Self-consumption as the new Holy Grail of the PV industry: From theory to reality

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ABSTRACT

There has been rapid development of renewables in Europe in the last decade thanks to various support schemes. These are now part of the electricity reality in Europe and will continue driving the energy revolution in the coming years. In the PV sector in particular, feed-in tariffs (FiTs) have proved quite successful: at the beginning of 2010 more than 51GW of PV systems were connected to the grid in the EU, compared to less than 5GW five years earlier. This translates to 2% of the electricity demand being fulfilled by PV systems in the EU27. But all coins are double-sided: FiTs have proved to be too successful in several countries, inducing uncontrolled market development. The time has come to identify how these mechanisms – and in particular support schemes based on pure electricity injection – should evolve in order to manage a sustainable transition to competitiveness.

Introduction

In a 2011 study [1], EPIA showed how PV competitiveness could be reached in the largest EU countries by 2020 given adequate political support. Since then, PV system prices have fallen more quickly than expected, resulting in competitiveness happening earlier, especially in countries that were close to a certain level of competitiveness. In addition, the current financial downturn, which has evolved into a real economic crisis, is putting any kind of policy under pressure, increasing the financial burden on taxpayers or electricity consumers.

All these elements together are driving towards new, renovated or complementary support schemes for renewables in general and PV in particular. PV especially is by nature decentralized, and a large portion of the market (70% in the EU in 2011) concentrates on rooftop installations, the electricity from which is consumed on site. This paves the way for a wide-scale development of support schemes based on compensation for local consumption of generated electricity, rather than focusing on electricity production only (as currently is the case of feed-in tariffs (FiTs) or green certificates).

This concept of compensation is fairly new in the PV sector. FiTs and similar support schemes were conceived for other types of renewable plant producing electricity for injection into the grid – wind turbines, biomass plants and geothermal plants. Since the schemes worked for these renewables, they were implemented in the same way for PV, with similar success. But the specifics of PV imposed a consideration of the main driver for investment in the rooftop segments: the compensation for local electricity consumption. With FiTs, the flow of electricity is measured in both directions and billed differently: consumers pay their electricity bill, while producers are paid for the electricity production.

This state of affairs has led to the rather strange situation where, despite real-time consumption, electricity is bought and sold at the same time. With the levelized cost of PV electricity (LCOE) now close to retail prices in certain countries and segments, this sounds rather strange and paves the way for compensation schemes: electricity brought to the consumer and electricity produced should naturally offset each other, either in real time or over a longer period of time.

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Self-consumption mechanisms

Compensation mechanisms are based on the idea that PV electricity can be used in the first place for local consumption, and that electricity should not be purchased from utility companies. There are several different options available for the part of the bill that can be compensated, depending on the country or region, as will be discussed next.

The mechanism of compensation in real time (or during a 15-minute time frame) will be called a 'self-consumption scheme.' A variant that allows compensating production and consumption during a larger time frame (up to one year) will be called a 'net-metering scheme.' In the latter, the network should be regarded as a long-term storage solution, with the PV electricity being occasionally injected without compensation and consumed later on.

Various intermediate schemes exist between these two. The debate has begun, however, to identify whether compensation can apply not only to the procurement price of electricity but also to grid costs and taxes.

Self-consumption ratios

It is widely accepted that a standard household running a PV system in central France or Germany can naturally achieve a level of self-consumption of around 30% (on a 15-minutes basis) without any specific measure being put in place. With regard to local consumption, the larger the system, the lower the self-consumption ratio. Optimization of the system size (annual production and consumption equalized) and the use of demand-side management tools, such as heat-pumps or a decentralized storage system, could increase that level to 70%. Reaching yet higher levels would require long-term local storage.

These relatively low levels can be explained by low consumption during weekdays in the summer, and high consumption in the winter at times when PV produces less electricity. On commercial or industrial rooftops, the self-consumption rate can be expected to reach 75% and above more easily because of the better correlation between consumption and production. Self-consumption rates of 100% are thus technically feasible, under conditions of size limitation for instance, and could therefore be considered equivalent to net-metering schemes.

Self-consumption incentivization schemes in Europe

In the last few years, several countries have implemented support schemes that aim to either replace or complete existing FiTs. The objective of all these schemes is to focus on the direct consumption of PV electricity in order to reduce or eliminate the associated FiTs.

