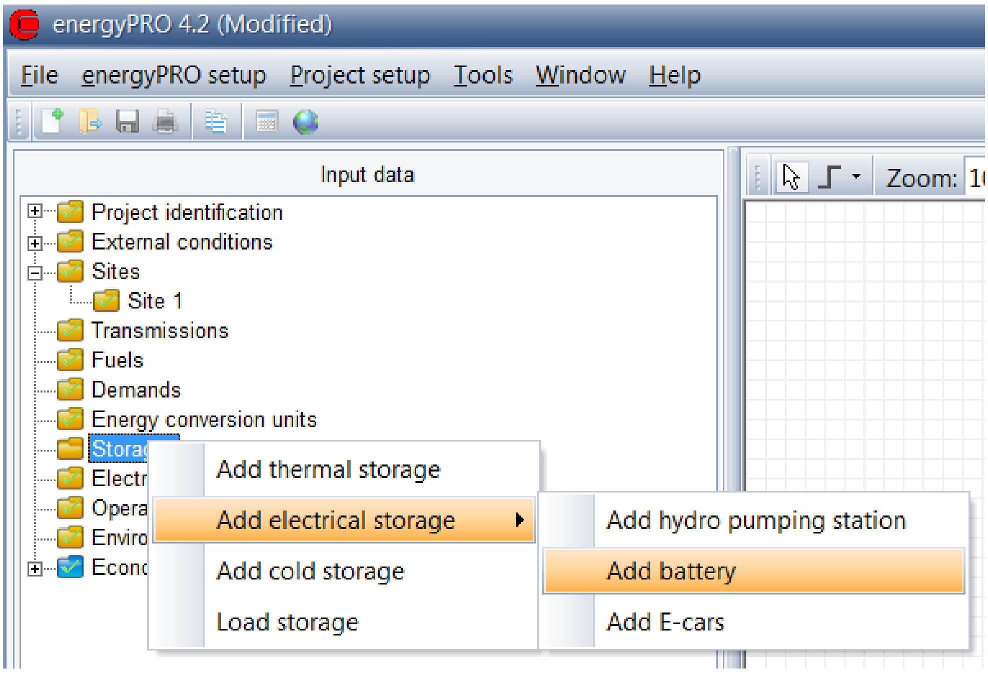

Figure 1. How to add a battery in energyPRO

The user interface consists of a few input fields as can be seen on Figure 2.

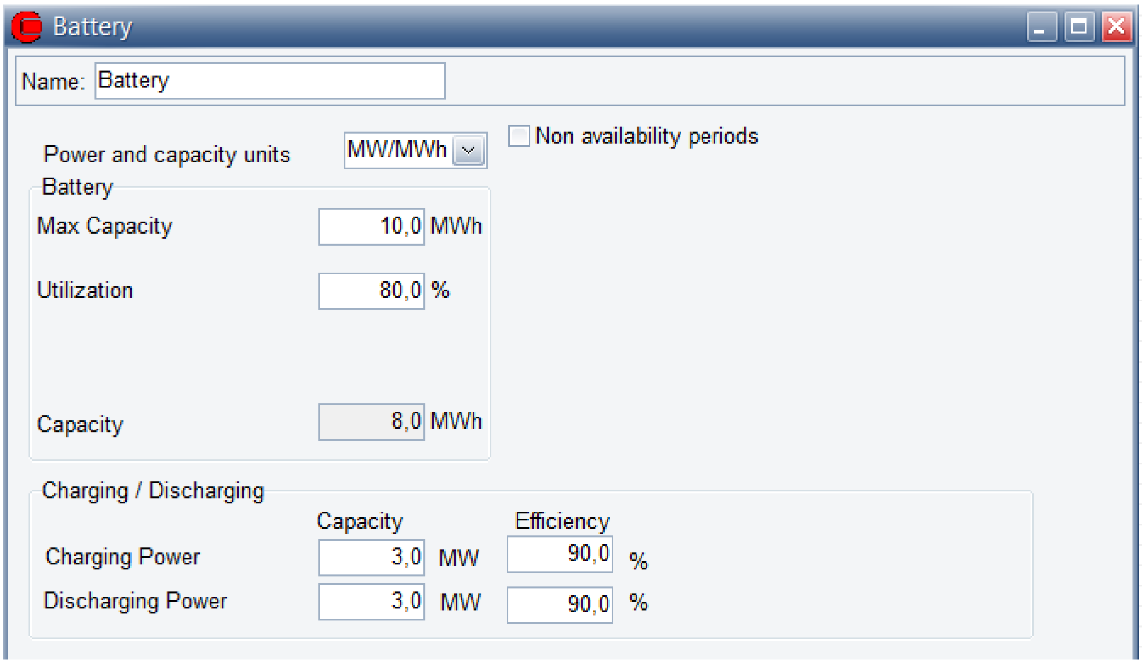

Figure 2. User interface for battery settings

Max Capacity multiplied with the Utilization sets the usable capacity of the batteries.

