*ORIGINAL PAPER*

# TECHNICAL AND ECONOMIC ANALYSIS OF COMMERCIAL PROSUMER 30 kW + CHARGING STATION FOR PLUG-IN ELECTRIC/HYBRID CARS 44 kW. CASE STUDY: ROMANIA

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***Abstract.*** *The support of prosumers in the countries of the European Union has registered significant growth, especially regarding the energy produced from photovoltaic panels in households or in commercial spaces after 2020. Romania will promote the distributed generation from renewable sources with installed power between 3 kW and 100 kW, the on-grid installations being subsidized through the financial support of the Environmental Fund Administration (3 kW for residential prosumers) with „photovoltaic green house„ program and Ministry of Economy, Energy and Business Environment with the „Electric Up„ program (between 27 kW - 100 kW power with recharging stations of at least 22 kWp for electric and hybrid electric vehicles for commercial prosumers). This paper proposes an analysis of a commercial prosumer with a specific case study in north Dobrogea in Romania, comprise of a comparative analysis for an integrated 30 kW comercial user with 44 kW charghing station for electric and hybrid electric vehicles installed on the ground, in order to reduce the energy consumption with a management system for the optimal coordination of the energy to the owner's need, also to see the rentability of the system when it's a comercial user and the own consumption is higher during the day. The project applies to Romanian legislation and can be used for similar projects considering that in coming years these types of systems will appear.*

***Keywords:*** *prosumer; photovoltaic panels; charghing station; energy.*

## 1. INTRODUCTION

The prospect of depleting non-renewable primary energy resources (fossil fuels), the threat of climate change and environmental degradation, growth in the load demand, power shortage and interconnection of new load types such as plug-in hybrid electric vehicles (PHEVs) have had the effect of mobilizing the international community to mitigate the negative consequences of these effects and enforced the energy sector using Renewable Energy Sources, such as photovoltaic panels which particularly are one of the fast-growing types of Distributed Generations (DGs) being integrated into power systems in recent years [1].

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The prosumer is not a simple consumer of energy, but also an energy producer who is having the possibility to optimize the moment of consumption, respectively to inject energy frrom their own production in the network. In this way, the prosumer can contribute to the integration of intermittent renewable energy sources production in the National Energy System. The new updated renewable energy sources promotion directive proposes to guarantee the right of individual consumers and local communities to become prosumers and to be remunerated for the energy delivered in the network, as well as other mechanisms that facilitate this transition. For example, consumers will have the right to request from the supplier a smart meter and a contract with a dynamic price, which will allow them to adapt their consumption to the variation of the price of electricity.

The price trend for solar modules by month from October 2021 to October 2022 per category (the prices shown reflect the average offer prices for duty paid goods on the European spot market) is between 0.22 Eurp/Wp to 0.43 euro/Wp. Please note: from May 2022 the price index is based on a different classification. For continuity reasons, module prices for April 2022 were re-calculated, using the new classification system (Fig. 1).

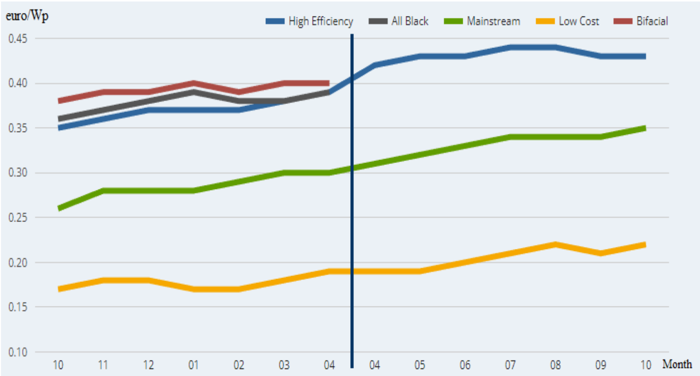



**Figure 1. Evolution of price for PV panels until octomber 2022 [2].**

Romania has also a 3.4 million individual homes potential, which may become prosumers which is 10.2 GW (3kW for each individual house). Romania will promote the prosumers through the two programs: photovoltaic greenhouse and Electric Up [3] and it will increase the power installed photovoltaic by a maximum of 500 MW by 2025. Thus, the photovoltaic capacity of Romania is expected to triple in the period 2021-2030, increasing from 1.4 GW in 2020 to 4.25 GW in 2030 which means that it will increase by more than 3 times from the current capacity. Also, the promotion of the charging station for electric and hybrid electric vehicles through the Electric up program will increase by at least 300 stations, for now in 2022 there are up to 1200 car charging stations in Romania. In 2030 are expected to be more than 18000 car charging stations.

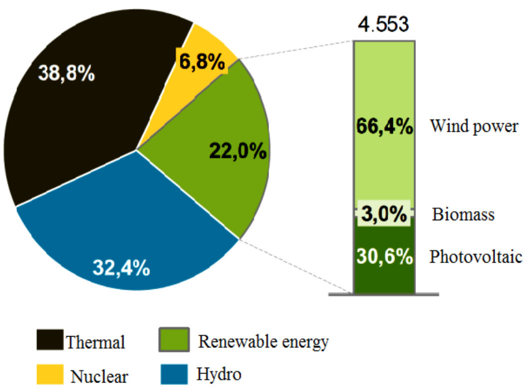



**Figure 2. RES-based generation in Romania (MW) at the end of 2018 [4].**

Solar Power plants reduce operation costs and provide added value to customers and utilities. The share of solar power plants capacities is increasing by roughly 40% annualy. According to ANRE (the national energy regulatory autorithy) [5] regulations prosumers who own electricity production units from renewable sources with an installed power of no more than 400 kW per point of consumption can sell the electricity produced and delivered to the electricity network to the electricity suppliers with whom they have signed electricity supply contracts.

At the request of prosumers who produce electricity in electricity production units with an installed power of up to 200 kW per point of consumption, the electricity suppliers with whom they have concluded contracts for the supply of electricity are obliged to make in the prosumers invoice a quantitative compensation between the electricity produced and delivered to the network and that consumed, in the situation where the amount of energy produced and delivered in the network is greater than the amount of electricity consumed, prosumers being able to use the amount of electricity reported for a maximum duration of 24 months from the date of invoicing.

At the request of prosumers who produce electricity in energy production units with an installed power of between 200 kW and 400 kW per place of consumption and with whom they have concluded electricity supply contracts, electricity suppliers are obliged to purchase the electricity produced and delivered at a price equal to the weighted average price recorded in the market for the next day in the month in which the respective energy was produced and to realize in the prosumers' invoice the financial adjustment between the electricity delivered and the electricity consumed from the network.

