

# Solar system with electric vehicle charging capabilities

**Róbert, Istók**

Óbudai Egyetem, Kandó Kálmán Villamosmérnöki Kar,  
Villamosenergetikai Intézet,  
1034 Budapest, Bécsi út, Magyarország,  
istok.robert@kvk.uni-obuda.hu

---

*Abstract: Increasing of the electric cars number determine an increasing of electric vehicle charger number too. The number of chargers in Hungary in under 2500 pcs. At Óbuda University was build a solar system with electric vehicle charging capabilities. The system contains storage capabilities too. One of the biggest advantage of the system is that the used batteries are second hand electric vehicle batteries. The batteries are coming from a Nissan Leaf car. The components of the system are connected to the internet. This fact offer the possibility to have not only historical data access but real time information from the system.*

*Keywords: electric vehicle charger; solar panels; solar inverter; battery management system; Lithium Ion battery;*

---

## 1. Introduction

In 2020 the market share of electrical vehicles in Hungary was 4,7%, and electric car charging points per 100km of road was 0.6 [1]. In figure 1. should be seen the evolution of annual registration of plug-in and electric passenger cars in Europe [2]. This increasing of electrical cars number require an increasing of the chargers too. In figure 2 is presented the increasing number of electrical vehicle chargers in Hungary.

At Óbuda University was built an experimental solar system with energy storage and electrical vehicles charging capabilities. The capacity of the solar system is 7kW. This system offer the charging possibility for two cars in the same time. The maximum current of the chargers is 32A. The chargers offer the possibility to control the output power through the internet. This is an important feature in case if we want to charge the EV only with energy produced by solar system.



Figure 1 Annual registration of plug-in electric passenger cars in Europe[2]

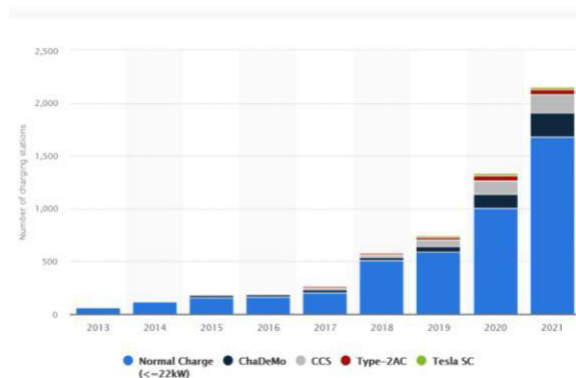


Figure 2 Increasing of number of electric vehicle charging stations in Hungary [3]

## 2. Solar electric vehicle charger system description

In figure 3 is presented the schematic draw of the solar system with electric vehicle chargers and storage capacities.

The system contains the next parts:

- solar panels
- solar inverter
- battery managements system BMS
- lithium ion batteries
- electric vehicle charger

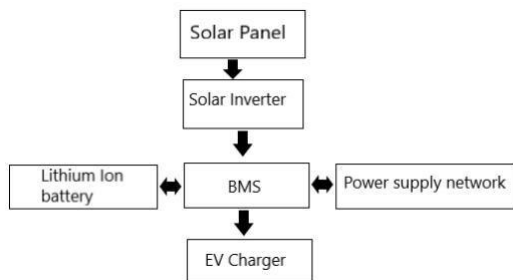


Figure 3 Schematic representation of solar EV chargers

## 2.1 Solar panels

For this project was used SoliTek glass-glass 320Wp solar panels. This type of solar panels are more advantages compare to glass-foil solar panels: it is damp proof , it has 30 years product and 87% efficiency warranty.

## 2.2 Solar inverter

The voltage conversion is done by Fronius Symo 8.2 kW solar inverter. The inverter is situated as close as possible to the solar panels to reduce the losses. The connection to the internet of the solar inverter give the possibility to have a real time overview on the solar energy production. In figure 4 should be seen the some online information from the solar inverter. It present the produced power and the momentary power of the system, and the daily energy production. There is a prediction of energy production for the next day too, and the daily weather.

