PROSUMERS, THE PORTUGUESE CASE

João FALCÃO
EDP Distribuição
Portugal
joao.falcao@edp.pt

Gonçalo SILVA
EDP Distribuição
Portugal
goncalo.ferreirasilva@edp.pt

Sérgio BARBOSA
EDP Distribuição
Portugal
sergio.correiabarbosa@edp.pt

Ricardo PRATA
EDP Distribuição
Portugal
ricardo.prata@edp.pt

ABSTRACT

Decentralised generation, storage and demand-side response solutions are emerging rapidly across all costumers' categories. These solutions combined with the increasing share of renewable energy sources are subjecting the power sector to structural changes and challenging all the players. A revision of the current regulation models must therefore be made, in order to guarantee that real benefits and costs are correctly assigned to the different end-user categories (avoiding cross-subsidization), while encouraging efficiency, promoting renewable generation, guaranteeing security of supply and ensuring the financial/economic balance of the DSOs.

In this paper we analyse the Portuguese prosumer figure and the impact on the tariffs revenues, according to three predefined prosumer penetration scenarios and considering their future compensation to support policy charges.

INTRODUCTION

Nowadays, mostly due to the easy access to information, customers are generally more aware and demanding.
With the wider development of distributed generation these new active and engaged customers can now opt not only to buy their electricity from a retailer but also to produce part of it themselves – thus becoming prosumers. On top of that, they benefit from the connection to the grid that provides a continuous supply of electricity in case the local generation cannot meet their demand [1].

Coping with this trend, the Portuguese government published in 2014 a decree (no. 153/2014) [2] that redefined the prosumer figure and named it UPAC - *Unidade de Produção para Autoconsumo* (Production Units for Self-consumption). It also reviewed the existing distributed generation schemes as UPP – *Unidades de Pequena Produção* (Small Production Units) for units up to 250 kW.

The prosumer figure had already existed in the Portuguese legislation (decree no. 68/2002) [3]. Still, by that time, due to the high technology prices the customers could not recover the investment made solely by avoiding paying part of their electricity. Therefore this scheme had a low number of units registered.

As a consequence, the government had to rethink how to promote distributed generation and renewable energy production. So, in 2007 and 2011 the micro and miniproduction frameworks were introduced, respectively. The units licensed under these schemes benefitted from a subsidized price that made the investment in distributed generation solutions appealing.

The electricity generated by micro and miniproducers was totally injected to the grid and sold to the LRS (Last Resort Supplier) at the referred subsidized price. In Portugal there are almost 28 thousands units of micro and miniproduction, with 167 MVA of installed capacity, mostly solar PV. These units produced about 280 GWh in 2015. These were the schemes that the recently published decree renamed as UPP, preserving most of their features. The existing units may continue to benefit from their previous frameworks.

All the referred schemes had the common objectives to:

- Promote efficiency by producing close to the point of consumption, thus reducing losses in the network;
- Promote renewable generation (typically solar origin) and the use of local resources;
- Reduce the concentration of production in large power plants benefiting the security of supply
- Decrease of investment needs in the grid in the medium / long term;
- Promote photovoltaic industry, which has a considerable local content (installers, maintenance, component manufacture).

Still, the new UPAC and UPP regimens also pretend to:

- Promote greater awareness, especially by consumers at low voltage, of the respective consumption profile, inducing behaviors of energy efficiency;
- Ensure the sustainability of the electric system by eliminating the previous subsidized feed in tariffs and introducing a bidding model to define the rate of small production units;
- Guarantee that self-consumption units are adapted to the consumption needs.

Despite all their benefits, as the UPAC units are mostly powered by solar PV, they solely reduce the energy distributed during solar hours. Therefore, the peak demand that occurs at evening time during the winter does not change with these units' production. As the distribution grid is designed to sustain the peak demand, its costs will remain similar or even rise if network reinforcement is needed [4]. Figure 1 shows the profiles of a low voltage customer with and without UPAC unit (per thousand) published by the regulator (ERSE). It also depicts the consumption peak of 2015. The three lines refer to the 20th of January.

