A PROSPECTIVE ECONOMIC ASSESSMENT OF RESIDENTIAL PV SELF-CONSUMPTION WITH BATTERIES AND ITS SYSTEMIC EFFECTS: THE FRENCH CASE IN 2030

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Overview

PV power has largely gained economic competitiveness over the last decade faced with the globalization. Consumers are likely consider adapting a PV self-consumption to reduce their energy bill. The end-user's economic calculation will be based on electricity tariffs that they pay to assess the profitability of PV self-consumption model. At the same time, the economic model of PV self-consumption in the residential sector will be improved by coupling with the battery solutions (e.g. Li-ion battery is one option). End-users will be more willing to switch to the self-consumption of PV electricity instead of purchasing power from the network if the combined PV model allows them to pay less for their electricity use. Furthermore, the PV self-consumption model would increase the individual energy independency (this inversely indicates political challenges in terms of national energy system planning). However, this perspective should be broaden to explain the real costs of PV power in the system. For example, in France, electricity tariffs paid by end-users also include grid financing and taxes. Therefore, policy makers should consider the potential risks and systemic impacts caused by outflow of the electricity consumption from the grid. If the demand for PV self-consumption rapidly increases in the near future energy systems, systemic issues will be raised related to an optimal mix of PV power and grid management (drastic change in mix is possible). Governments must prepare the transition towards PV self-consumption to maintain the security of the national energy system. It is thus necessary for policymakers to anticipate the timing of this transition.

In this context, this study aims to evaluate the economic analysis of French residential PV systems coupled with lithium-ion (Li-ion) batteries. The objective is to identify possible systemic risks of PV integration and to anticipate possible ruptures in the residential sector. The article defines the future demand for residential PV systems created by the enhancement of economic competitiveness of the systems. French case can provide a late bound scenario for the transition towards distributed PV systems because of the high PV system costs and low electricity tariffs. The calculation was conducted based on the learning curve approach and IEA energy scenarios. We calculated the PV LCOE in 2030 based on the International Energy Agency (IEA) scenarios using the estimated costs of Li-ion batteries. The ultimate goal of article is to give political messages in preparing future energy scenarios related to PV self-consumption. It enables policymakers to prepare for the future transition toward PV distributed systems based on strategic orientation. The study concludes with key messages and policy recommendations to prepare the proper institutional and political strategies.

Methods

- **Economic analysis of residential PV systems with Li-ion batteries in France in 2030**: this aims to figure out potential ruptured scenario in the future residential energy systems caused by continuous advancement of economic competitiveness of PV systems and batteries.
- **Sensitivity analysis of PV LCOE in 2030**
- **Systemic analysis of PV integration impacts on energy system** under the identified scenario: this identifies possible systemic effects of PV integration (e.g. impacts on load duration curve, loss related to grid financing...)
- Discussion about the results of analysis by taking concerned stakeholders into account
- Conclusions with political messages

Results

Firstly, our study produced the result of the residential PV system costs in France in 2030 from 1.5 \$/Wp (hi-Ren scenario) to 2.19 \$/Wp (6DS scenario).

$$BIPV\ system\ price\ in\ 2030\ (2DS) = 2.67 \times \left(\frac{227}{842}\right)^{-\frac{ln(1-18\%)}{ln\ 2}}$$

Secondly, we highlighted the added value by coupling with the storage system in the residential PV systems. As an example, lithium ion (Li-ion) batteries were considered; they are one of the most developed storage technologies with potential cost reduction by economies of scale in the coming near future. As below Figure shows, many studies expect that the price would be further fallen between 100$/kWh and 150$/kWh in 2030 with a stabilized price. These reduced prices of battery would bring synergies related to the residential or commercial usage of the PV systems. In this regard, our calculation considered a price of 500 $/kWh in 2015 and a price of 150$/kWh in 2030.

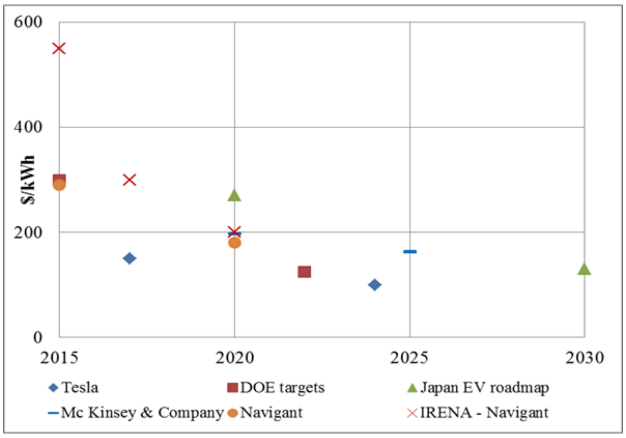

Figure 1: Projections of Li-ion battery costs

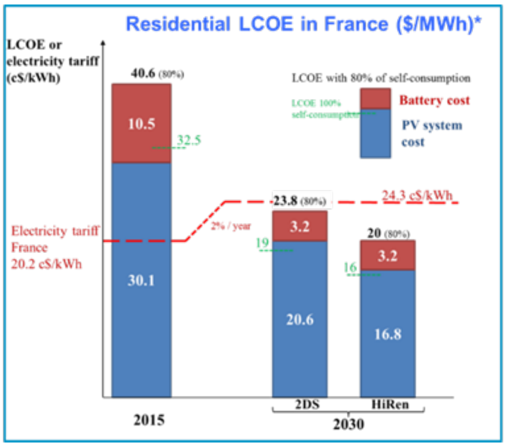

Figure 2: Residential PV system LCOE with batteries in 2030 (France)

Finally, based on our economic model, the considered PV systems with batteries are currently far to the break-even point in France, but they would become almost competitive in France by 2030 under all IEA scenarios (see Figure 2). The variation of several parameters will be further explained in our sensitivity analysis. However, what if 18.8 millions of French individual houses suddenly decide to install PV systems for their economic gains? The national electricity system would undergo dramatic changes. Our study thus figured out the quantified systemic impacts. For example, we demonstrated how the identified transition scenario change the load duration curve of French electricity mix.

Conclusions

This study has shown that PV self-consumption with batteries could become profitable in France before 2030. The demand in the residential sector would thus be natural in the next 15 years in France. It is also possible to advance the timing by improving PV economic competitiveness (e.g. non-module share in the PV system price). In this regard, the demand in PV self-consumption would be created naturally in the future. However, expanded PV integration through a self-consumption model raises new issues related to changes in the interests of stakeholders in the energy market. It must not be forgotten that PV self-consumption induces losses in terms of the network funding (loss of grid operator revenues). Policymakers will have to prepare for this change. It is very important to prepare a regular and progressive policy for the transition to PV self-consumption. This should enable the relevant stakeholders to have enough time to adapt to the new market situation. In addition, the policy would put more focus on limiting the systemic impact of PV power in the future as PV penetration becomes significant. How policymakers prepare for this change with a proper institutional framework supported by a long-term vision will affect the success of PV integration.

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