The quantitative compensation of prosumers with installations with a power of up to 200 kW per place of consumption will be granted until December 31, 2030, in the context of the measures and actions related to reaching the commitments regarding the share of energy from renewable sources in 2030 specified in the Plan National Energy and Climate Change, according to an ANRE methodology, and after this period the respective prosumers can sell the electricity produced under the conditions provided for prosumers with installed capacities between 200 kW and 400 kW, per place of consumption. The distribution operators ensure the acquisition, installation, sealing, verification, reading and, if necessary, the replacement of the electricity measurement groups produced, located in the users' installations, according to ANRE regulations.

The methodology supports final customers who have the quality of prosumers, in the sense that they have ensured the electricity produced for their own consumption, but also the sale of surplus electricity produced from renewable sources and delivered to the electricity network, under the conditions that, as a result of the production reduced by electricity and the slightly unpredictable nature that does not in all cases overlap with consumption and in the absence of a regulation in this sense, they would encounter difficulties in selling the amounts of electricity that exceed their own consumption.

For the time being, the capping of electricity prices in Romania must be taken into account until March 2023. The capping of electricity prices mean that no non-household customer who meets the conditions of GEO 27/2022 will pay a total price of electricity (taxes and VAT included) higher than 1 RON/kWh.

Starting with the consumption of April 2022, all non-domestic customers, with the exception of those who have benefited from the provisions of the Government's Emergency Ordinance no. 81/2019 for the amendment and completion of the Government Emergency Ordinance no. 115/2011 approved with modifications by Law no. 262/2021 will benefit from capping, so they will have the final invoiced price of electricity capped at no more than 1 RON/kWh, VAT included (30% less than normal price) [4] and this must be taken into account for the profitability calculation of the system. Also, the price for kWh until 2025 can be more than 4 lei/kWh so a price 4 time higher than now.

Generating electricity with photovoltaic solar panels is a viable solution in all regions of Romania both for independent photovoltaic systems and for the construction of photovoltaic plants connected to the national energy system [6]. Romania is privileged in terms of solar energy, the level of solar irradiance being higher than in Western European countries with a tradition in using these systems. The installation criteria of prosumer are influenced by different factors: technical, economic, environmental and socio-political.

## 2. MATERIALS AND METHODS

### *2.1 USER PRESENTATION*

Currently the type of electricity supply source at the place of consumption is the national energy system (SEN) with an approved power of 20 kWp and because of that an increase of power suply will be made up to 64 kWp. The energy of the consumers was measured through a year and thus a paradigm of consumption of the commercial user was made (Fig. 3).

**Summer (Jun-Aug)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 10.0 | 11000 |
| Air conditioning | 2 | 2000W/app | 16.5 | 66000 |
| Deep-freeze | 5 | | 23 | 25000 |
| Fridge | 2 | | 6 | 5500 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Total daily energy | | | | 161600Wh/day |

**Autumn (Sep-Nov)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 11.0 | 12100 |
| Deep-freeze | 5 | | 23 | 25000 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Total daily energy | | | | 91200Wh/day |

**Winter (Dec-Feb)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 11.0 | 12100 |
| Deep-freeze | 5 | | 23 | 25000 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Total daily energy | | | | 91200Wh/day |

**Spring (Mar-May)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 11.0 | 12100 |
| Deep-freeze | 5 | | 23 | 25000 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Total daily energy | | | | 91200Wh/day |

**Figure 3. Tables with daily consumers. Seasonal modulation (case 1).**

The user regisetered a consumption of 39300 kWh accumulated over a period of 12 months wich is on average 3275 kWh/month, the reference being for a year based on seasons (winter, spring, autumn, summer) (Fig. 3). To this consumption will be added the charging station for EV's, with a total installed power of 44 kWp with 2 conectors of 22 kWp, with a average use of 2.25 hours per day over a year, resulting in a predicted consumption for 12 month of 35640 kWh/year (Fig. 4). On average, this time was considered for charghing a car battery of an electric/hybrid car with a capacity up to 50 kWh, because most of the electric/hybrid cars in Romania have this capacity.

**Summer (Jun-Aug)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 10.0 | 11000 |
| Air conditioning | 2 | 2000W/app | 16.5 | 66000 |
| Deep-freeze | 5 | | 23 | 25000 |
| Fridge | 2 | | 6 | 5500 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Charghing station | 1 | 44000W tot | 2.5 | 110000 |
| Total daily energy | | | | 271600Wh/day |

**Autumn (Sep-Nov)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 11.0 | 12100 |
| Deep-freeze | 5 | | 23 | 25000 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Charghing station | 1 | 44000W tot | 2.0 | 88000 |
| Total daily energy | | | | 179200Wh/day |
| | | | | |

**Winter (Dec-Feb)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 11.0 | 12100 |
| Deep-freeze | 5 | | 23 | 25000 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Charghing station | 1 | 44000W tot | 2.0 | 88000 |
| Total daily energy | | | | 179200Wh/day |
| | | | | |

**Spring (Mar-May)**

| | Number | Power | Use | Energy |
|---|---|---|---|---|
| | | W | Hour/day | Wh/day |
| Lamps (LED or fluo) | 15 | 30W/lamp | 18.0 | 8100 |
| PC's + others | 1 | 1100W/app | 11.0 | 12100 |
| Deep-freeze | 5 | | 23 | 25000 |
| Refrigerated display cases | 4 | 500W tot | 23.0 | 46000 |
| Charghing station | 1 | 44000W tot | 2.5 | 110000 |
| Total daily energy | | | | 201200Wh/day |
| | | | | |

**Figure 4. Tables with daily consumers. Seasonal modulation (case 2).**

Based on the existing consumption of the user, but also of the predicted consumer, the annual consumption curve was created wich suggestively illustrates the dispesion of the consumption trend over the 12 months of the year, with a total existing annual consumption of almost 75500 kWh (Fig. 5).

