IN2RURAL

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# Differences between two photovoltaic systems in irrigation

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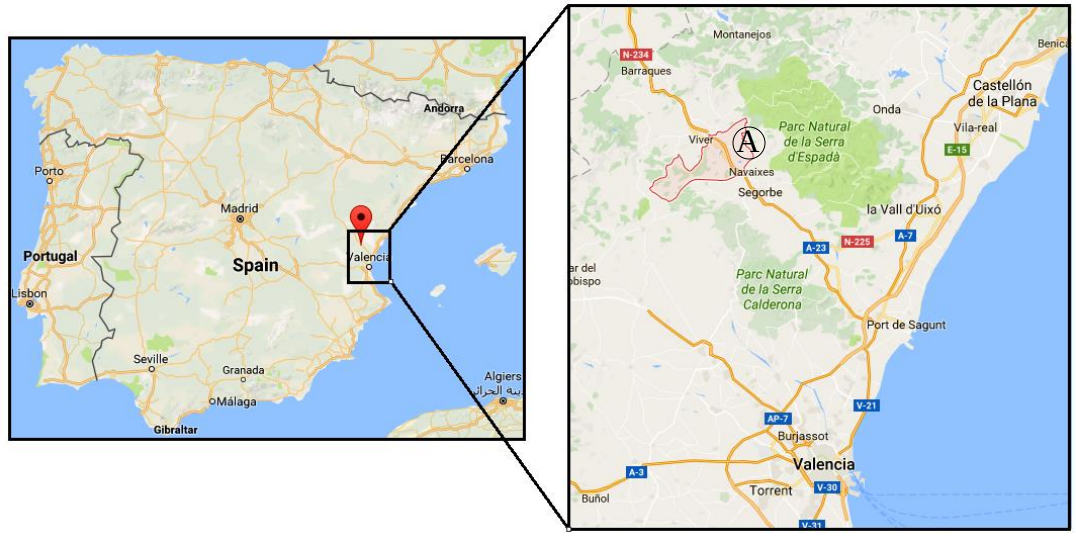
UMANS – Urbanisme I Medi Ambient Nebot I Segarra

