# THE EFFECTS OF THE ENTRY INTO FORCE OF THE NEW ELECTRIC TARIFF ON ITALIAN RESIDENTIAL HOUSEHOLDS EQUIPPED WITH A PV PLANT

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## ABSTRACT

*This paper explains the details of the reformation process of the electric tariff for domestic end users in Italy and illustrates the results of the analyses carried out comparing the old tariff to the new one, with specific reference to a type of domestic end user, who can be considered representatives of the whole Italian residential population equipped with a PV plant.*
*The results show that the "traditional" solution (i.e. based on the use of fossil fuels for cooking, heating and producing hot water) is always more cost effective for a residential customer than the "all electric" one (i.e. in which electricity is used to satisfy all energy demands) with a PV plant with the old tariff; on the contrary, the new tariff allows the "all electric" solution with a PV plant to be both more energetically and economically advantageous than the "traditional" solution.*

## INTRODUCTION

The entry into force of the new electric tariff (with a flat price structure, except for a small portion of the taxes, called "Accise") for residential end users on January 1st, 2016 in Italy has the goals to overcome the progressive structure of the old tariff with respect to consumption and to adjust its components to the cost of the provided service. This is considered a way to stimulate end users' virtuous behaviours, by prompting them to switch from the traditional liquid or gaseous fossil fuels towards the electric vector in order to satisfy their domestic energy demands.
Taking this into account, R.S.E. has evaluated the possible impact of the new tariff structure (both in terms of the annual cost of the energy consumption and in terms of primary energy savings and greenhouse gases emissions) for a residential end user who decides to renovate his home without recurring to fossil fuels, thus going from a "*traditional*" home (i.e. based on the use of fossil fuels for cooking, heating and producing hot water) to a new "*all electric*" one (i.e. in which electricity is used to satisfy all energy demands) equipped also with a PV plant, thus becoming a prosumer.
This paper first of all explains the details of the reformation process which has been undertaken by the Italian Authority for Energy, Gas and Water (AEEGSI) and shows how it fits in the process of making the Italian energy system more efficient.
After this overview, the paper illustrates the results of the analyses carried out with specific reference to two types of domestic end users, who can be considered representatives of the whole Italian residential population with different a PV plant.

## METHODOLOGY

The analysis have been carried out on a specific case study referring to a type of domestic end user, who can be considered representatives of the whole Italian residential population equipped with a PV plant: it is a newly built or completely renewed detached house of 100 $m^2$, occupied by a family of 4 members, located in the Italian cold-temperate climate zone (zone E). The economic evaluation of the effects of the new tariff is made considering the following solutions to satisfy the demand of air conditioning and cooking and the production of hot water:

- *"traditional"* solution: it consists in the installation of a condensing boiler for heating and hot water production, with underfloor heating, of an air conditioning unit for cooling and of a gas stove for cooking;
- *"all electric"* solution: it consists in the installation of a reversible heat pump for air conditioning and hot water production, with a fan coils units distribution system and of induction cooking plates. The cost of such a solution is higher than the cost of the *"traditional"* one.

The energy demands are shown in **Table 1**, while in Table 2 you can find the annual demand of natural gas ($m^3$) and of electric energy (kWh).

| Default consumption [$kWh_e$] | Heating demand [$kWh_t$] | Hot water demand [$kWh_t$] | Cooling demand [$kWh_f$] | Cooking demand [$kWh_t$] |
|---|---|---|---|---|
| 3.200 | 17.650 | 2.300 | 2.508 | 705 |

**Table 1: annual energy demands of the house.**

| | Default consu-mption | Heating demand | | Hot water demand | | Cooling demand | | Cooking demand | |
|---|---|---|---|---|---|---|---|---|---|
| | Electr [kWh] | Gas [$m^3$] | Electr icity [kWh] | Gas [$m^3$] | Electr icity [kWh] | Gas [$m^3$] | Electr icity [kWh] | Gas [$m^3$] | Elect. [kWh] |
| ***"Traditional"* solution** | 3.200 | 2.043 | - | 282 | - | - | 760 | 134 | - |
| ***"All electric"* solution** | 3.200 | - | 5.348 | - | 767 | - | 809 | - | 783 |

**Table 2: annual demand of natural gas ($m^3$) and of electric energy (kWh).**

Table 3 displays the operating costs of the *"traditional" vs.* the *"all electric"* solution in the above described case study with the old and new tariff.

| ***"Traditional"* Solution** [€/year] | | ***"All electric"* Solution** [€/year] | | **Δoperating costs *"traditional" vs. "all electric"* solution** [€/year] |
|---|---|---|---|---|
| Old tariff | 915 (electric)<br>1.952 (gas) | Old tariff | 3.493 (electric) | -626 |
| New tariff | 766 (electric)<br>1.952 (gas) | New tariff | 2.002 (electric) | +716 |

**Table 3: operating costs of the *"traditional"* solution *vs* the "all electric" solution.**

As you can see, the operating costs of the *"all electric"* solution are higher than those of the *"traditional"* solution with the old tariff; the opposite situation occurs with the new tariff, thus showing that the new tariff tends to encourage the use electric technologies in order to efficiently satisfy the user's needs for air conditioning, hot water production and cooking.