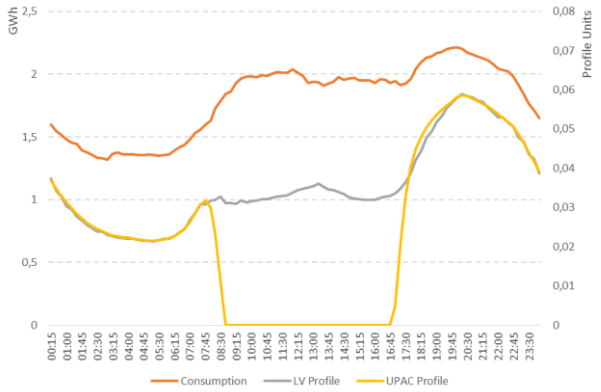

Figure 1 – LV profile with and without UPAC and consumption peak of 2015

Currently the grid access tariffs are mostly based on volumetric charges, so when the consumers start producing part of their needs, the net amount of electricity distributed decreases, leading to a smaller grid access tariff revenue. As the fixed networks costs tend to be maintained with the increase in self-consumption, its recovery will have to be achieved by rising the network tariffs to the customers, making the prosumer option even more appealing.

Figure 2 sketches how the penetration of UPAC units will impact grid costs and tariffs revenues.

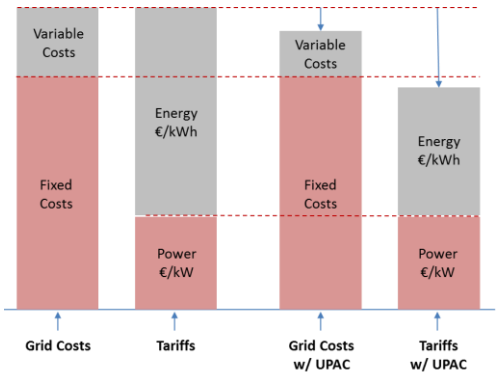

Figure 2 – Grid costs and tariffs revenues with and without self-consumption

In the next chapters, the Portuguese prosumer scheme is described and simulations are made to study the impact of UPAC penetration on tariffs revenues.

PROSUMERS SCHEME

In Portugal, as mentioned above, a recent decree published on the 20th of October of 2014 [2], defined the prosumer scheme, among other acts, and several costumers are already opting for this regimen.
The next sections present a description of the UPAC regimen and an analysis on the consumer to prosumer transition rate.

Scheme

The UPAC regimen states the production unit is intended to satisfy the customer's consumption needs, so it favors units that are sized accordingly. Yet, it allows the electricity surplus to be injected to the grid.
The units can use a mix of renewable and non-renewable energy sources and may or may not be connected to the grid.

Access to the regimen
The access to the UPAC regimen is very simple for small production units. The licensing requirements increase with the units' power capacity.

For units up to 200 W there is no need to licensing. Still, customers are advised to contact the DSO so it can check if the connection point at their premises is technically prepared.
For units from 200 W to 1,5 kW or not connected to the grid, the costumers must communicate their registration.
For units from 1,5 kW to 1 MW, the costumers must communicate their registration, pay a registration fee and obtain an operation certificate. A successful inspection to the unit is needed to issue the operation certificate.
Units larger than 1 MW, must obtain production and operation licenses, that include registration fees.

Metering equipment with remote reading capacity must be installed for units larger than 1,5 kW, except for the ones not connected to the grid, to record the electricity production.

Additionally, any unit that intends to sell the electricity surplus to the grid must register and get an operation certificate and install metering equipment with remote reading capacity.

All the units are registered on a dedicated platform, managed by DGEG – *Direção Geral de Energia e Geologia*, a Portuguese government's authority.

Connection to the network and operation
As already mentioned, the unit must be sized accordingly to the customers' consumption needs.
To accomplish this purpose, the UPAC regimen states the unit's connection power is at most the contracted power and the annual production must be less than the annual consumption (the excess is not paid). Still, there is no limit to total installed power.
The momentary surplus is injected to the grid.

Reward for electricity surplus
The momentary surplus that is injected to the grid may be sold to the LRS at pool price.
Again, the customer maximizes its return by consuming as

much energy produced as possible, since the energy surplus is sold at 90% of the wholesale price (a 10% fee is charged for market services) that may not represent its LCOE (Levelized Cost Of Energy).
These conditions are only applicable to units with less than 1 MW and with a renewable energy source. A 10-year contract is established with the LRS, with optional 5-year renewal periods. The remaining units may sell the electricity surplus through bilateral contracts.