La Vall d'Uixó, March-April 2017

# Location and Purpose



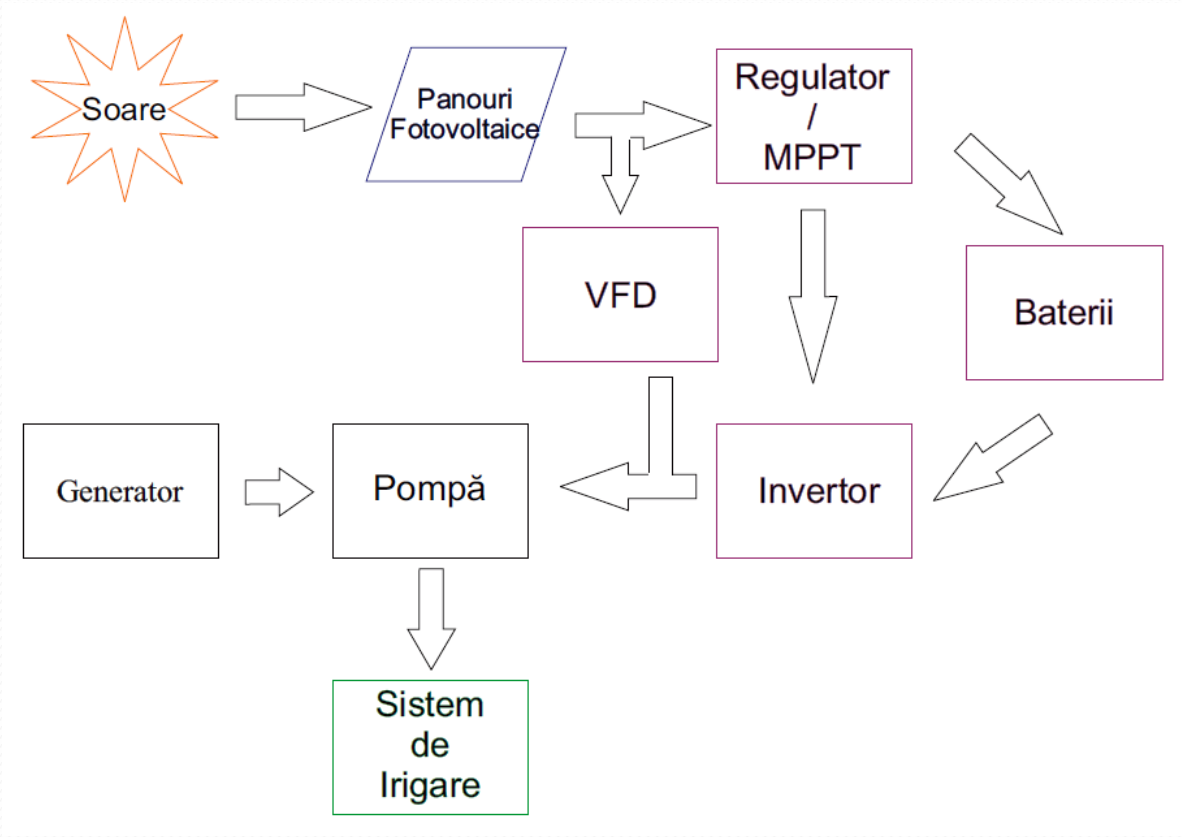

A


The project aims to develop a photovoltaic power supply system for an irrigation pump located near the town of Jérica in Castellón, Spain

Agricultural area

- 75660 m2
- 30 ha of almonds;
- 3 ha lavender;

# Photovoltaic installation



# The Actual System

Generator CTM-60 L, Carod

≈ 9225.66 Liters of fuel

- 8.59 l/h;
- 1.120 €/l

→ 10332.74 €/ an

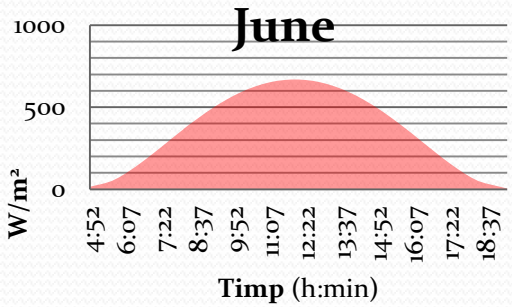
≈ 27.7 equivalent $tCO_2$

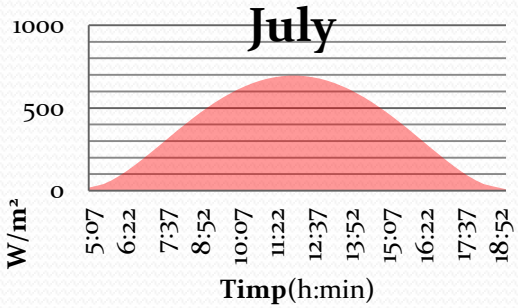
# Sizing of the plantinstalaţiei

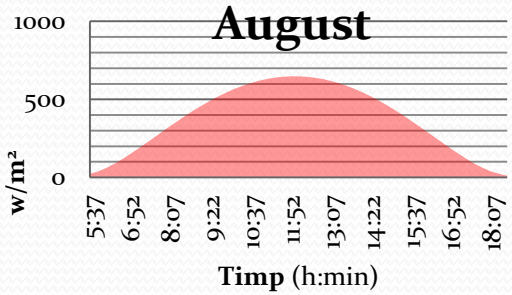
| | | | |
|---|---|---|---|
| Producer | | HN Bombas | |
| Model | | GJ012-25 | |
| kW | HP | 11 | 15 |
| Tension | | 400 V | |
| Frequency | | 50 Hz | |

The need for irrigation hours

| Monts | Mar. | Apr. | Mai | Iun | Iul | Aug. | Sept | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|---|
| Hour | 3 | 4 | 4 | 5 | 5 | 5 | 4 | 3 | 2 |



# First plantinstalaţie

68 Panouri Fotovoltaice *AS-6p-310*

- 4 rânduri (4 x 17 panouri)
- 21.08 kW.

| Producer | Amerisolar |
|---|---|
| Model | AS-6P-310 |
| Nominal power($P_{max}$) | 310 W |
| Open circuit voltage($V_{oc}$) | 45.5 V |
| Short circuit current($I_{sc}$) | 8.85 A |
| Voltage at rated power($V_{mp}$) | 36.9 V |
| Current at nominal power($I_{mp}$) | 8.41 A |
| Efficiency (%) | 15.98 |