Therefore, in the case of the new tariff, it is possible to calculate the payback time of the extra investment cost of the *"all electric"* solution with respect to the *"traditional"* one, thanks to the lower operating costs of *"all electric"* solution: such a payback time is equal to 1.3 years.

## ANALYSIS WITH A PV PLANT

### PV plant on both "traditional" and "all electric" solution

We now move to evaluate the convenience of the installation of a PV plant to (partially) cover the electric energy demand in both the *"all electric"* and *"traditional"* solution. The respective yearly demands of electric energy are those defined in Table 2 and, for convenience, they are summarized in TABLE 4.

| | **Annual demands of electric energy** [kWh] |
|---|---|
| ***"Traditional"* solution** | 3.960 |
| ***"All electric"* solution** | 10.908 |

**Table 4: annual demands of electric energy (kWh).**

The analysis is performed considering two possible sizes of the PV plant: 3 kWp and 6 kWp. The additional assumptions for the economic evaluation are summarized below:

- electric energy production of 3,600 kWh per year for the 3 kWp PV plant and 7,200 kWh per year for 6 kWp power plant;
- annual decline of PV plant performance equal to 1%;
- discount rate equal to 4%;
- tax deductions of 50% on the cost of investment (purchase and installation) of the PV plant, equally distributed over a period of 10 years.

In this first version of the study we do not take into consideration the possibility of reducing the amount of available power in the presence of a PV system, which would make the operating costs of the *"all electric"* solution lower.

The values of the payback times for the installation of the PV plants with the old and new tariffs are shown in Table 5.

| | **Payback time** [years] | |
|---|---|---|
| 3 kWp PV plant | Old tariff | New tariff |
| *"Traditional"* solution | 6.9 | 9.3 |
| *"All electric"* solution | 4.5 | 8.6 |
| 6 kWp PV plant | Old tariff | New tariff |
| *"Traditional"* solution | 7.7 | 10.8 |
| *"All electric"* solution | 4.3 | 8.2 |

**Table 5: payback times for the installation of the PV plants in the analysed cases.**

As you can see, the new rate causes an extension in the payback times of the installation of the PV plant with respect to those obtained with the old tariff.

However, it is interesting to note that, with the new tariff, the payback time of the PV plant in a house with a *"all electric"* solution is approximately equal to the one which would occur with the old tariff in the same house with a *"traditional"* solution (8.6 years vs. 6.9 years with a 3 kWp PV plant; 8.2 years vs. 7.7 years with a 6 kWp PV plant); this shows that the new tariff keeps the convenience of the PV plant at the same level of the situation occurring with the old tariff provided that the electric energy consumption of the house is increased through the adoption of energy efficient technologies (heat pumps, induction cooking,..) which make use of electric energy as the only energy vector to satisfy the energy demands of the house.

Changing the annual electric energy consumption of the house and the size of the installed PV plant, there is a variation in the payback time of the PV plant; in particular, going from the old to the new tariff, there is an increase in payback time of PV plant, as you can see in Figure 1: the increase is approximately equal to 2 years for values of consumption less than 4,000 kWh/year, about 3 years for values of consumption of about 8,000

kWh/year and stabilize around four years for values of consumption more than 8,000 kWh/year.

