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LANDSCAPE AND ENERGY PRODUCTION: POSSIBLE CO-EXISTENCE?

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ABSTRACT: This paper shows the energy production of some photovoltaic plants located in the province of Ragusa (Italy) and their impact on the landscape. The systems were realized and monitored by the authors since installation. The plants located in Ragusa, Marina di Ragusa, Santa Croce Camerina, Pozzallo, in Ragusa province, have been studied from the point of view of the yield and of their installation compared to the surrounding environment. The goal imposed by Italian regulations and design analysis of the authors, was to find solutions to find a balance between productivity and impact on the landscape.

Keywords: Photovoltaics, Landscape, Production

1 INTRODUCTION

"It seems to have opened up a conflict between landscape and environment, between reasons of protection and those, seemingly opposing, of development of a system more energy clean, renewable, capable of reducing greenhouse gas emissions. The conflict is primarily cultural, concerns the way in which you look to the challenges of modernity, to how you interpret and deal with the transformation of the territory, energy issues and climate change" [1].

Together with the limited availability of sources of fresh water and arable land, the supply of energy to the growing consumption of advanced societies and others, will mark the choices of international politics for decades to come. In the face of declining production from fossil fuels (whose deposits are being depleted) the energy industry worldwide has chosen the path of rapid conversion, using advanced technologies evolving to the use of renewable sources. Sun, wind, water, earth, biomass: is being a real race in technological research on the widespread production of energy in the area of low environmental impact, which coincides with the emergence of new players capable of contributing to the energy balance at a local level. New crops, wind farms, dams along the rivers, channels for the installation of micro hydro and solar farms are just some of the highlights that have for years, often in the form of conflict, in our countryside. But what impact it can have on the landscape spread of new forms of sustainable production?

During journeys made in Malta the authors had the opportunity to appreciate the Maltese countryside and the impact they have had in the skyline of residential photovoltaic systems, as shown in Figure 1.

Figure 1: Photographs of PV systems in Malta.

This landscape has prompted the preparation of this paper, to compare what was achieved in Italy, so as to appreciate the different ways installation requests imposed by Italian regulations and related design analysis of writers that despite penalize in part production, seek to protect as much as possible the landscape.

It is true that there are significant differences between the types of construction between Italy and Malta, especially in the building roof, pitched in the first case and pitched in the second.

In the subsequent roundup of exposed cases you will see installations both pitched and flat, with different azimuth and tilt.

2 ANALYSIS OF CASE STUDIES

2.1 **30 kWp PV system**

The photovoltaic system in question (Figure 2), having a power of 30 kWp is at the service of a dairy farm.

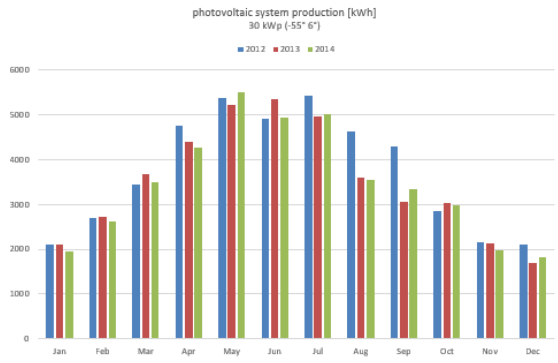
It is situated in Pozzallo, 36°43'58.57"N, 14°49'53.22" E and is positioned on the roof terrace of the property.

It became operational on 28/12/2011. The modules are placed on trestles with azimuth -55 °; this choice is due to the shape of the cover and to the stages of production of the company.

The tilt 6° was imposed by the rules of IV Conto Energia.

Figure 2: 30 kWp PV system in Pozzallo.

The total production of electricity in 2012 amounted to 44,771 kWh with an average of 1490.33 kWh / kWp. In 2013, it amounted to 4,1945 kWh with an average of 1,398.17 kWh / kWp and in 2014 it registered 41,480 kWh with an average of 1,382.67 kWh / kWp.



2.2 **9.60 kWp PV system**

The photovoltaic system in question, having a power of 9.60 kWp is at the service of a dwelling.

It is located in Santa Croce Camerina, 36°47'58.37"N, 14°32'3.41" E and is positioned on the pitched roof of the property (Figure 3).

