IMPROVING THE BUSINESS CASE FOR CONSUMER-LEVEL ENERGY STORAGE IN THE UK

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Overview

UK electricity consumers are supported by the Government's Feed-in Tariff (FiT) scheme, which offers them a financial reward for each kWh of electricity generated from renewable technologies, and additional payments for each kWh of electricity exported to the grid. However, electricity is typically exported at times of low demand, meaning that this electricity is likely to be curtailed.

Energy storage technologies can provide value to electricity consumers who own a solar photovoltaic (PV) micro-generating system, particularly due to their ability to provide the services of peak-shaving, cost reduction and management. Using a linear programming optimization model, we show that it is not profitable for consumers to invest in storage technologies at their currently high costs. However, given the potential of energy storage to reduce the consumer's operating costs by shifting energy in time, policies aimed at supporting the technology are necessary to enable a widespread deployment of energy storage systems among consumers. As the capital cost of energy storage falls over time, these policies will become increasingly valuable.

This paper aims to understand how the current FiT scheme can be modified to simultaneously incentivize the deployment of both solar PV and energy storage technologies among UK electricity consumers.

By developing a mathematical model that solves for the optimal generation tariff, this paper demonstrates that it is possible to improve the business case of consumer-level energy storage technologies by setting a zero or negative FiT export tariff whilst simultaneously raising the FiT generation tariff in a way that does not negatively affect the business case for solar PV. Moreover, we show that such a policy eliminates incentives for consumers to export electricity to the grid during off-peak times, which improves network conditions and, especially, reduces the curtailment of renewable energy.

Furthermore, our analysis indicates that consumers are always better off with dynamic tariffs, independently of the combination of energy technologies they own. This is also true for consumers who do not own any technology at all. Our results also show that, over the studied period 2016-2042, energy storage never improves the value of solar PV systems to a typical UK consumer, both at current and 90%-lower, future battery costs. Although storage improves consumers' self-consumption of renewable energy and reduces their operating costs, these reductions are insufficient to offer any meaningful contribution to the business case for solar PV. This result is directly attributable to the low average levels of insolation in the UK. Hence, extending this approach, to study potential policies aimed at integrating storage in other markets, could be a fruitful exercise.

The results reported in this paper are useful to design appropriate incentives to improve the integration of consumer-level energy storage in the UK.

Methods

We propose a robust method for minimizing the operational costs of a household electricity consumer. The optimization of operational costs ensures that the consumer is able to gain the highest performance from their onsite generation and storage assets. We employ a linear programming approach to minimize these costs, which explicitly considers different electricity tariffs and subsidy regimes.

The second part of this paper employs a dynamic mathematical model to evaluate consumers' investments in solar PV and energy storage. This model derives the optimal digressing FiT generation tariff level that improves the business case for energy storage without altering the profitability of solar PV. This exercise is designed to enable the abolishment of the FiT export tariff with the aim of simultaneously reducing system costs.

Results

This paper shows that it is possible to improve the business case for consumer-level energy storage technologies by increasing the FiT generation tariff whilst setting a zero or negative FiT export tariff, in a way that does not alter the business case for solar PV. This policy provides additional benefits to the system because it eliminates incentives for consumers with solar PV to export electricity to the grid during periods of low demand, thereby reducing renewable curtailment and system costs, and improving the security of electricity supply.

Other results indicate that consumers are better off with dynamic time-of-use tariffs, independently of the combination of energy technologies they own. This is also true for consumers who do not own any technology, although most consumers currently pay static tariffs for their electricity. We also show that energy storage is unable to improve the value of solar PV systems to a typical UK consumer, both at current and 90%-lower, future battery costs. This is due to the low levels of insolation in the UK, meaning that the resulting improvements in self-consumption and the reduction in operating costs, attributable to the use of a supporting battery technology, are insufficient to offer any meaningful contribution to the business case for solar PV.

Conclusions

Among our result, we show that, by setting a zero or negative export tariff, it is possible for policymakers to eliminate incentives for consumers to export electricity to the grid at times when this electricity is not required by the electricity system. We show that, by raising the generation tariff to a level which maintains a constant level of income to holders of solar PV systems, it is also possible to improve the business case for storage, and reduce the curtailment of renewable energy. However, our work also shows that, as a result of the low levels of average insolation in the UK, energy storage is not a profitable investment for the typical UK consumer, both at current and 90%-lower battery costs, and that it is essentially unable to improve the consumer's business case for solar PV technology.