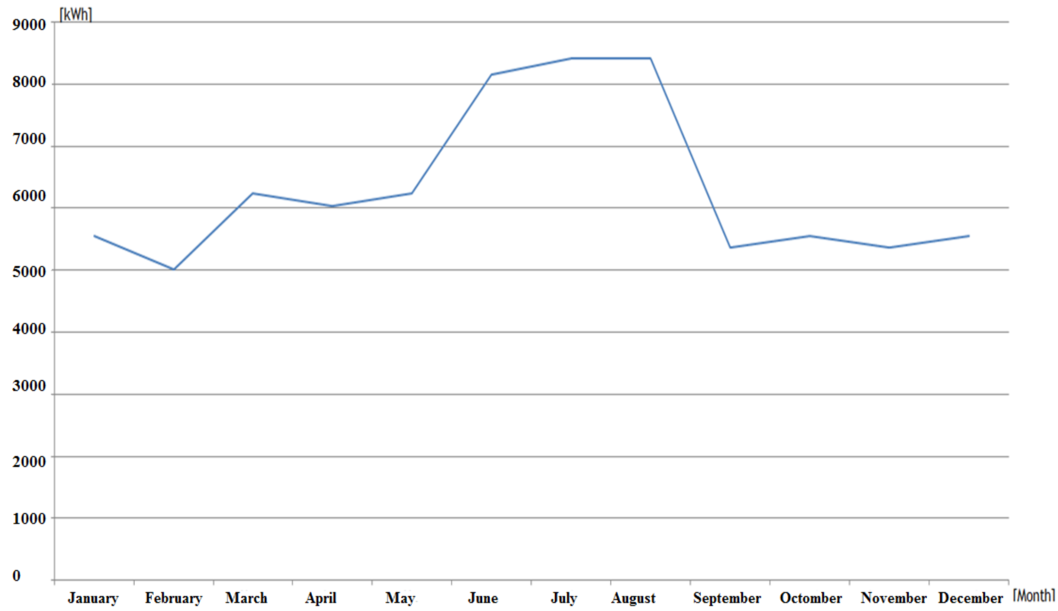



**Figure 5. Predicted energy consumption curve per year.**

To obtain the user's average electricity consumption over the period of one day, the existing annual consumption of 39300 kWh will be dived by the number of days with activity, which is 109 kWh per day, to wich is added the predicted daily consumption of the power station car charging to be installed at the project implementation location, resulting an expected daily consumption of almost 207 kWh. Based on the montly/season consumption of the user but also of the predicted consumer, the daily consumption per hour was created wich suggestively illustrates the dispersion of the consumption trend over the 24 hours of a day (Figs. 6 and 7).

The user has the following consumers as we previous specified in this paper with fallowing installed powers and operating times (Figure 3) depending on the month and season.

These are distribuited according to the user's needs. During the hot season (June, July, August) the air conditioners and the fridges are in operation, wich means that the energy consumption is higher (Fig. 3). On average, according to the calculations, the electricity consumption during the the user's schedule between 7-21 a.m. is 15% to 55% higher than the rest of the day (Fig. 6). To this consumption will be added as we previous specified in this paper (Fig. 4) the charging station, with a simulation of charghing the electric cars between 12-15 p.m. (Fig. 7) when the solar iradiation is at its highest. With the charghing station added, the consumption increased more than 5 times between 12-15 p.m. (Fig. 7).

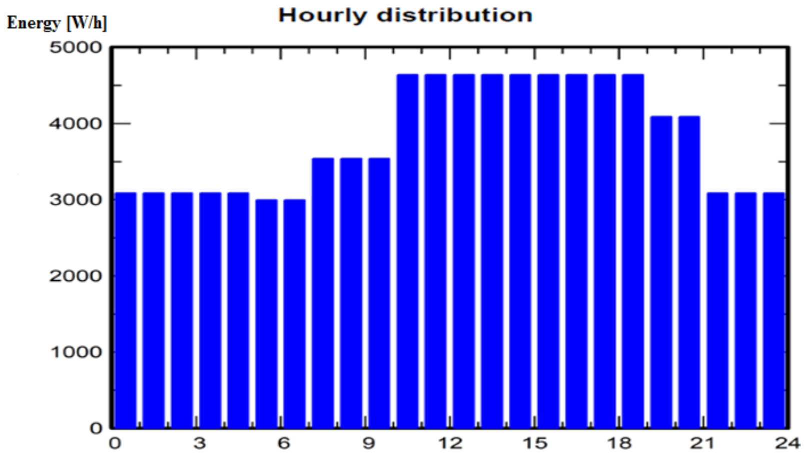



**Figure 6. Energy consumed hourly per day (with charghing station for EV's).**

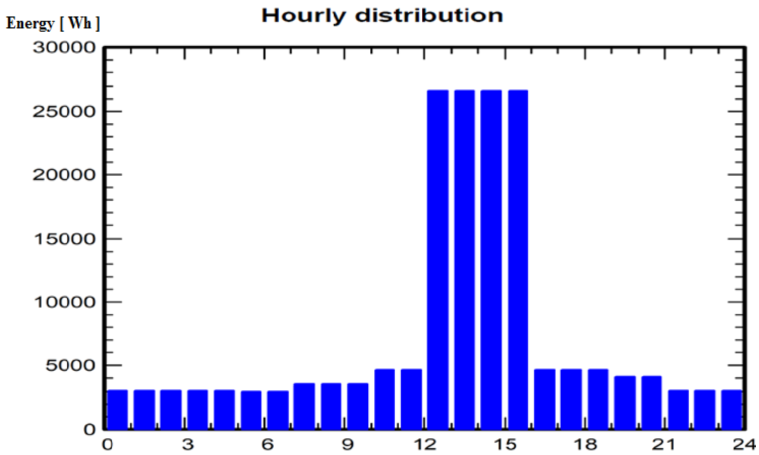



**Figure 7. Energy consumed hourly per day (with charghing station for EV's).**

*2.2. PHOTOVOLTAIC SYSTEM ANALYSIS*

The implementation address is in an area which is one of the best solar irradiation areas in Romania, in north region of Dobrogea in Tulcea county wich is over 1400 kWh/m$^2$. The implementation location of this project is located in an urban area, the installation being carried out on a plot of land without shades near the consumer at 50 meter away from the commercial consumer’s BMPT (three-phase protection measuring block). In this region are less than 20 electric/hybrid car charghing stations.