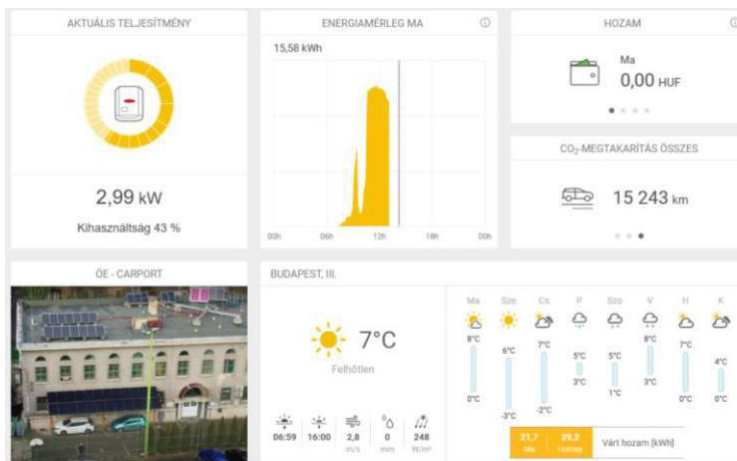


Figure 4 Online information from solar inverter

## 2.3 Battery management system BMS

The role of BMS is done by Victron Quattro Inverter & Charger, as the name suggests, this device is a combination of an inverter and a charger. The BMS interconnects the batteries, the solar system, the power supply grid and the electrical vehicle chargers too. This interconnection is presented in figure 5.

The figure 5 presents not only the interconnection of the BMS but the real time status and energy production/absorption of all system. In this case the solar system produces 2597W, the batteries absorb 75W, the chargers have a 57W consumption, and the rest of energy is sent to the power supply network. Because in this day there was not any electric vehicle connected to the chargers in the historical data the energy production and consumption is in balance, and the batteries capacity is on 100%.

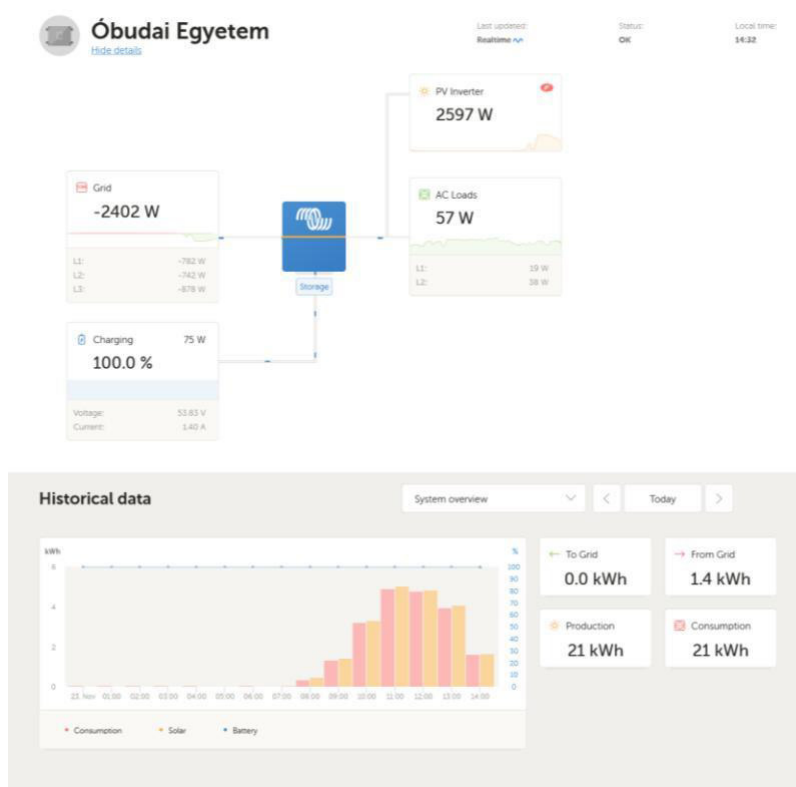


Figure 5 Interconnection and real time information of BMS

## 2.4 Lithium ion batteries

One of the biggest advantage of this system is that for charging capacities are used 2<sup>nd</sup> life Nissan Leaf batteries. The batteries are coming from a first generation Nissan Leaf. The capacity of the batteries were enough only for 100 km compare to 200km (on JC08 mode) [4]

## 2.5 Electric vehicle charger

For chargers were used Wallbox Copper SB Smart Chargers. The system contains two chargers, which are connected to the internet. in figure 6 and 7 are presented the energy supplied by the chargers.