The evolution in **Germany** towards incentivization of self-consumption started in 2011 with a premium tariff for self-consumed electricity. The remuneration was even higher if a rate of self-consumption over 30% was reached, encouraging prosumers to look for ways to increase their direct consumption ratio. Since then, the decreased generation cost of PV has prompted German authorities to consider self-consumption incentivization without a premium tariff: with the retail price of electricity in most cases now higher in the residential segment in this country than the generating cost for a PV system, self-consumption becomes obviously more profitable than an awarded FiT. The review of the German Renewable Energy Act (EEG) in 2012 has introduced a limiting factor for grid injection that can be interpreted as a way of favouring direct consumption. With a maximum injection of production of 90% for systems above 10kWp, the legislation sends the signal of a clear intention to favour self-consumption over pure production.

In **Italy**, the country's fifth energy bill – Quinto Conto Energia – introduced a specific self-consumption premium scheme which will be in place as from Q4 2012; the way it will work is very similar to the scheme introduced in Germany in 2011. The Scambio sul posto scheme will run in parallel: this was an initial (and complex) attempt to favour direct consumption, featuring a mix of net-metering aspects (especially for grid costs) and self-consumption (for electricity costs).

In **Belgium**, all regions have chosen a net-metering scheme for systems up to 10kW (10kVA). No remuneration is foreseen for the excess electricity generation that is then injected into the grid but uncompensated.

In the **Netherlands**, yearly-based net-metering is allowed for 'small users'. This applies to systems up to 15kWp with a grid connection limited to 80A in three phases, but compensation is received for only a maximum of 5000kWh. Consequently, this naturally limits the size of a system to meet this consumption in order to maximize the rate of return. Excess electricity generation can be sold at a price similar to wholesale prices (€0.05/kWh).

The case in **Denmark** is similar to that in the Netherlands, but limited to 6kW systems. The excess generation can be sold at €0.08/kWh (through a specific FiT).

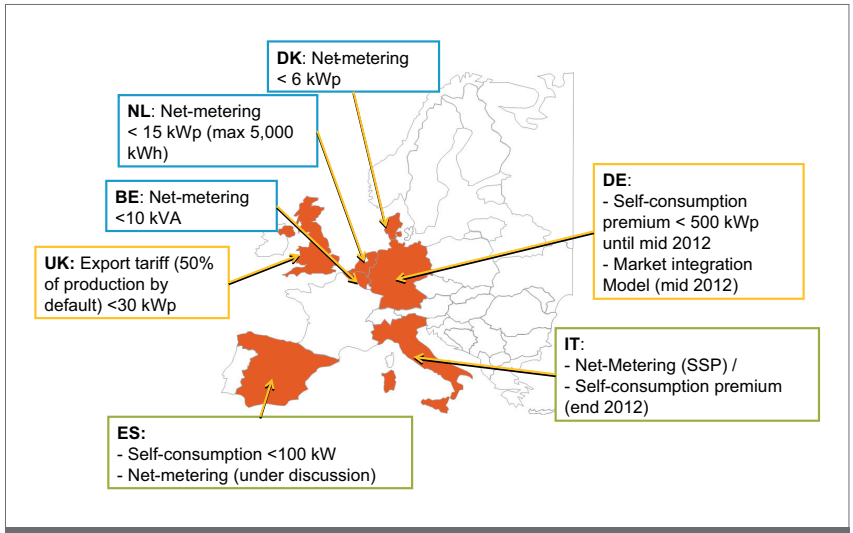

Figure 1. Overview of current net-metering and self-consumption schemes in the EU.

In **Spain**, self-consumption (without any specific premium) has been authorized since November 2011 for systems up to 100kW. The net-metering concept has not yet been finalized and discussions are still ongoing. A partial net-metering scheme could be introduced: the compensation of electricity would be granted on a yearly basis but some grid costs might have to be paid by the prosumer anyway. Moreover, the possibility of combining and net-metering the production from several users could be part of the discussion as well.

Finally, in the **UK**, the existence of an 'export tariff' for electricity injection into the grid (deemed by default to be 50% of PV production) could be regarded as an indirect self-consumption scheme. This system valorizes self-consumption, since the consumption invoice will decrease as the self-consumption electricity ratio increases.

Fig. 1 illustrates the situation in various countries in Europe: real net-metering systems exist in Denmark, Belgium and the Netherlands, and the scheme is being discussed in Spain. Self-consumption is favoured in Germany and soon will be in Italy too. Italy's Scambio sul posto is a hybrid scheme, with net-metering features combined with partial self-consumption aspects. The non-classical situation in the UK could be considered to be an indirect self-consumption scheme.