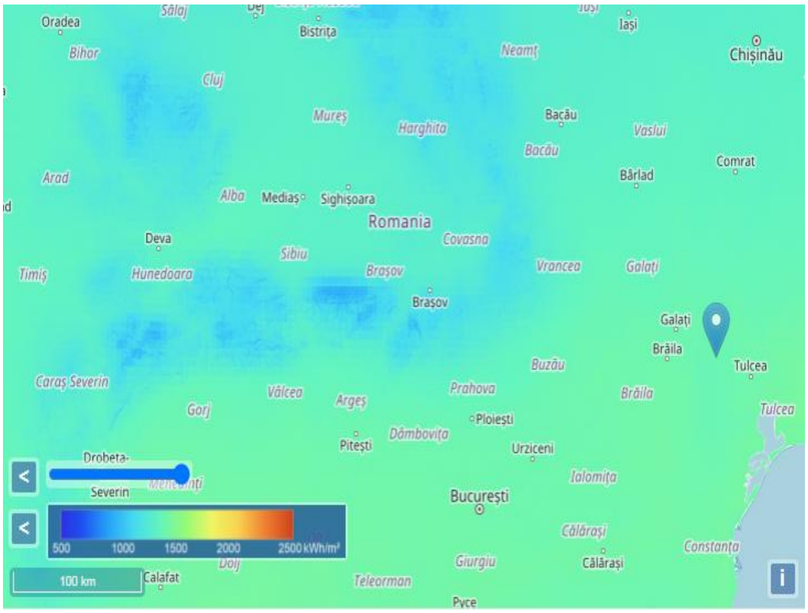



**Figure 8. Sollar irradiation and location of the commercial user [7].**

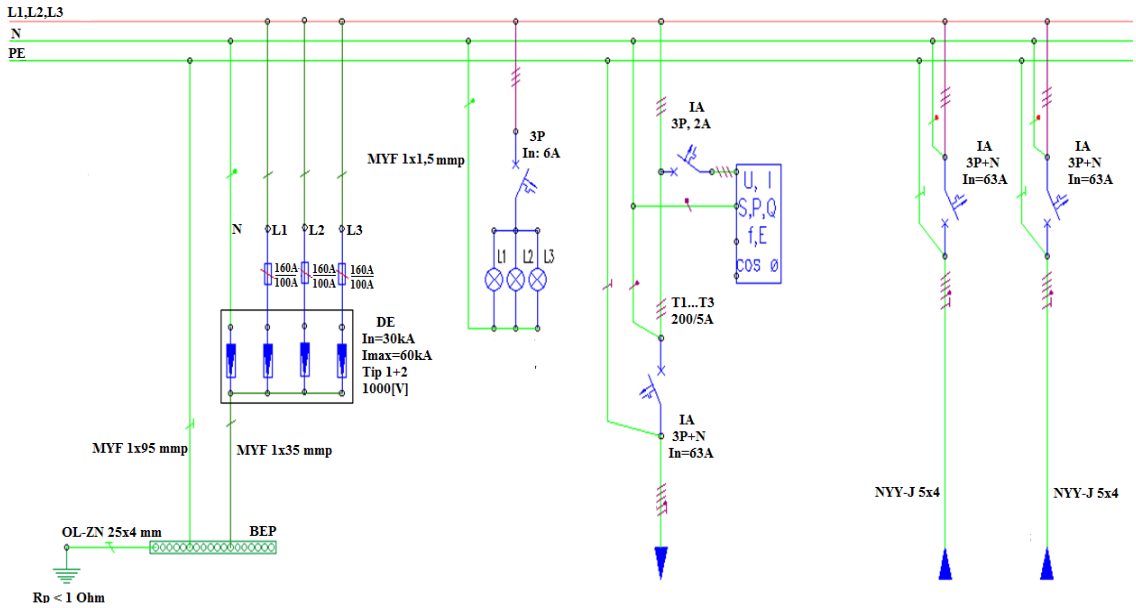



**Figure 9. Monofiler scheme of photovoltaic installation 30 kWp: IA - circuit breaker; DE- surge arrester; K- coil contactor; NYY-J - power cable; L - phase conductor; N - neutral conductor.**

The operating priciple of the proposed system is as follows: if the solar electricity produced is greater than that taken by the consumers, the system allocates the full required amount of energy consumed from the photovoltaic network, the surplus energy inserted into the national energy system with a quatitive compensation. If the consumption increases over the solar production (cloudy days, mornings, evenings, winter, etc.), in addition to the available solar enegy, the system takes the necessary electricity from the national grid, so that it has the requested solar energy. For the system it was dimensioned the inverter, the minumum and maximum number of modules that can be inserted, the number of strings, cables (nominal voltage, minimization of cable losses according to the chosen section, fuses for strings, etc).

The system has a power of 30kWp so the inverter can output a minumum of 27kWp with 44kWp car charghing station with 2 conectors of 22 each. It has three-phase connection for a line current value of 2 x 32 A. There are 80 premium monocrystaline quality halfcut photovoltaic panels of 370Wp (AXI premium HC) [8] each, with 4 rows of 20 photovoltaic module inserted. Each string of 20 photovoltaic panels has a $U_{mpp}$ = 623V and $I_{mpp}$ = 43 A. The operating voltage of the inverter is between 200V-800V. The module had almost an area of 150 $m^2$.

**Table 1. The electrical characteristics of the inverters.**

| Description | TE-INV | Inverter 1 | Inverter 2 |
|---|---|---|---|
| Circuit | TEG | INV | INV |
| Power $S_i$ [kW] | 30 | 15 | 15 |
| Power $S_a$ [kW] | 27.3 | 13.7 | 13.7 |
| Voltage [V] | 400 | 400 | 400 |
| Intesity [A] | 51.1 | 26.8 | 26.8 |
| Protection [A] | 63 | 32 | 32 |
| Section [$mm^2$] | 5x10 | 5x4 | 5x4 |