Unlike thermal stores the charging and discharging capacity of Batteries is not modeled unlimited. You have to set charging and discharging power together with an efficiency factor.

2.1 Operation strategy

Typically, batteries will be used in island systems, where there is no or limited connection with the surrounding grid, or it will be used in spot markets where it can charge when the price is low and discharge at high spot prices.

In Island operation the electricity producing units will start by covering the electricity demand. Then if they still have surplus capacity in a given period, they will charge the battery. The battery will be discharged in periods where the electricity demand exceeds the production.

In a spot market situation the battery will discharge and sell electricity when the spot price is high. It needs to charge the battery first by buying electricity when the spot price is low.

The price for buying depends on the efficiency of the charging and any costs connected to buying and selling electricity.

The Island operation can be added under “Operation Strategy” but only if an electricity demand exists.

2.2 Reports

On Figure 3 is an example of the report “Production, graphic” in a case where a battery operates on the spot market.

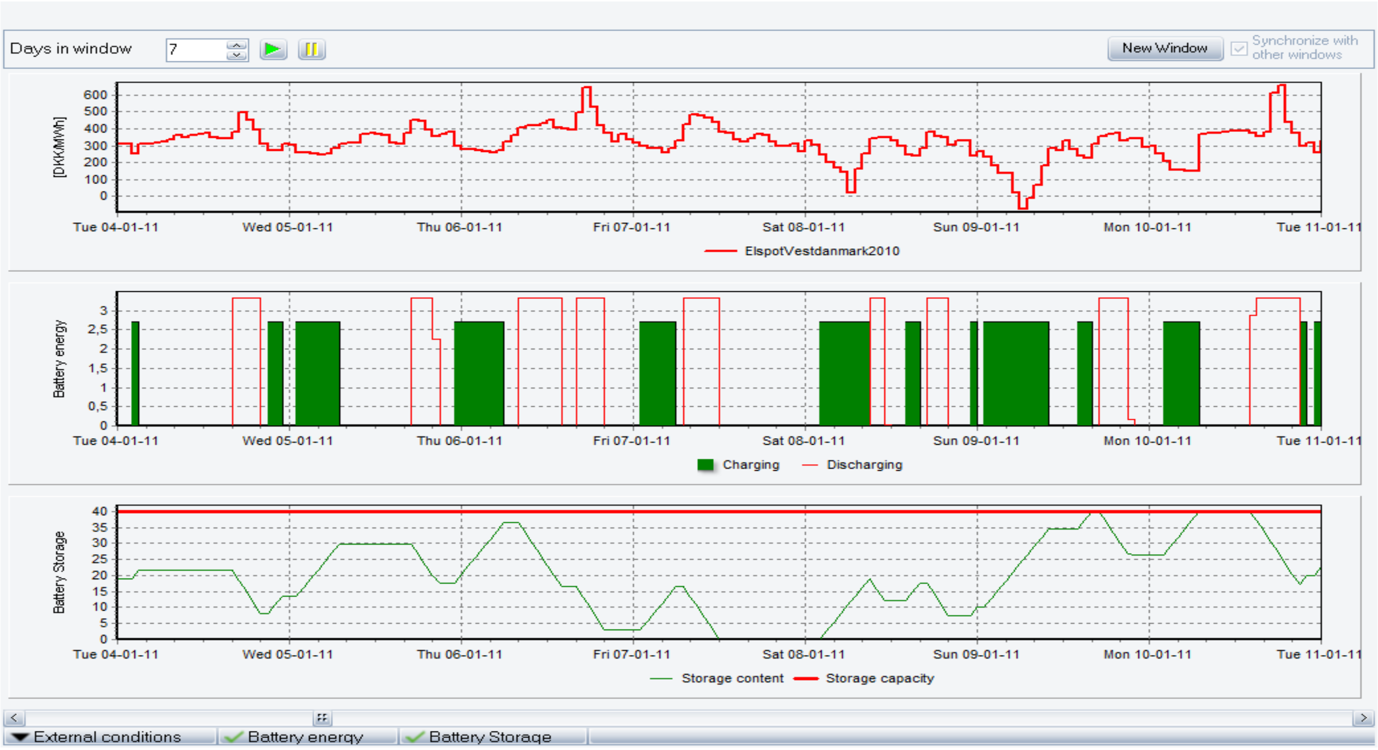

Figure 3. Graphic illustration of a battery operating on the electricity market

The battery appears as follows on Figure 4 in Energy conversion, annual.