Comparison of existing schemes in Europe

Fig. 2 summarizes the different schemes in Europe that allow compensation. Italy, the UK and Germany favour self-consumption schemes, whereas net-metering is being considered in Denmark, Belgium and the Netherlands, and possibly in Spain in the future. The figure should be interpreted as follows:

- In order to compare all schemes, a residential household is assumed, with a yearly consumption of 3,500kWh and installed PV production of 3,300kWh per year.
- Of the electricity produced, 30% is instantaneously self-consumed and the remaining 70% is injected into the grid.
- The yellow bars represent FiTs for grid-injected electricity.
- In the case of net-metering on a yearly basis, part of the additional electricity needed for consumption is net-metered (i.e. withdrawn from the grid and debited against electricity previously injected) and the remaining part is purchased from the electricity retailer.
- The electricity consumed must be purchased from the grid operator; this is larger in the case of self-consumption, since with net-metering the total production compensates for electricity requirements (red bars).
- The net financial balance (green bars) is given by the total PV production minus the total grid withdrawal.
- The savings (purple bars) represents the money saved compared to a standard customer without a PV system.

Different points of view regarding self-consumption schemes

Direct consumption schemes have a major psychological advantage over FiTs: they consider only the difference between consumption and production, and therefore promote the very nature of decentralized PV. While FiTs show all electricity flows, compensation schemes focus on the net balance and look more closely at the physical reality of electricity exchanges between the prosumer and the grid. This is reflected in the exchanged cash flows as well in the reduced amounts being considered, which is an element of major importance in supporting PV

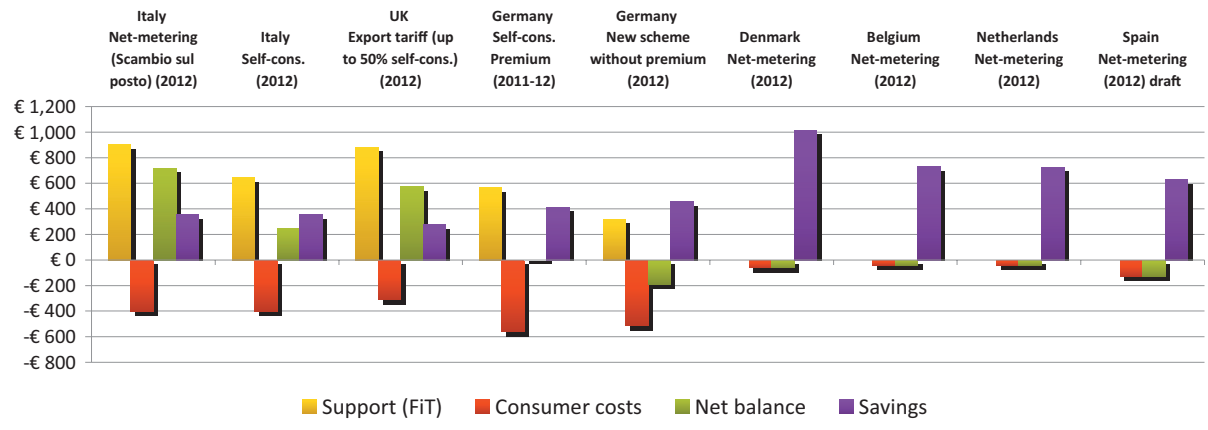

Figure 2. Yearly cash flow balance with self-consumption/net-metering incentives.

development during the transition to competitiveness, in a time of economic sensitivity for all players.

Depending on the scheme, the impacts on players in the electricity market could be quite different. First of all, electricity suppliers may have to support the cost of net-metering: this scheme obligates them to provide electricity for no charge during a part of the year, while PV produces excess electricity that is injected into the electricity network and therefore reduces the need for production. But whereas the reduction in revenues for the supplier is clear, the savings on the consumer side are less obvious. This imbalance could lead to severe opposition from suppliers with regard to accepting such net-metering schemes in the long term, while self-consumption does not trigger such opposition.

Grid operators may be the ones suffering the most from the situation: since grid costs are paid according to electricity consumption, prosumers will not pay part of the totality of their grid costs, in reality reducing the financing ability of grid operators. This situation is not specific to net-metering and affects self-consumption schemes as well.

Governments will see tax income decreasing as well. Although this is easily conceivable in a self-consumption scheme (if you grow tomato plants on your terrace, you do not pay taxes on these), net-metering schemes could force governments to find alternative ways to finance themselves through energy taxes.

Finally, from the consumer point of view, compensation schemes can be easily understood; in the case of self-consumption, the schemes encourage a positive behaviour by displacing part of the consumption during the production time. In the case of both net-metering and self-consumption, the evidence is that net-metering electricity flows can be a positive factor for enhancing PV acceptance. From a financial perspective, net-metering schemes maximize savings and eliminate the need for direct support to prosumers as soon as the LCOE of PV moves into the range of retail electricity prices: the cost of the support is transferred to the electricity suppliers, who absorb the long-term compensation costs. Self-consumption schemes, however, maintain cash flows towards electricity retailers.