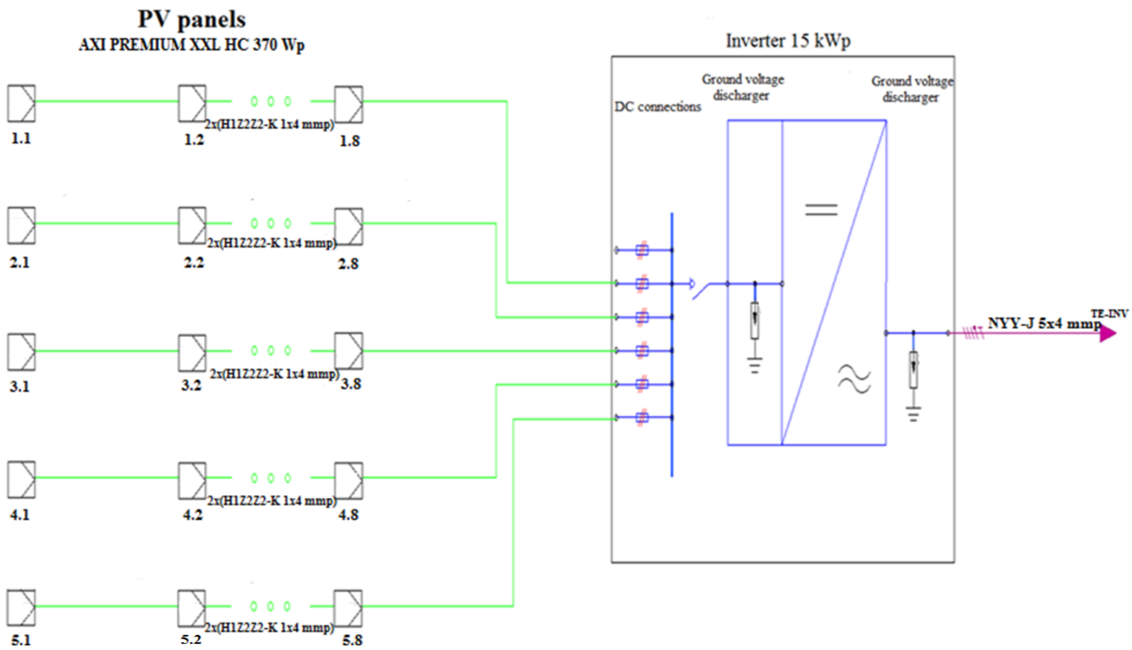



**Figure 10. Principle Diagram of photovoltaic installation 30 kWp (string of photovoltaic panels).**

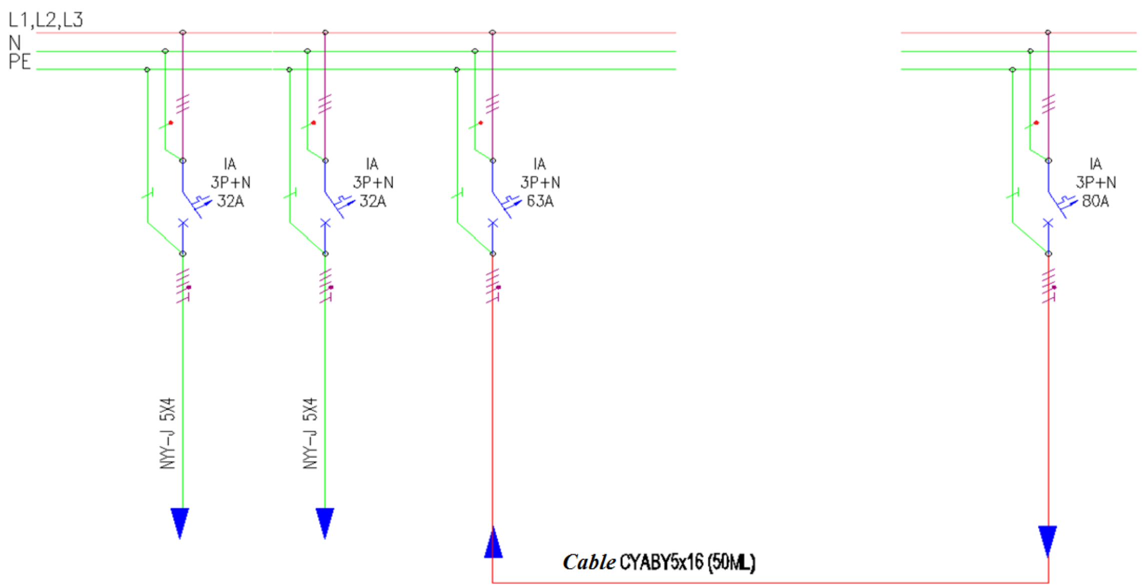



**Figure 11. Diagram of the charging station (2x22 kWp).**

**Table 2. Electric parameters of the charghing station.**

| Circuit number | EV-Socket | EV-Socket | Entry T-SE |
|---|---|---|---|
| Description: | Socket 1-22 KW | Socket 2-22 KW | 44 kW |
| Circuit: | P1 | P2 | Entry |
| Power Pi [kW] | 22.0 | 22.0 | 44.0 |
| Power Pa [kW] | 21.8 | 21.8 | 40.7 |
| Electrci Voltage [V] | 400 | 400 | 400 |
| Electric Intensity [A] | 30.2 | 30.2 | 61.2 |
| Protection [A] | 32 | 32 | 63 |
| Section [mmp] | 5x4 | 5x4 | 5 x 16 |

The photovoltaic panels will be fixed on a metal structure, designed for photovoltaic power plants at 30 degres. The placement of the photovoltaic panel field will take into account the geometry/inclination of the land and will be supported by a structure made up of constructive elements capable of ensuring the stability of the whole assembly and taking the loads resulting from its own weight and the panels, as well as those resulting from the action wind and snowfall. Placing the panels on the structure and fixing them will be done with special clamps (intermediate and end) provided by the manufacturer. The electrical connections are three-phase and single-phase, according to the attached electrical diagram. They are made with WAGO type strips at the entrance/exit of the photovoltaic panel. The electrical cables on the alternating current section are of the MCCG type and for direct current they are dedicated. The mode of communication it is of TCP-IP and MODBUS type, having the ability to centralize data in encrypted or non-modifiable format on the platform of their producer and in the buffer memory. The online platform of the photovoltaic equipment manufacturer has the option of configuring periodic reports (daily, weekly, monthly) from which total production, total consumption, data on the use of the energy storage component and other relevant information can be analyzed based on which the financing yield can be analyzed during the monitoring period.

## 3. RESULTS AND DISCUSSION

Two simulations of the photovoltaic system were made [9], one of them A) without the car charging station and one of them B) with the car charging station, for a better centralization of the results. Also, the panels were measured in the laboratory using the Pasan Highlight solar simulator which is designed to test, evaluate and determine the operating parameters of photovoltaic modules. They were measured to certify the data given by the manufacturer. The value of a panel was 360 Wp, so a minimum of 3% loss of the nominal power of 370 Wp.

The equipment is tester module type composed of:

- Flash generator, which is the power supply of the light source;
- Flash lamp separated by two tubes, generating a calibrated light pulse;
- Electronic load, which scans the tested device (DUT) response to the UI curve during the light pulse;
- Control and monitoring cells that allow to control and measure the effective light of irradiation;
- A temperature measurement, which is included in the monitor cell, but which can also be independent (as an option);
- Computing unit with Pasan software for calculating and storing measured data.