It became operational on 28/10/2011. The modules are positioned on the two slopes of the roof having azimuth -90° and 90° (East and West); this choice is due both to the conformation of the cover and both for the presence of a landscape bond that insists on the property. The tilt 17° was imposed by the shape of the roof and by the rules of the IV Conto Energia.

Figure 3: PV system in a dwelling (Santa Croce)

The total production of electricity in 2012 amounted to 14,817 kWh with an average of 1,543.44 kWh / kWp. In 2013 it amounted to 14,452 kWh with an average of 1,505.42 kWh /

kWp and in 2014 it reached 13,866 kWh with an average of 1,444.38 kWh / kWp.

2.3 **5.875 kWp PV system**

The photovoltaic system in question, having the power of 5.875 kWp is at the service of a dwelling.

It is located in Santa Croce Camerina, 36°47'58.43"N, 14°32'2.87" E and is positioned on the pitched roof of the property.

It became operational on 20/12/2011. The modules are positioned on the pitch of the roof having azimuth -90° (East). This choice is due to the shape of the roof. The tilt 9° was imposed by the shape of the roof and by the rules of the IV Conto Energia (Figure 4).

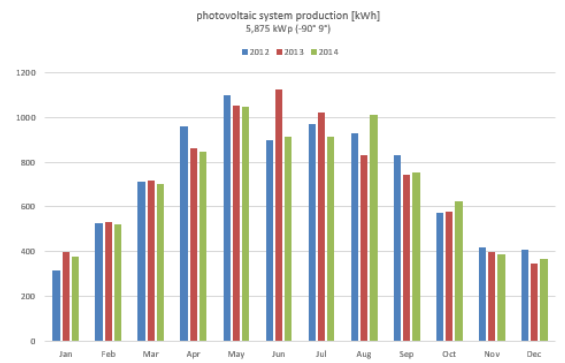


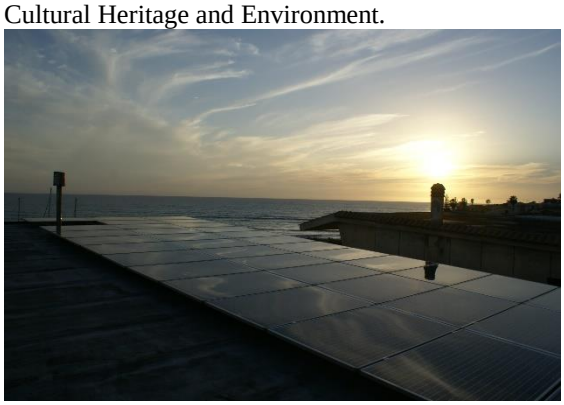
Figure 4: PV system in a dwelling (Santa Croce)

2.4 **9.12 kWp PV system**

The photovoltaic system in question, has a power of 9.12 kWp and is at the service of a dwelling.

It is situated in Marina di Ragusa, 36°46'58.18"N, 14°32'37.74" E and is positioned on the roof terrace of the property (Figure 5).

It became operational on 21/12/2012. The modules are positioned on the pitch of the roof having azimuth -360° (North); this choice is due to the shape of the roof. The tilt 2nd only by the shape of the roof was imposed by the rules of the V Conto Energia and since the property is close to the sea is subject to the rules of the Superintendence of Cultural Heritage and Environment.



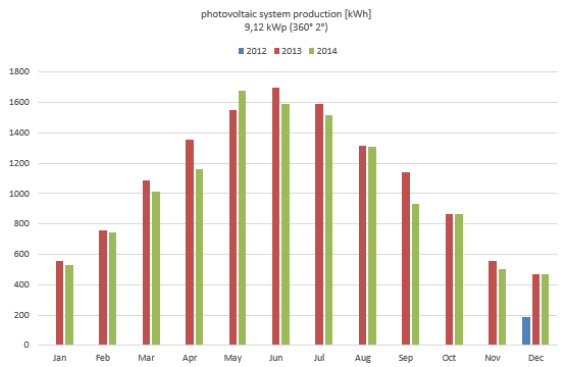


Figure 5: PV system at Marina di Ragusa.

The total production of electricity in the year 2013 amounted to 12,932 kWh with an average of 1,417.98 kWh / kWp and in 2014 it amounted to 12,320 kWh with an average of 1,350.88 kWh / kWp.