Electric storage:	
Battery	
Charging	6.554,1 MWh-elec.
Discharging	-5.308,8 MWh-elec.
Change in storage content	0,0 MWh (As potential elec. output)
Losses	-1.186,3 MWh-elec.

Figure 4. The annual energy conversion of a battery

Likewise, the Operation Income report can be seen on Figure 5.

(Allamounts in)								
Revenues								
Sale on spot	:					=	2.298.944	
Total Revenues								2.298.944
Operating Expenditures								
Buy on spot	:					=	1.704.021	
trading cost, selling electricity	:	5.308,8	MWh	at	8,0	=	42.470	
trading cost, buyingelectricity	:	6.554,1	MWh	at	8,0	=	52.433	
O&M discharging	:	5.308,8	MWh	at	5,0	=	26.544	
O&M charging	:	6.554,1	MWh	at	5,0	=	32.770	
Total Operating Expenditures								1.858.239
Operation Income								440.706

Figure 5. A report showing the operation income of a battery

3. E-cars

Like batteries, an E-car is defined as a store in energyPRO and added the same way as shown on Figure 6.

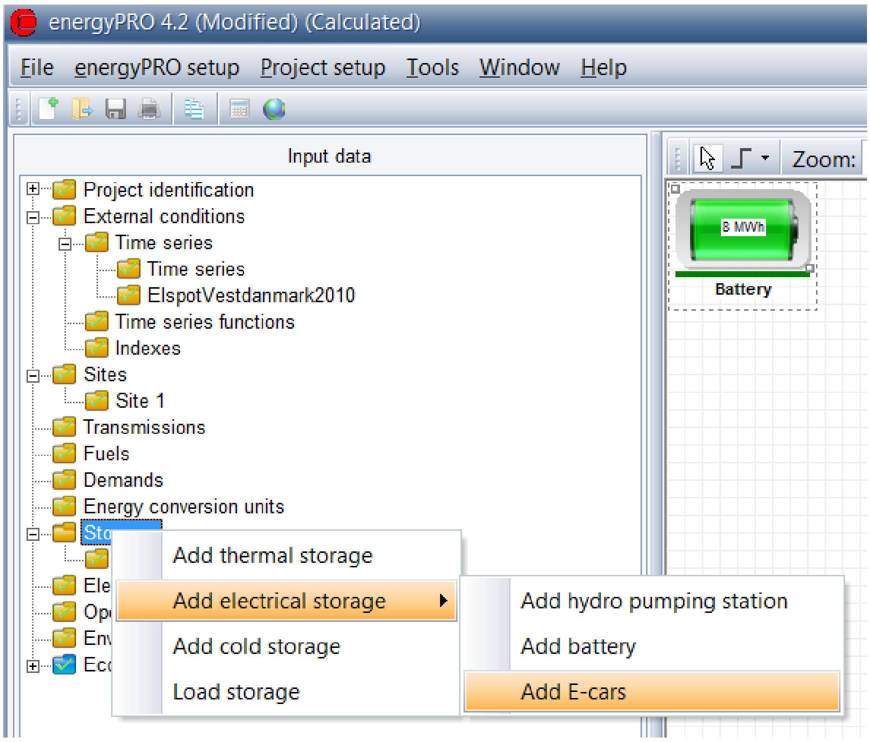

Figure 6. How to add an E-car in energyPRO

The user interface consists of two tabs with the first tab "Storage and charging" shown on Figure 7.