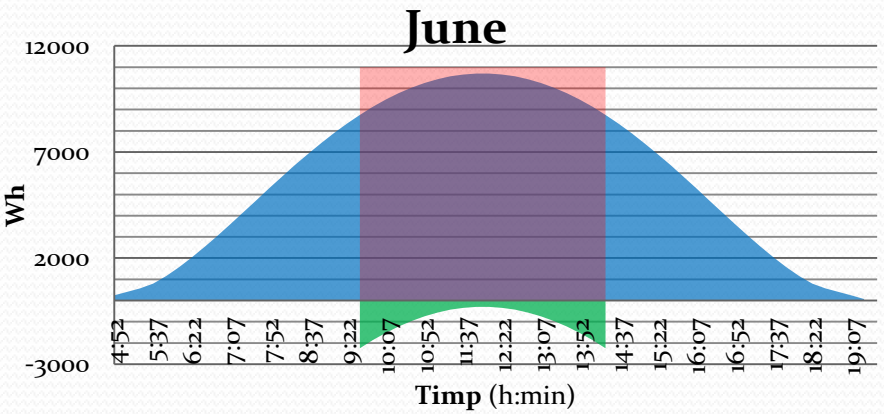
| Producer | Baico |
|---|---|
| Model | Iskut Solar 425 |
| V in (VDC) | 320 - 850 V |
| Vin P1 nom* (VDC) | > 560 V |
| Max V out (VAC) | 3 x 400 V |
| Max I out (A) | 25 |
| Weight | 8.5 kg |

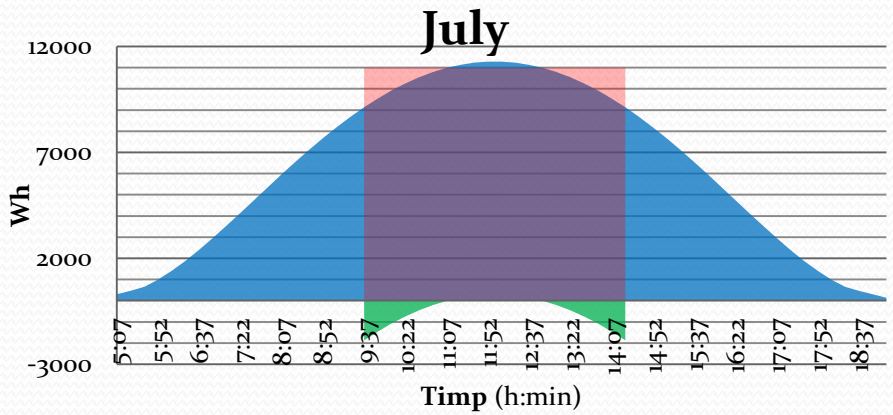
# 2nd installation

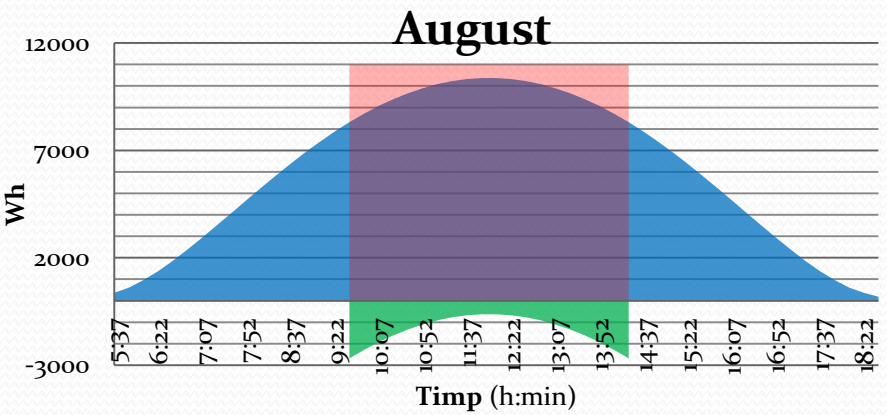
52 Photovoltaic Panels AS-6p-310

4 rows (4x 13 panels)

16.12 kW.