2.5 **4.90 kWp PV system**

The photovoltaic system in question, having a power of 4.90 kWp is at the service of a dwelling.

It is situated in Marina di Ragusa, 36°47'1.77"N, 14°32'59.93" E and is positioned on the roof terrace of the property on the trestles below the walls of the crowning of the terrace.

It became operational on 21/12/2012. The modules are positioned in two groups on trestles with azimuth 0° (South); this choice is due to the shape of the roof and the rules imposed by the IV Conto Energia. The tilt 6 ° and 10 ° as well as the shape of the roof were imposed by the shape of the roof and by the rules of the IV Conto Energia (Figure 6).

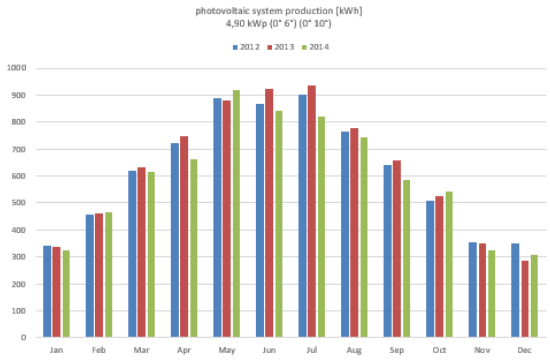


Figure 6: PV system in Marina di Ragusa.

The total production of electricity in the year 2013 was equal to 7512 kWh with an average of 1533.06 kWh / kWp and in 2014 amounted to 7158 kWh with an average of 1460.82 kWh / kWp.

3 ANALYSIS OF PRODUCTION DATA

Using simulation software, SIMULARE 12, was used to simulate a photovoltaic system in Ragusa, with data ENEA (94-99) (ENEA = Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile) and with data UNI 10349 (UNI = Ente nazionale italiano di unificazione), 1 kWp with azimuth 0° and 30° tilt, as recommended in the literature. A comparison was then made between the results and the actual systems. The production values obtained with data ENEA are 1,456.44 kWh / kWp while those with data UNI are 1,619.30 kWh / kWp.

Comparing the case study 2.1 with data ENEA, it was found the following results: in 2012, + 2.47%; in 2013, -4.00%; in 2014, -5.07%. Instead with data UNI it was found the following results: in 2012, -7.84%; in 2013, -13.66%; in 2014, -14.61%.

Comparing the case study 2.2 with data ENEA, it is shown that in 2012, it yielded + 5.97%; in 2013, + 3.36%; in 2014, -0.13%. While with the data UNI, it was worse with the following results: in 2012, -4.68%; in 2013, -7.03%; in 2014, -10.80%.

Comparing the case study 2.3 with data ENEA, were found the following results: in 2012, + 0.97%; in 2013, + 0.97%; in 2014, + 0.55%. Instead with the data UNI were found the following results: in 2012, -9.56%; in 2013, -9.18%; in 2014, -9.56%.

Comparing the case study 2.4 with data ENEA, were found the following results: in 2013, -2.64%; in 2014, -7.25%. Instead with the data UNI were found the following results: in 2013, -12.43%; in 2014, -16.58%.

Comparing the case study 2.5 with data ENEA, were found the following results: in 2013, + 5.26%; in 2014, + 0.30%. Instead with the data UNI were found the following results: in 2013, -5.33%; in 2014, -9.79%.

Ultimately, as regards the data ENEA, the comparison shows a range that goes from + 5.97%

to -7.25%.

Instead examination of the data shows a UNI range from a -4.68% to a -16.58%.

4 CONCLUSIONS

It is clear that the expected loss of yield is between 75.78 kWh / kWp and 268.48 kWh / kWp. Transforming these values into money would yield a loss of between 18.95 and 67.12 Euro/kWp.year (assuming a feed-in tariff of 0.25 Euro, including tax).

From experience, homes with PV systems consume around 50% of their PV generate energy at best and export the rest to the grid. Residences usually have 3kWp systems and therefore the money lost from installing the PV system in a different inclination and azimuth could be a maximum 100.68 Euro/year.

Economically, is it worthy ruining the landscape for these lost profits? The Italian rules, the sites available and the sensitivity of the technicians although not perfect, have tried to find the right balance between production and landscape.

5 LEGISLATION REFERENCES

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