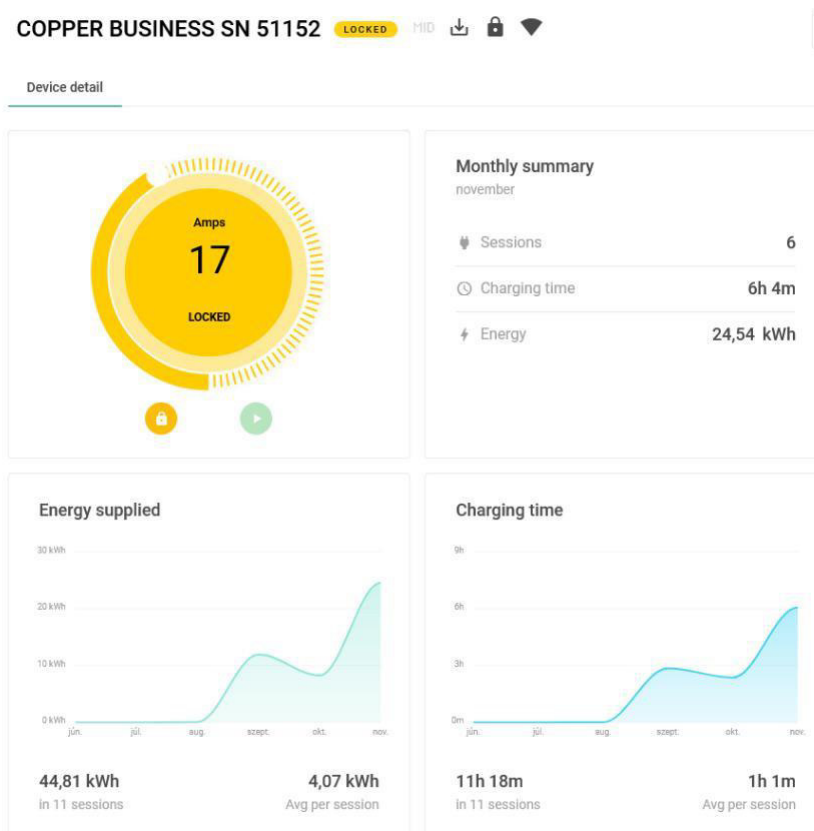


Figure 6 Energy supplied by the 51152 charger

The pictures give us information about the energy supplied by every charger and the charging time of its.

One of the most important feature of the system is that the output current of the chargers should be modified trough web page of the chargers. The maximum output current is 32A.

If the charging of the electric vehicle is done with maximum output power 7kW and the energy produced by solar system is lower than 7kW, then the rest of the power is take from the power system network. If the output power from chargers is reduced till level of the solar system production, then the electric vehicle is chargin only with green energy.

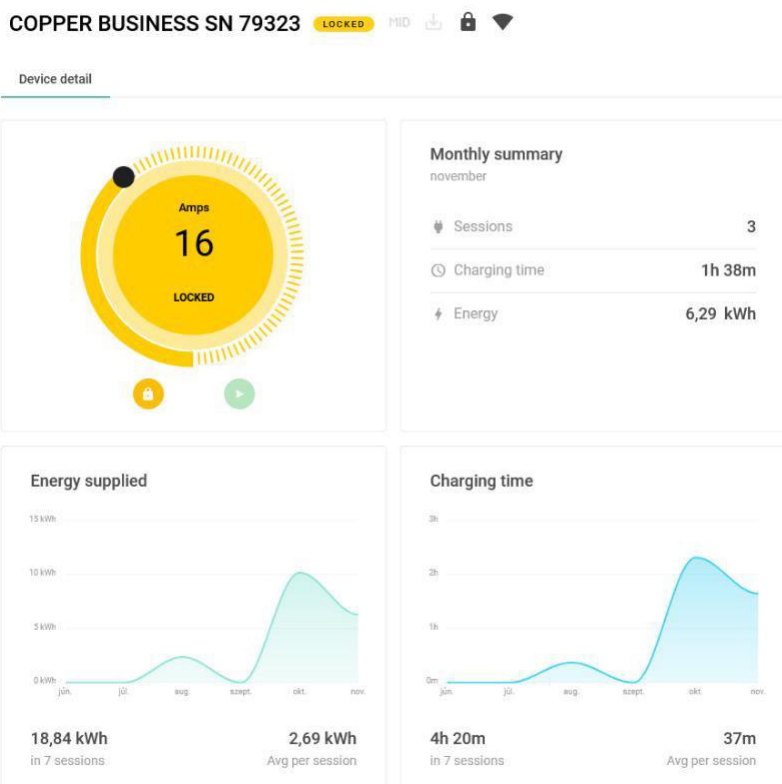


Figure 7 Energy supplied by the 79323 charger

In figure 8 is presented the total energy used for electric car charging. In total was used 63,65kWh for charging. In figure 9 is presented the total energy produced by solar system from middle on april. The system working from middle of appril. The total energy production of the system is 7,18MWh. In this year June was the moonth with the best energy production 1294kWh.