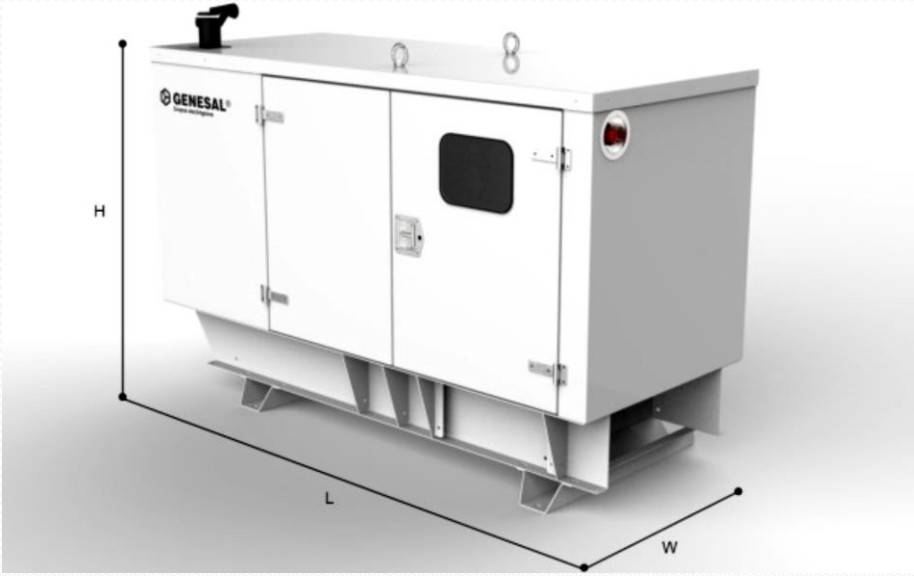



| | |
|---|---|
| Producer | Schneider Electric |
| Model | XW MPPT 80 600 |
| Battery nominal voltage | 24 and 48 V |
| Voltage panels | 195 to 550 V |
| Maximum voltage | 600 V |
| Battery voltage | 16 to 67 VDC |
| Load current | 35A (28 A @STC) |
| Maximum charge current | 80 A |

- 24 Units


| | |
|---|---|
| Producer | Tab+ |
| Model | 12 OPzS 1500 |
| Voltage | 2 V |
| Ah C10 | 1613 |

| Producer | Schneider Electric |
|---|---|
| Model | Conext XW+ 5548 NA |
| Power at 25ºC | 5500 W |
| Power at 40ºC | 4500 W |
| Frequency at exit | 50 / 60 Hz |
| Input voltagee intrare | 42 / 60 V (48 nominal) |
| Maximum input current | 150 A |




Genesal Generator XS Power Gen22KC

- 16 kW
- 4 l/oră
- 3108 €

# Investiţia. Indicatori economici

| Prodct | Price per unit(€) | Total (€) |
|---|---|---|
| Photovoltaic panels (68) | 214 | 14552 |
| VFD | 2210.68 | 2210.68 |
| Structure | 50 | 3400 |
| Cables and auxiliary elements | 0.264 | 5565.12 |
| Personal | 0.119 | 2508.52 |
| Proiectare | 2200 | 2200 |
| Total | ≈ 1.444 €/Wp | 30436.32 |

Investiţia iniţială a sistemului de 21 kW

| Product | Price per unit (€) | Total (€) |
|---|---|---|
| Photovoltaic panels (52) | 214 | 11128 |
| MPPT (4) | 921.4 | 3685.6 |
| Batery (24) | 458.4 | 11001.6 |
| Inverter (3) | 2375.24 | 7125.7 |
| Structure | 50 | 2600 |
| Monitoring panel | 764.22 | 764.22 |
| Cables and auxiliary elements | 0.384 €/Wp | 6190.08 |
| Personal | 0.158 | 2546.96 |
| Design | 2800 | 2800 |
| Total | ≈ 2.968 €/Wp | 47842.16 |

Initial investment of the 16 kW system

| | 21 kW | | 16 kW | |
|---|---|---|---|---|
| | Initial cost(€) | O&M (€/year) | Initial cost(€) | O&M (€/year) |
| **Total** | **25727.8** | **385.92** | **42495.2** | **637.43** |

| | Energy consumptionk Wh | Current generator | | | |
|---|---|---|---|---|---|
| | | € / kWh | Cost combustibil | O&M | Cost total |
| Anual | 11770 | 0.878 | 10332.74 | 200 | 10532.74 |
| **Total** | **235400** | **0.878** | **206654.8** | **4000** | **210654.8** |