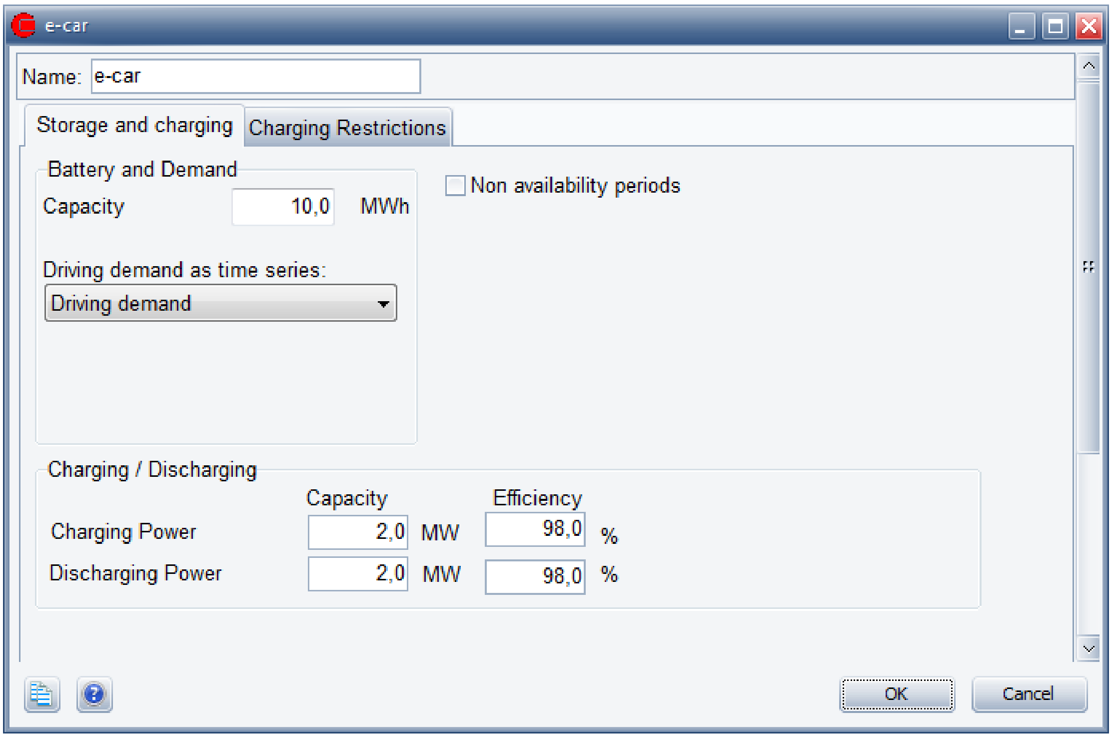

Figure 7. Storage and charging settings of an E-car

You add the driving demand as a time series and select the time series in the E-car interface.

It is possible to define that the E-cars batteries are available for discharging. This means that if we have high spot prices and the batteries are charged you can sell on the electricity market. If you don't want that option, set the Discharging power to zero.

In the second tab, Charging Restrictions, you can select between three different restrictions on availability for charging and discharging as shown on Figure 8.

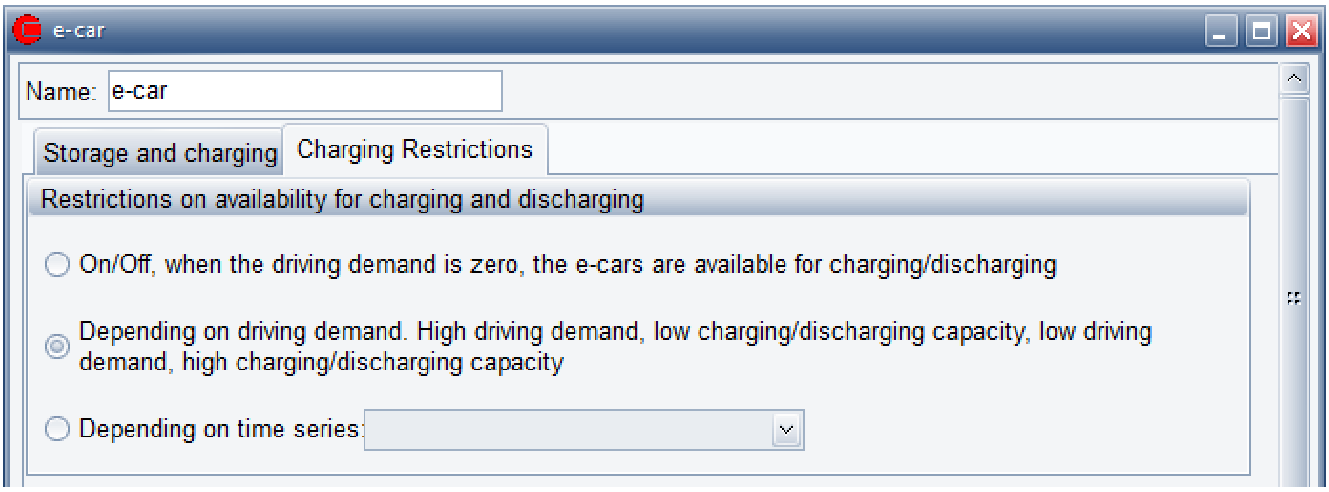

Figure 8. Charge restrictions settings of an E-car

If your E-car unit represents a single car you select the On/Off option. Are you simulating a number of cars, the availability is not on/off but varies depending on driving demand.