Figure 8 Total energy used for electric car charging

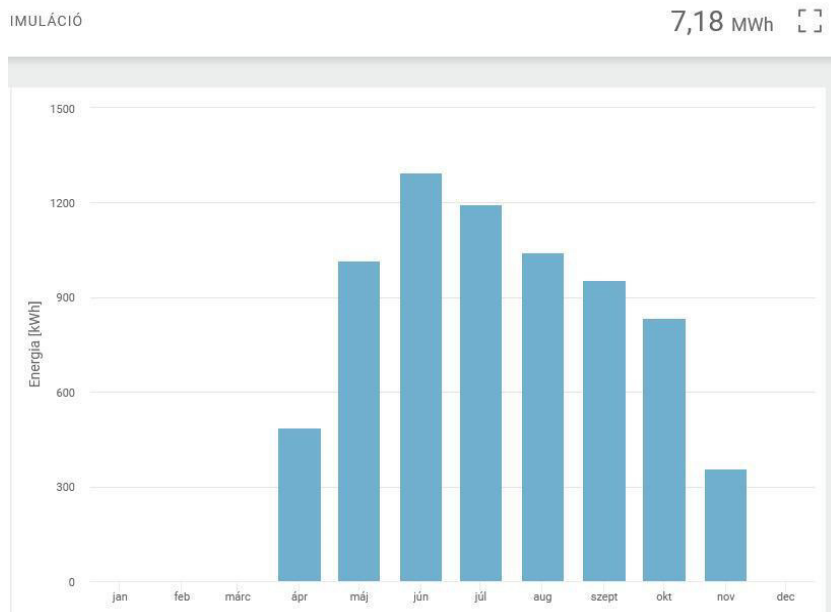


Figure 9 Total energy produced by solar system

## Conclusions

The solar system with electric vehicle chargers capabilities builded at Óbuda University contains four parts: solar panels with solar inverter, battery managements system, lithium ion battery, electric vehicle chargers. It is a fully green concept, not just because of the solar panels, or because it is charging electric vehicles, but most importantly, because it is giving a 2nd life to electric vehicle batteries of which very soon we will have a huge amount, coming back from the automotive market and ready to be utilized for green energy storage [5], [6].

## Acknowledgement

This work was supported by European Institute of Innovation and Technology (EIT) Urban Mobility, Premium Napelem kft and Fronius Hungary Kft.

## References

- [1] [1] [https://en.wikipedia.org/wiki/Plug-in\\_electric\\_vehicles\\_in\\_Europe#/media/File:Annual\\_PEV\\_registrations\\_Europe\\_from\\_2011\\_2019.png](https://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Europe#/media/File:Annual_PEV_registrations_Europe_from_2011_2019.png)
- [2] [https://en.wikipedia.org/wiki/Plug-in\\_electric\\_vehicles\\_in\\_Europe#/media/File:Annual\\_PEV\\_registrations\\_Europe\\_from\\_2011\\_2019.png](https://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Europe#/media/File:Annual_PEV_registrations_Europe_from_2011_2019.png)
- [3] <https://www.statista.com/statistics/933078/number-of-electric-vehicle-charging-stations-in-hungary/>
- [4] <https://global.nissannews.com/en/releases/101203-01-e>
- [5] D. Benedetti, J. Agnelli, A. Gagliardi, P. Dini and S. Saponara, "*Design of an Off-Grid Photovoltaic Carport for a Full Electric Vehicle Recharging*," 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), 2020, pp. 1-6, doi: 10.1109/EEEIC/ICPSEurope49358.2020.9160655.
- [6] Péter Kádár, Róbert Istók, Levente Reizer "*Solar Carport*" 19th International Conference on Renewable Energies and Power Quality (ICREPQ'21), Almeria Spain July 2021 ISSN 2172-038, Volume No. 19, September 2021