*Current generator costs in 20 years*

| | O&M Cost 21 kW | O&M Cost 16 kW | Fuel cost | Fuel cost | 21 kW PV panels (€) | | 16 kW PV panels (€) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Total Cost GA | Total Cost GS | Total Cost GA | Total Cost GS |
| Annual | 385.92 | 637.43 | 1123.08 | 784 | 1509 | 1169.92 | 1760.51 | 1421.43 |
| **Total** | **7718.4** | **12748.6** | **22461.6** | **15680** | **30180** | **23398.4** | **35210.2** | **28428.6** |

*Costs generated by systems in 20 years*

| LCOE | SA | PFGA 21 kW | PFGS 21 kW | PFGA 16 kW | PFGS 16 kW |
|---|---|---|---|---|---|
| €/kWh | 0.895 | 0.338 | 0.506 | 0.743 | 0.684 |

LCOE per sistem

| Annual revenue | 21 kW (€) | | 16 kW (€) | |
|---|---|---|---|---|
| | GA | GS | GA | GS |
| | 9023.74 | 9362.82 | 8772.23 | 9111.31 |

Venit per sistem

Given the revenue generated by each system, the following amortization period results:
PFGA 21 kW - 4 years (5658.64 € profit); 150038.00 € profit after 20 years;
PFGS 21 kW - 4 years (3906.96 € profit); 153712.08 € profit after 20 years;
PFGA16 kW - 6 years (4791.22 € profit); 127602.44 € profit after 20 years;
PFGS16 kW - 6 years (3717.70 € profit). 131276.04 € profit after 20 years.

Taking into account a 5% rate for net current value,
Resulting in a different amortization period:
PFGA21 kW - 4 years (1561.42 € profit); ($ 82019.43 profit after 20 years);
PFGS21 kW - 5 years (6991.79 € profit); (83137.11 € profit after 20 years);
PFGA16 kW - 7 years (2917.24 € profit); (61479.22 € profit after 20 years);
PFGS 16 kW - 7 years (1771.28 € profit). (62596.90 € profit after 20 years).