3.1 Operation strategy

First of all, the operation strategy shall insure that the driving demand is covered. Next, if discharging is enabled the operation strategy for charging and discharging is similar to the operation strategy for batteries.

3.2 Reports

The "Production, graphic" shows how the E-car batteries are charged during the night and discharged by the driving demand during the day. In the weekend without driving demand the E-cars are used for buying and selling on the electricity market as shown on Figure 9.

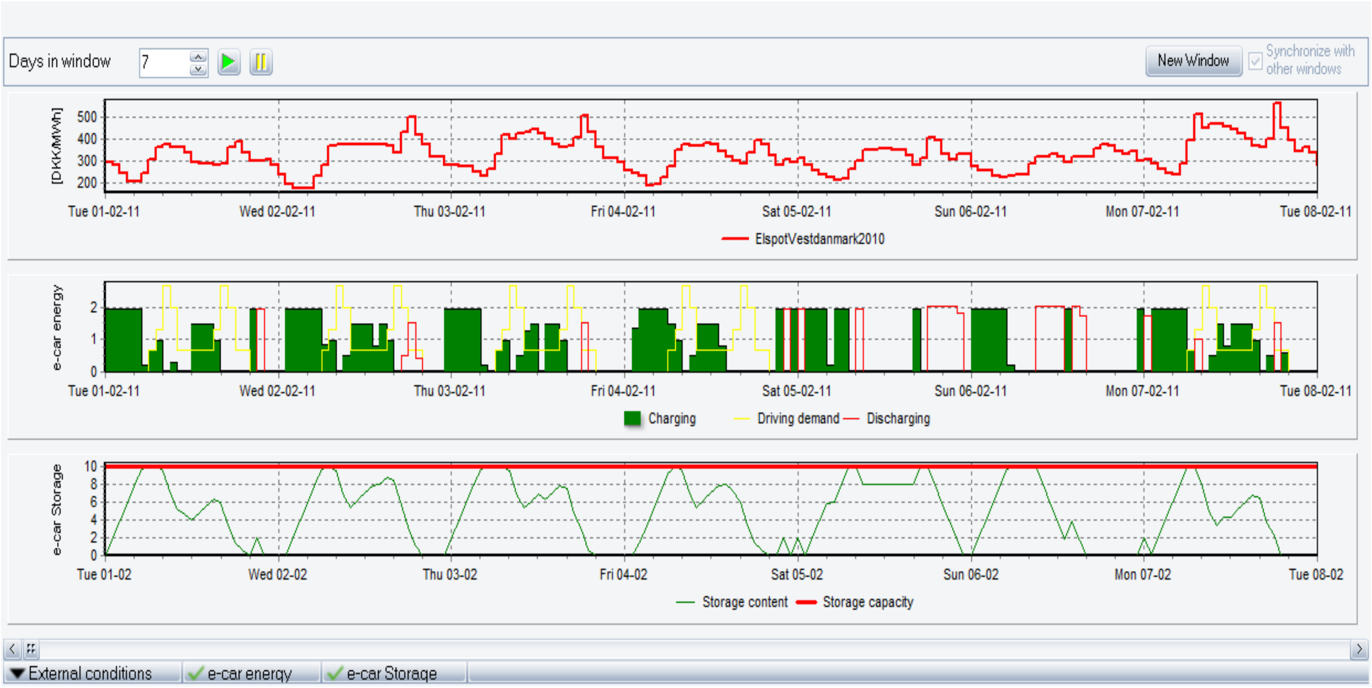

Figure 9. Graphic illustration of an E-car operating on the electricity market

The Energy conversion, annual report sums up the demand, charging, discharging and losses and can be seen on Figure 10.

Electric storage:

e-car	
Charging	127,3 MWh-elec.
Driving demand	-88,4 MWh (As needed elec. input)
Discharging	-37,3 MWh-elec.
Change in storage content	0,0 MWh (As needed elec. input)
Losses	-3,3 MWh-elec.

Figure 10. The annual energy conversion of an E-car

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