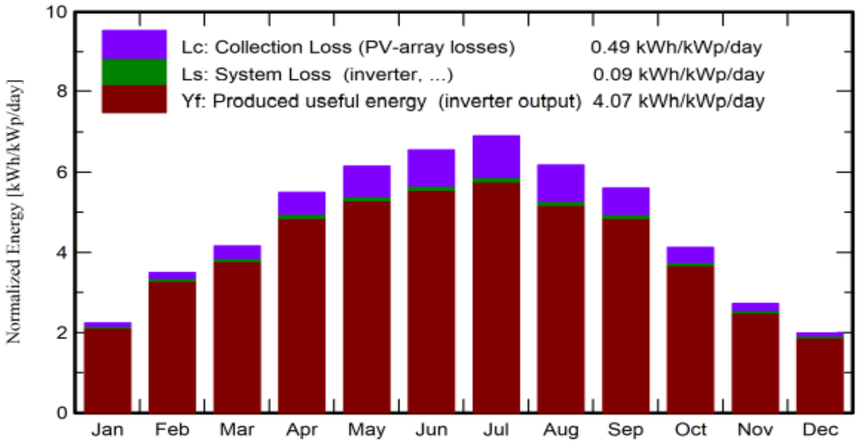
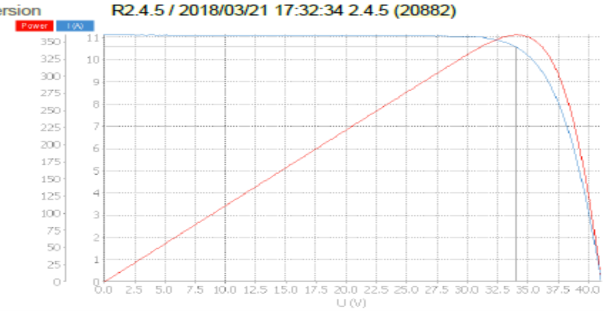



**Figure 12. Production of energy per month with system losses (over a year).**

PASAN MEASUREMENT SYSTEMS

Performance measurement
PASAN Tester

| | |
|---|---|
| Operator | Serban Tiberiu |
| PASAN Tester version | R2.4.5 / 2018/03/21 17:32:34 2.4.5 (20882) |




**AXI premium XL HC 370Wp**

| | | | |
|---|---|---|---|
| Manufacturer | AXITEC | Type | Monocrystal line |
| Serial number | | Configuration DUT | Module |
| Single cell area | 135.17 cm² | DUT area | 18216.90 cm² |
| Cells in series | 60 | Cells in parallel | 2 |

| Cell mono+th | | Irradiance Channel 1 |
|---|---|---|
| Serial number | 123 | |
| Sensitivity | 129.180 mV/(kW/m²) | |

| Direct | | | Irradiance Channel 1 |
|---|---|---|---|
| Monitor cell temperature | 19.38 °C | Fill factor | 78.90 % |
| DUT temperature | 24.18 °C | Cell efficiency | 22.20 % |
| Compensated | 25.00 °C | DUT efficiency | 19.77 % |
| Gavg | 1002.37 W/m² | | |
| GstdDev | 0.32 W/m² | | |
| Compensated Irradiance | 1000.00 W/m² | | |
| Voc (linear regr.) | 41.059 V | | |
| Isc (linear regr.) | 11.118 A | | |
| Regression linear for | 0.314 Ω | | |
| Rsh (linear regr.) | 405.125 Ω | | |
| Maximum power | 360.158 W | | |
| Voltage at Maximum | 34.040 V | | |
| Current at Maximum | 10.580 A | | |

**Figure 13. Measurement of the photovoltaic panels (370Wp) with PASAN [10].**


**Figure 14. Flash generator.**

**Functional Parameters:**

- Generator module: includes power source (capacitors) and control electronics for the light pulse emitted by the flash box. Maximum voltage: 800V, cycle: 30s.
- Flash box: emits light pulse due to xenon lamps. It is connected to the generator module by a high voltage cable

**Figure 15. System's Generator Module**

**Figure 16. Flash box**

*A) Without the car charghig station for EV's*

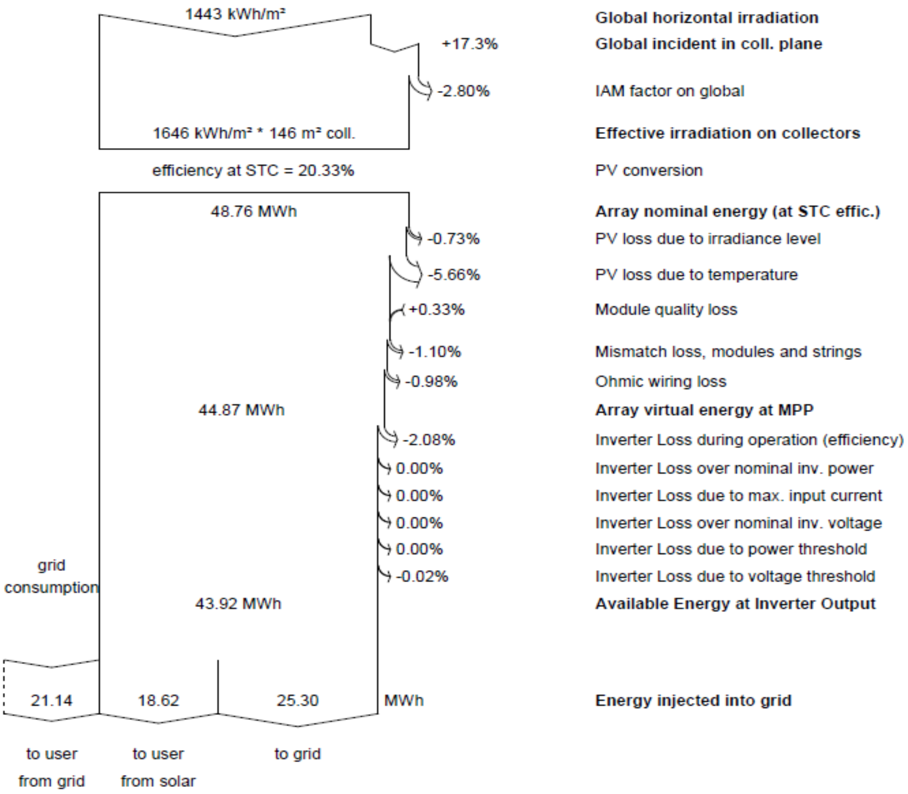



**Figure 17. Diagram of losses for the entire year (without the car charghig station)**

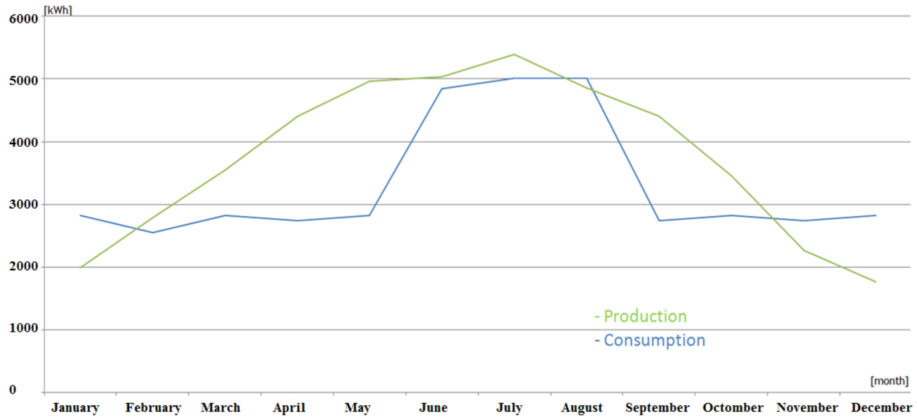



**Figure 18. Production curve vs. consumption curve without the car charghing station.**

Following the simulation of the classic on-grid photovoltaic system of 30 kWp, for the entire year, 48760 kWh is produced, wich is a hight energy production for this power of which 4840 kWh are lost (Fig. 17) and an energy of 43920 kWh remains "net", of which: 18620 kWh is used by the user, resulting a contribution of 42.39% of photovoltaic energy; 25300 kWh is sold in the electricity grid; the remaining 21140 kWh is extracted from the grid.