The customers' self-consumed energy can benefit from future transaction of Origin Guarantees (OG) if the energy source is renewable. The energy sold to the LRS does not entitle the costumer to receive OG.

Additionally, new prosumer units larger than 1,5 kW will have to pay a compensation to support part of the policy charges (which represent about 60% of network tariffs) that depends on the units' installed power and is paid monthly during a 10-year period. Only units installed after the UPAC unit's share of total power system capacity reaches 1% are going to pay this compensation. The compensation importance increases for units installed after the share reaches 3%.

Evolution

The first UPAC units were only registered on March of 2015, a few months after the decree's approval. Since then, not only their number has considerably increased, but also their capacity, with some large units being installed. By the end of 2015 the number of units added up to 2 606 with a total power of 17,7 MW - the 50 largest units had a capacity of 15 MW.

Most of the UPAC units are solar PV, with a few cases being powered by wind turbines. Some customers with CHP (combined heat and power) units are also opting for this regimen after their feed-in tariffs contracts end.

The Figure 3 shows the aggregated evolution of both the number of new UPAC units and installed power capacity.

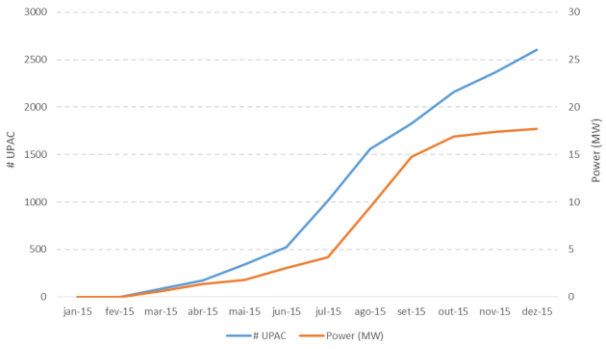

Figure 3 - Evolution of UPAC units and power capacity

This growth trend both in number of units and power is also observed in the first two months of 2016. Considering a scenario where the capacity grows with a rate similar to the one of these two first months, by the end of 2017 the installed capacity will have more than doubled.

SIMULATIONS

To study the impact that the UPAC units' penetration will have on the tariffs revenues, three growth scenarios until 2025 are analyzed. As the UPAC are mostly powered by solar PV technology, the scenarios presented consider the forecasts of new solar PV units.

The first scenario, referred by several authors, foresees a compound annual growth rate (CAGR) of 10% until 2025 [5][6].
The second scenario foresees a CAGR of 20% until 2020 and 14% in the period of 2020 to 2025 [6].
The third scenario considers a CAGR of 47% until 2025. It assumes that solar PV will grow at the same rate than the average growth in the period of 2001 to 2015 [7]. The different scenarios are depicted in Figure 4.

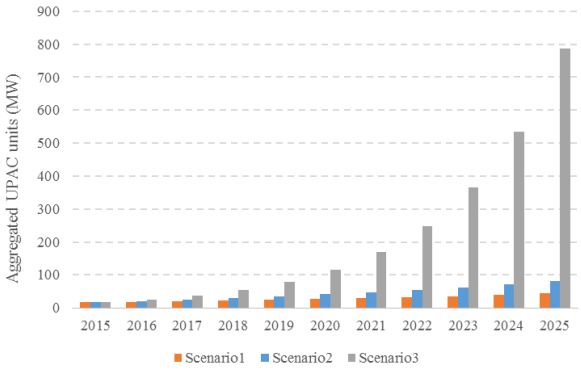

Figure 4 – UPAC's power growth scenarios

To calculate the impact on the tariffs revenues several assumptions were taken:

- The tariff structure remains the same;
- All the calculation were based on the tariffs published for 2016 by ERSE and a 1% yearly tariff raise is assumed until 2025;
- The UPAC's production profiles published by ERSE were used;
- The power system capacity evolution in Portugal was based on the TSO development plan;
- The evolution of the distributed energy in Portugal was based on internal forecasts;
- The number of costumers and their contracted power was assumed constant until 2025.

The Figure 5 depicts the total amount, in million euros, not recovered yearly by grid access tariffs as a result of a lower level of energy demanded by the costumers.