| RIR % | 21 kW | | 16 kW | |
|---|---|---|---|---|
| | GA | GS | GA | GS |
| | 28.24 | 26.58 | 17.46 | 17.03 |

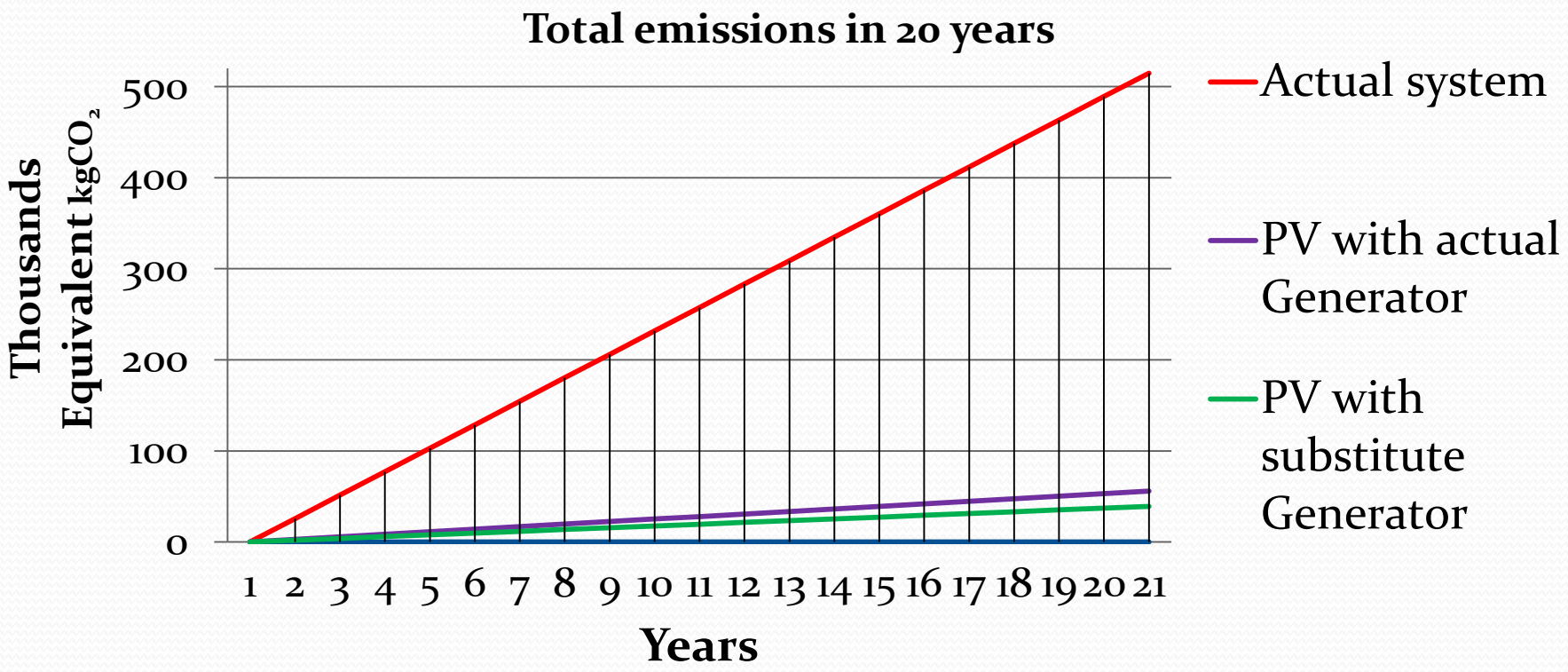
Rata interna de retur

# The main economic and technological disadvantages and disadvantages in irrigation

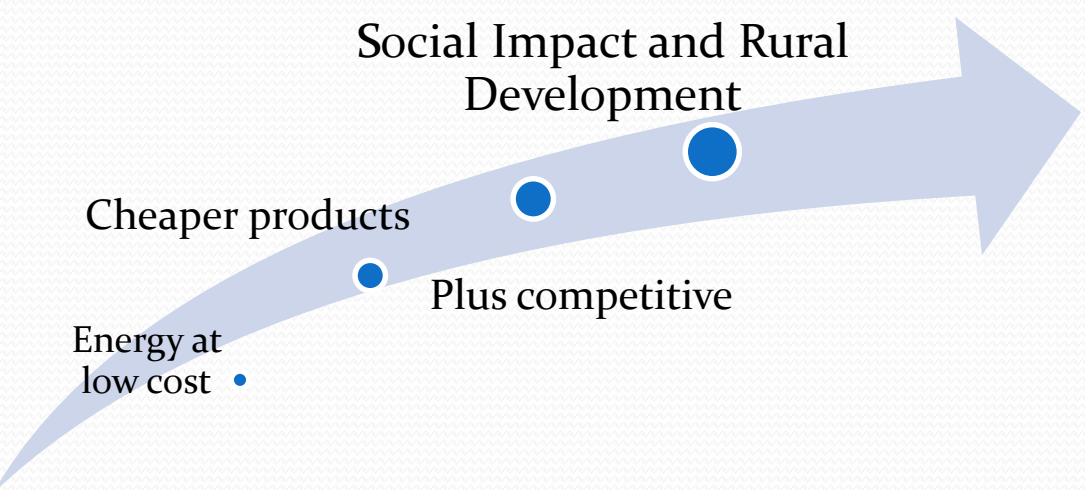
| First plant | | The second installation | |
|---|---|---|---|
| Benefits | Disadvantages | Benefits | Disadvantages |
| ➢ Changing the frequency from 50 Hz to 40 Hz can extend the irrigation period.<br>➢ Network losses are lower due to the small number of equipment;<br>➢ Low initial cost as well as a small O & M cost. | ➢ Can not provide energy requirements under low irradiation conditions;<br>➢ Large number of photovoltaic panels. | ➢ Ensure energy needs at any time of day due to batteries;<br>➢ Low number of photovoltaic panels. | ➢ High network losses due to the large number of equipment;<br>➢ Batteries generate an extra cost when they change (10 years);<br>➢ Initial cost, high O & M. |

# Impact on the environment

| Total | Annual equivalent emissions | | |
|---|---|---|---|
| | Actual Generator | PFGA | PFGS |
| | **27739.59** | **2798** | **1953** |



# Social Impact and Rural Development




- Marketing
- School Trips

# Conclusion

It has come to the conclusion that the 21kW photovoltaic plant equipped with the frequency converter is optimal in this situation due to:

- Possibility to extend the irrigation period by changing the frequency from 50 Hz to 40 Hz;
- Initial investment is low (30436.32 €);
- Fast depreciation (4-5 years);
- Poor pollution of the generator.

Thank you for your attention

Corneliu Zediu