Considering that the current price at ENEL Dobrogea is for now 1 RON/kWh or 0.2 EURO/kWh (with the ceiling on the price of electricity until March 2023) results an average monthly for the electricity bill invoiced value of:

$$1\ \text{RON/kWh} \cdot 3275\ \text{kWh} = 3275\ \text{RON} \quad \text{or } 39300\ \text{RON/year} \tag{1}$$

Doing the calculations after the simulation we have the following financial contribution: the annual reduction of 18620 kWh to the energy consumed from the electricity grid being produced by the photovoltaic system. The value of this saving is:

$$1\ \text{RON/kWh} \cdot 18620\ \text{kWh} = 18620\ \text{RON} \tag{2}$$

In the event that the amount of energy produced and delivered to the electricity grid is greater than the amount of electricity consumed, prosumers being able to use the amount of electricity carried forward for a maximum period of 24 months from the date of invoicing. The non-use by the prosumer of the quatity of electricity carried over within a maximum period of 24 months from the date of its delivery to the electricity network from the one provided in the invoice leads to the inclusion of the value of its electricity that remained unreturned in the financial compensation process but in reality only 1/3 of the energy that goes to the electircity grid from the photovoltaic system is return back to the user because only the active energy is purchased without taxes sucs as: transport and distribution tax, energy excise, system services, cogeneration tax, green certificate tax plus other components provided in the supply contact on a case-bycase basis, so only 1/3 from 1 RON/kWh is calculated. For the electricity delivered in the electircity grid will be calculate with 0.33 RON/kWh. The value of this ratio is:

$$0.33\ \text{RON/kWh} \cdot 25300\ \text{kWh} = 8349\ \text{RON} \tag{3}$$

From the total value saved per year will be (2) (3):

$$18620\ \text{RON} + 8349\ \text{RON} = 26969\ \text{RON} \tag{4}$$

Of the 21140 kWh taken from the electricity grid, the following will be paid:

$$1\ \text{RON/kWh} \cdot 21140\ \text{kWh} = 21140\ \text{RON} \quad (5)$$

From the calculations (4) (5) it results that per year the beneficiary has a surplus of enegy and calculated in money if the energy is not be used, will be:

$$26969\ \text{RON} – 21140\ \text{RON} = 5829\ \text{RON} \quad (6)$$

Following the simulation of the classic on-grid photovoltaic system of 30 kWp, for the entire year, 48760 kWh is produced, wich is a hight energy production for this power of which 4840 kWh are lost (Fig. 19) and an energy of 43920 kWh remains "net", of which: 34520 kWh is used by the user, resulting a contribution of 42.39% of photovoltaic energy; 9410 kWh is sold in the electricity grid; the remaining 41410 kWh is extracted from the grid.

*B) With the charghig station for EV's*

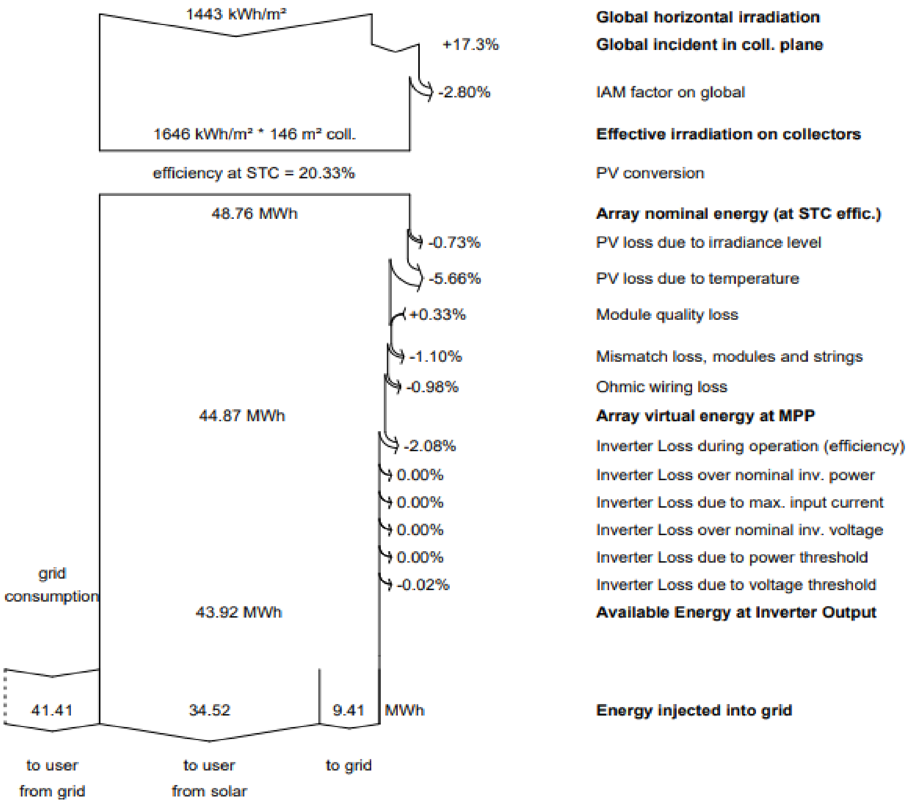



**Figure 19. Diagram of losses for the entire year (with the car charghig station).**

Considering that the current price at ENEL Dobrogea is for now 1 RON/kWh (with the ceiling on the price of electricity until March 2023) results an average monthly for the electricity bill invoiced value of:

$$1\ \text{RON/kWh} \cdot 3275\ \text{Wh} = 3275\ \text{RON or } 39300\ \text{RON/kWh (per year)} \quad (7)$$

Doing the calculations after the simulation we have the following financial contribution: the annual reduction of 34520 kWh to the energy consumed from the electricity grid being produced by the photovoltaic system. The value of this saving is:

$$34520\ \text{kWh} \cdot 1\ \text{RON} = 34520\ \text{RON/kWh (per year)} \quad (8)$$

In the event that the amount of energy produced and delivered to the electircity grid is greater than the amount of electricity consumed, prosumers being able to use the amount of electricity carried forward for a maximum period of 24 months from the date of invoicing, but in reality with all the taxes only 1/3 of the energy that goes to the electircity grid from the photovoltaic system is return back to the user.