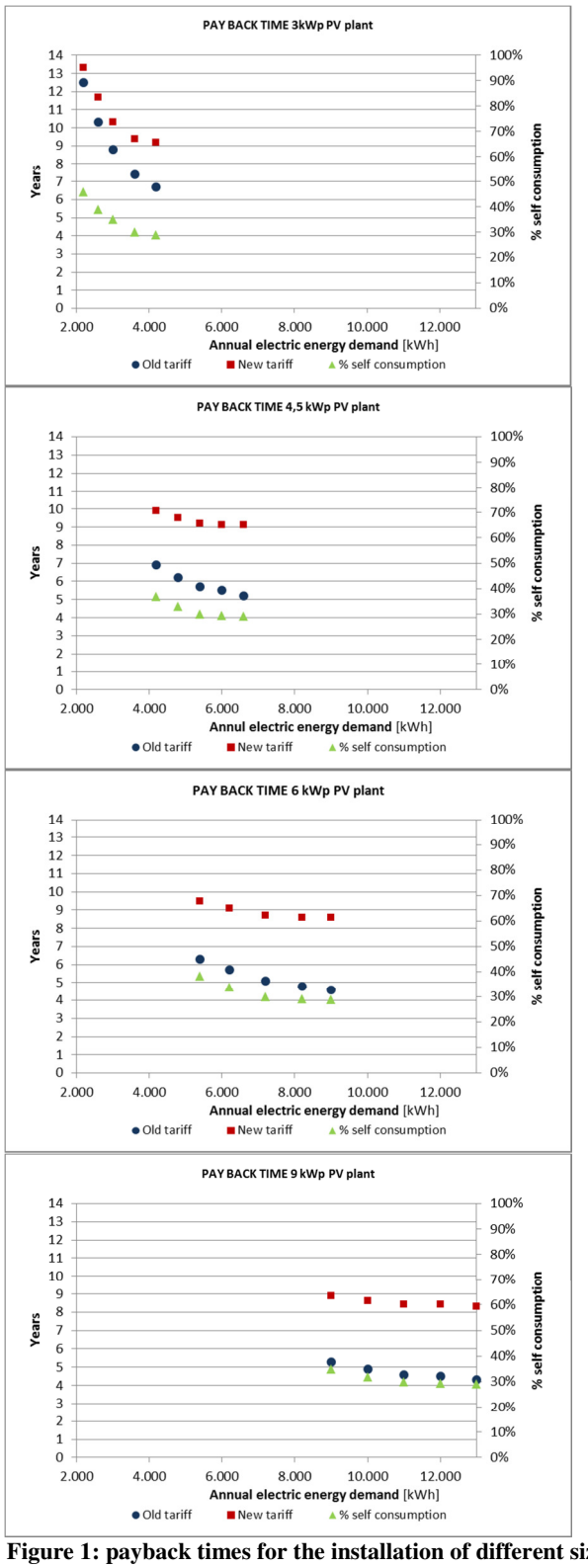


**Figure 1: payback times for the installation of different sizes of PV plants with different electric energy demands of the house.**

## PV plant only on "all electric" solution

The next step is the comparison of the convenience of the *"traditional"* solution without a PV plant with the *"all electric"* solution equipped with a PV plant partly satisfying the electric energy consumption of the house.

The configuration and the cost of *"traditional"* and the *"all electric"* solutions, as well as the PV plant and the annual electric energy demands, are the same of the analysis shown in the previous paragraphs. The economic evaluation of the two solutions is made by considering:

- Δ(investment cost) between the *"all electric"* solution equipped with a PV plant and the *"traditional"* solution without a PV plant, as the investment costs of the first former solution is higher than those of the latter one;
- Δ(annual operating) cost between the *"traditional"* solution and the *"all-electric"* solution equipped with a PV plant, as the operating costs of the former solution are higher than those of the latter one with both the new and old tariff. Such savings obtained by the end user are discounted over the entire technical life of the equipment installed.

The payback times are shown in the following Table 6.

| | **Payback time** [years] | |
|---|---|---|
| | Old tariff | New tariff |
| *traditional"* solution *vs.* *"all electric"* solution with a 3 kWp PV plant | > technical life | 5 |
| *traditional"* solution *vs.* *"all electric"* solution with a 3 kWp PV plant | 7 | 6 |

**Table 6: payback times for the installation of the PV plants in the analysed cases.**

As you can see, the adoption by a residential end user of the *"all electric"* solution equipped with a 3 kWp PV plant, instead of a *"traditional"* solution, is not convenient with the old tariff as the extra investment cost of the *"all electric"* with PV solution with respect to the *"traditional"* one is not recovered within the technical life of the installed technologies; on the contrary, the value of the payback time is about five years with the new tariff.
The *"all electric"* solution with a 6 kWp PV plant is, on the other hand, convenient with both the old and new tariff, even if such a convenience if higher with the new tariff with respect to the old tariff (the payback time is, respectively, 6 and 7 years).

Therefore, in the analysed cases the new tariff makes the

*"all electric"* solution equipped with a PV plant more convenient than the *"traditional"* solution without a PV plant.

## CONCLUSIONS

It is quite common for those end users who have the possibility to install a PV plant in their home to also meet the appropriate logistic and spatial requirements to adopt a solutions exclusively based on the electric vector for their needs of air conditioning, hot water production and cooking.

The old tariff for household end users, although generally more favourable than the new tariff towards the installation of a PV plant (as a result of its progressive structure with respect to consumption), was not supporting the *"all electric"* solution. Therefore, the end users were particularly encouraged to install a PV plant in order to partially cover his consumption, but less supported towards the adoption of such *"all electric"* solution.

The new domestic tariff, although a little less favourable than the old one towards the installation of a PV plant (due to its flat price structure), makes the adoption of the *"all electric"* solution more convenient with respect to the old progressive tariff: such a conclusion is supported by the analyses described in this paper, in line with the goals of the tariff reformation declared by the AEEGSI.

The analyses also show that the convenience of a PV plant is higher with the old tariff than with the new tariff for consumptions larger than 2,000 kWh/year. This occurs because the old tariff has a progressive structure and therefore the PV production cuts the consumptions falling in the slots with the highest price, while, with the new tariff, due to its flat price structure, the same consumptions have a lower cost.

However, despite longer payback times, the PV installation is still a fruitful investment, with acceptable payback time for residential end users.

Finally, despite the above-mentioned extension of the values of payback times of PV plants going from the old to the new tariff, the choice of the *"all electric"* solution equipped with a PV plant is both more energetically and economically convenient than the *"traditional"* solution with the new tariff with respect to the old tariff, thus providing an overall benefit to the whole Italian energy system.

The new tariff therefore supports efficient solutions based on the electric vector combined with the production of electric energy using PV plants, in line with the goals of the tariff reform undertaken by the AEEGSI.

## REFERENCES

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