> "Self-consumption schemes maintain cash flows towards electricity retailers."

Self-consumption and its impact on the competitiveness of PV

Either current compensation schemes are associated with financial support schemes such as FiTs or green certificates (Belgium), or they are considered as the sole support system, as in the Netherlands. All existing schemes at the beginning of 2012 considered the possibility of compensating taxes and grid costs at least for the portion of electricity that was consumed. But as we have seen, this does not happen automatically, and future compensation schemes may have to deal with partial compensation of either taxes or grid costs (or possibly both). In this case, the impact for prosumers on the competitiveness of PV can be quite important and should be taken into account.

Under the assumption that currently the retail price of electricity in Germany can basically be split into three equivalent parts, namely electricity, grid costs and taxes, the competitiveness of those PV systems with such a compensation scheme will vary. Fig. 3 highlights, for five different countries, the impact of non-compensation of taxes and grid costs on the incoming competitiveness of PV in the residential segment. Details for other segments have been published by EPIA in the second part of their study on competing in the energy sector [2].

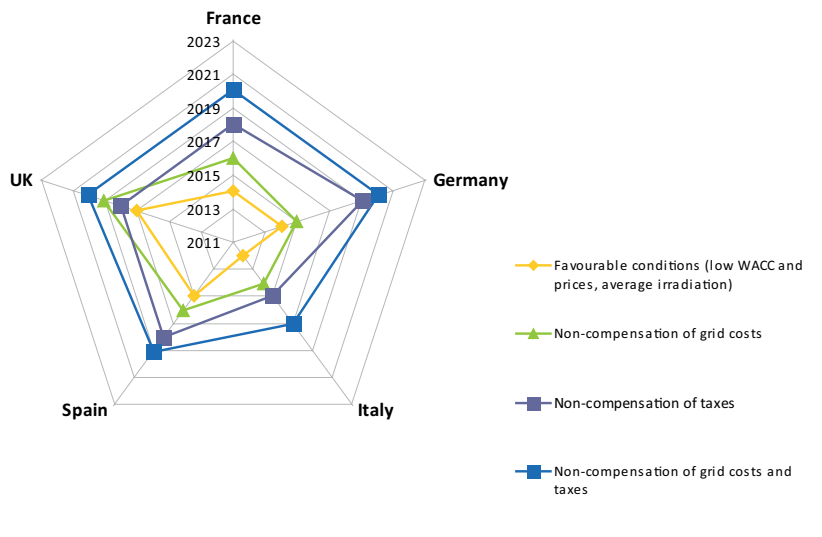

Figure 3. Impact of the non-compensation of grid costs or taxes on PV competitiveness in the residential segment.

Conclusion

The transition to competitiveness for PV is accomplished through adequate, intelligent support schemes that will progressively help to reduce and finally phase out existing FiTs. While the largest installations will require different support, prosumers in all market segments will finally have to compete with retail electricity prices. This transition could be smoothed by using compensation schemes such as the ones describe in this paper. Depending on local conditions, different versions of self-consumption schemes could be implemented and fine-tuned to accommodate country-specific needs.

> "Compensation could represent a smart and efficient means of paving the way for sustainable market development."

Net-metering schemes, despite their drawbacks, have already been successful in certain countries in kick-starting the development of some market segments. Discussions in Spain in 2011 and 2012 have indicated that this idea is not obsolete. While the Spanish market has evolved thanks to large systems, specific schemes (including net-metering) may need to be considered in the prosumer market, especially in the residential segment. In other countries with a large PV presence, compensation schemes certainly represent the future of PV development and require attention. Compensation could represent a smart and efficient means of paving the way for sustainable market development, on the basis of the natural competitiveness that PV is progressively achieving.

References

[1] EPIA 2011, "Solar photovoltaics competing in the energy sector – Part 1".

[2] EPIA 2012, study on grid integration to be presented in September at the *27th EU PVSEC*, Frankfurt, Germany.

About the Authors

Gaëtan Masson manages EPIA's Business Intelligence Unit, which is dedicated to studying market, PV competitiveness and industry development, as well as grid integration, technology and sustainability impacts of PV. He contributes to IEA-PVPS, where he co-represents EPIA in its Executive Committee. Gaëtan is an electromechanical engineer (Université Libre de Bruxelles in Belgium), and also holds master's degrees in political sciences, in management (from the Solvay Business School) and in environmental studies.

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