OPPORTUNITIES AND CHALLENGES OF PHOTOVOLTAIC (PV) GROWTH WITH SELF-CONSUMPTION MODEL

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Overview

The photovoltaic (PV) system is one of the promising technologies for power generation as it provides an abundant energy resource and lends itself well to decentralized systems. The Feed-in-Tariffs (FIT) system has played an important role in the recent PV market growth, providing incentives to investors. Policy support with a long-term vision has helped stimulate PV demand and accordingly attracted industrial investment, thus leading to more cost reductions via economies of scale in manufacturing. The FIT system is an effective tool but needs a sophisticated price design mechanism to avoid any uncontrolled market development. The FIT scheme is very tariff-sensitive policy instrument containing a risk factor; investors aim to maximize windfall profits from a margin of the marginal PV electricity generation cost and the fixed tariff. Under the FIT system, there are installation peaks just before the application of new reduced tariffs.
The global PV market needs a new approach that is more stable to incite further PV growth. Since energy systems evolve with the aim of supplying energy to end-users at the lowest possible costs, energy policy should aim to minimize PV electricity costs, while minimizing grid integration costs and risks as PV penetration progresses. The PV system's integration in the current or future energy system can be justified when such efforts are based on the way of improving social welfare.
In this context, this article explores opportunities for PV electricity use under a self-consumption mechanism to find ways of PV penetration growth. The objective is to find better ways of increasing PV installations in a society with least costs. The promotion of self-consumption of PV system can be a more natural way of using PV systems. It can improve the use of PV electricity in the current and future energy system if applicable under a properly designed framework.

Methods

The study aims to look for opportunities of PV electricity use under a self-consumption mechanism following the steps below.

1. Explore new opportunities based on a model of self-consumption
   - Present the PV self-consumption model
   - Conduct stakeholder analysis: Identify stakeholders of PV self-consumption and understand their interests/ influences
   - Define policy risks and mitigation strategies
2. Conduct a micro-economic case study to quantify self-consumption opportunities: France's existing supermarkets
   - Present key data & assumptions
   - Demonstrate possible opportunities of PV electricity use in the building sector
   - Identify possible impacts on stakeholders and mitigation strategies
3. Policy recommendations/conclusion

Results

A micro-economic case study has been conducted to review opportunities for the PV self-consumed model by using the existing surface area of supermarkets in France. Possible challenges and risks under this model are also considered so as to better prepare future strategies. From the simulation, we were able to conclude that the supermarket sector fits well with PV self-consumed usage model for PV power for the following reasons:

1. Opportunities to utilize the existing large surface areas to install PV modules on the roof
2. Good correspondence between onsite consumption and produced PV power: almost all power generated can be self-consumed
3. The new mode will reduce electricity peak demand purchased from the grid with self-consumption of PV power, thereby reducing pressure on the grid
4. Grid reinforcement is not needed: PV electricity production never exceeds the electricity demand level of supermarkets.

We have also found that possible nation-wide PV installations in France could represent 2.56 GWp on the condition that all the existing supermarkets in question install the PV systems on their roofs. This accounts for 47% of the total French PV installation of 2015. The total annual PV production in Paris is 148 kWh/m2, which is around 23% of supermarket consumption. This means the model contributed to increase the energy independence of supermarkets to 23%. If we consider that production in Paris is representative of the French average production, the total possible production could reach 2.36TWh. The midday electricity demand peak in supermarkets is shifted to the end of the day. The impact is greater during the summer than in winter and depends on the local configuration; the demand peak is reduced by around 55 W/m^2 in Paris during the summer, therefore putting less pressure on the grid. The peak shaving result will produce larger positive results in regions or countries with a midday peak in summer.

In this regard, we have seen that the self-consumed PV system can maximize benefits with the best correspondence between onsite demand and production, encouraging better returns on investment than in poorly corresponding areas. Policy should promote targeted areas with the best correlation between onsite consumption and PV production peak like supermarkets. In addition, local PV production should be consumed locally to increase the self-consumption ratio on a local level. The PV self-consumed model may provide a good solution for congested regions or areas with grid problems.

However, the large deployment of the PV self-consumed model conflicts with some stakeholder interests. This can be threat factors when the government decides to develop the PV self-consumed model in the energy system. Therefore, possible strategies to avoid expected hindrance actions from stakeholders should be also considered.

Conclusions

Self-consumption using a proper mechanism can provide a way to improve the existing model of decentralized PV systems with better cost sharing as the energy transition takes place. The growing interest in the PV self-consumed model requires new business models which provide enough economic incentives to create a new mode of PV electricity consumption, while avoiding social losses particularly in terms of negative impacts on grid issues. To do so, well-designed policy support with a long-term vision is first needed to create the opportunities defined in this article. We also found that the stakeholder groups represent a threat to PV self-consumed policy when the new model conflicts with their interests. Therefore, it is necessary to prepare future strategies to mitigate the expected financial damage to other key stakeholders in order to alleviate such policy risks.

With appropriate political support, the deployment model can also provide PV growth opportunities. The model proposed in this study provides us with the basic information need to further analyze and define the global PV market for the future. From a strategic perspective, the PV self-consumed model should be applied in sectors with the best correlation between the load profile of electric consumption and PV production, so as to gain the best results. In the future, as electricity prices continue to rise while PV system prices goes down, the PV self-consumed model will benefit from better conditions for its application. The economics of the PV self-consumed model will greatly improve, making the model profitable for other sectors whose correspondence ratios are poorer, e.g. residential. Before achieving the ideal level, current policy should aim to prepare targeted strategies for each sector, e.g. residential, commercial and industry, so as to achieve the best results.

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