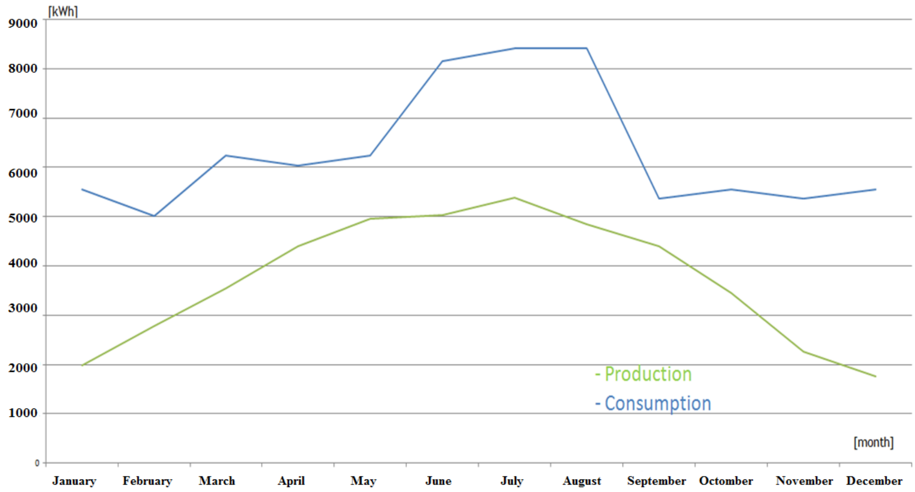



**Figure 20. Production curve vs. consumption curve with the car charghing station.**

In reality the energy is returned in 24 month (2 years) to prosumer, but we wil calculate the value of that energy by referring to the 1/3 of the capped price of the electricity. For the electricity delivered in the electircity grid will be calculate with 0.333 RON/kWh. The value of this ratio is:

$$0.33 \text{ lei/kWh} \cdot 9410 \text{ kWh} = 3105.3 \text{ RON/kWh (per year)} \quad (9)$$

From The total value saved annually will be (8) (9):

$$34520 \text{ RON} + 3105.3 \text{ RON} = 37625.3 \text{ RON/kWh (per year)} \quad (10)$$

the 21140 kWh taken from the electricity grid, the following will be paid:

$$1 \text{ RON/kWH} \cdot 41410 \text{ kWh} = 41410 \text{ RON/kWh (per year)} \quad (11)$$

From the calculations (11) (12) it results that per year the benefeciary will pay:

$$41410 \text{ RON} – 37625.3 \text{ RON} = 3784.7 \text{ RON} \quad (12)$$

The beneficiary (the prosumer) will receive money for the energy from the charghing station for EV's and for now in 2022 the price for charghing the electric/hybrid cars (EV'S) is up to 3 RON/kWh. The energy diference of the user from the grid (Figs 15 and 17) of this two cases, 20270 kWh of 35640 kWh required for the charghing station is taken from the grid and the rest of almost 16000 kWh is taken from the photovoltaic system (more than 40 % of the energy given by the car charging station is taken from the photovoltaic system). The energy calculation that is taken from the photovoltaic system with 3 RON/kWh from the car charging station and the energy from the electricity grid with 2 RON/kWh (the diference between the price for charghing the car and the ceiling price for the purchase of electircity) for the car charghing station, more than 85000 RON/year will be paid to the prosumer.

## 4. CONCLUSIONS

The sizing of the photovoltaic system is done taking into account the power peaks during the day, moving consumers, as much as possible, during the 6 hours centered on noon. Given that the price of one kW / installed is on average or higher than 1350 Euro with the car charging station (VAT + installation + transport + maintenance), the cost for 30 kWp with the 44 kWp charghing station will be aproximately 42000 Euro, it results from calculations that the investment in the case A) will amortize in 6-7 years if the photovoltaic energy produced per day will be at least 40% consumed, and in the case B) will amortize in less than 3 years on this specific consumption. But through the Electric Up program, which represents approximately 100 % of the investment, for this user, the investment will amortize less than 1 year (other expenses may occur such as the extra power suply from the grid).

For the payment versus the collection to be equal to 0, the share of energy consumed in photovoltaics should be less than 40%, which is possbile with a consumer who has a constant consumption and that during the day beteween 10 AM-16 PM is at least 30% higher than the rest so that the consumption curve approaches the production curve as much as possible. For now the project is at the beginning, the prefeasibility and feasibility studies (creating a detailed system plan calculation of solar resources and environmental characteristics, shadowing study, sketching the appeearance of suitable areas for the develpoment of system have been completed for this project, evaluation of technological options that ensure costs/benefits for the locations in the project like the types of modules and assembly structure, design scheme of the system, request for permission to make the system, estimated energy yields, financial model) have been made. The capacity of the network to accept the energy injected from the photovoltaic system but also the car charghing station (the power is double of the approved powert of the user) will depend on the existing network infrasturcture and the current use of the system.

The evaluation of overhead lines cables and transformers will be an important factor in evaluating the available connection capacity. Swithcing fault levels and protection settings can also be affrected by the connection of a photovoltaic installation. In cases where we have a network that does not have the existing capacity to allow the connection, there are two options avaialbe wich is one to reduce the power injected at the peak to the admissible limits of the network an two what must be done in this case, to upgrade the network to allow the injection of the desired capacity. Considering that obtaining the technical approval for the connection to the grid of the photovoltaic system and the car charghiong station chages periodically in the current legislation and the solution for the power increase made by the energy distribuitor, for now it is not possible to say the cost for this boost power, but in general the cost will not be higer than cost of the system itself. This is an ideal case, in reality the photovoltaic system produce less than almost 44000 kWh/year (around 38000 kWh/year) and the car charghing station is used only between 12-15 PM when the production is the highest, so the profitability is much higher. This combination of photovoltaic panels and charghe car stations for EV's as well as the user's consumers is one for future and responds at first sight to the energy and electromobility deficit and thus increase the profitability of the system. Locally produced energy ensures an increased degree of energy resilience, because in case of a lack of voltage at the level of the main network, the prosumer can operate insularized (similar to the microgrid). The digitization of electricity networks, together with the increase in the "intelligence" of energy consumption devices - enhanced in particular by the development trend of the "internet of things" will gradually lead to an increase in automated two-way energy exchanges, between distribution networks and active consumption systems. However, there are also some risks related to the still insufficiently known behavior of such systems, so that their efficient integration in the energy markets involves pilot projects and comparative studies, in order to learn good practices.

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