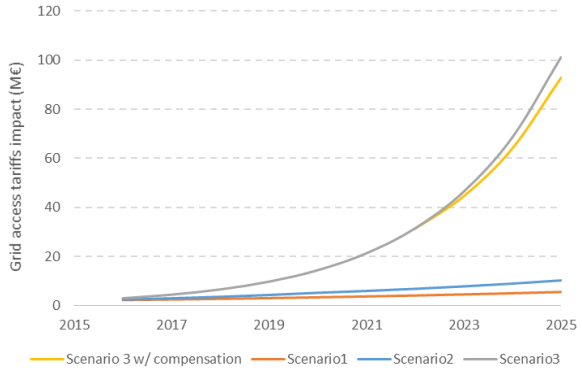

Figure 5 - Grid access tariffs impact

As shown in Figure 5, scenarios 1 and 2 have no major impact on tariffs until 2025. Consequently, the increase in the grid access tariffs to recover this costs wouldn't be meaningful. Figure 6 shows the necessary increase (in percentage) in the grid access tariffs to cover all grid costs.

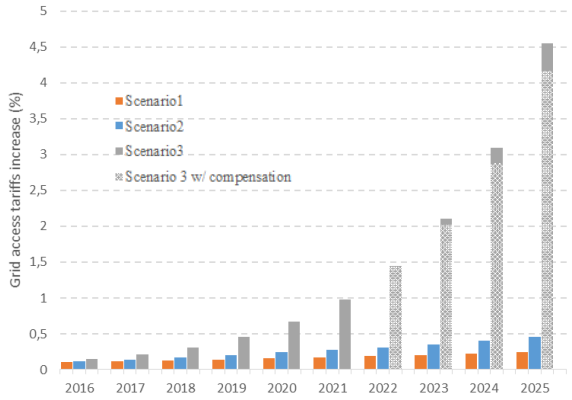

Figure 6 – Grid access tariff increase (%)

Analyzing Scenario 3, one can conclude that it has a significant impact on tariffs revenues, considering no modification is made to the tariff structure. In 2025 the total amount of tariffs revenues not recovered is about 93 M€, representing 2,6% of that year's total revenues. A total amount of 300 M€ is not recovered during the studied period (2016-2025).

In addition, one can verify that the UPAC's power capacity reach 1% of the total power system capacity in 2022. From that year on, new UPAC units start paying the compensation referred in the previous chapter (orange line). Even with this compensation, the gap between tariffs revenues with and without UPAC's effect is still considerable and a 4,5% tariff raise in 2025 would be necessary to reverse it, as is shown in Figure 6.

CONCLUSION

The new self-consumption regimen opened up the options costumers can take regarding their electricity consumption. As a result of customers' awareness and the easy access to regimen, there are already more than 2500 units registered under this regimen, spread across all customers' categories. Considering this good acceptance, one can foresee more and more units being installed.

Most UPAC units are powered by solar PV, so the peak demand that occurs at evening during the winter will not be curtailed by their production. As the grid is designed to sustain this peak, its costs will be of a similar dimension. In addition, as the grid access tariffs are currently designed to recover most of its revenues through volumetric charges, the total amount recovered will be smaller due to the decrease in the energy provided by the grid.

Despite the compensation that UPAC units will pay to support part of the policy charges, the results showed that it won't be enough to cover the gap in the grid access tariffs revenues, thus making a tariff raise mandatory. This raise would mostly impact customers that did not joined this regimen, making it even more appealing.

The results proved that a revision of the tariff structure and UPAC activity, namely the compensation, must be made in order to guarantee that real benefits and costs are correctly assigned to the different end-user categories. Otherwise to recover the grid costs, the tariffs will have to be raised, making the prosumer option even more appealing and compromising the system's financial stability.

REFERENCES

[1] EURELECTRIC, June 2015, "Prosumers – an integral part of the power system and the market".

[2] "Decreto-Lei n.º 153/2014", *Diário da República, 1.ª série – N.º 202* (20th of October of 2014), 5298-5311.

[3] "Decreto-Lei n.º 68/2002", *Diário da República, 1.ª série— N.º 71* (25th of March of 2002), 2837-2839.

[4] Simshauser, Paul, 2016, "Distribution network prices and solar PV: Resolving rate instability and wealth transfers through demand tariffs", *Energy Economics* vol. 54 (2016), 108-122.

[5] Photovoltaic Technology Platform, June 2015, "PV LCOE in Europe 2014-30 – Final Report.

[6] AGORA, February 2015, "Current and Future Cost of Photovoltaics".

[7] MIT, 2015, "The Future of Solar Energy", 125-151.