3 Challenges: increasing electricity price and environment tariff

According to the BEIS price of the electricity procure, the electricity procurement price of large consumers whose annual consumption is higher than 20,000MWh has increased as much as 46% during the last decade [1]. Furthermore, the electricity cost and environmental tariff will increase the total operation cost for the energy-intensive industry by 4.9% in 2030 [2].

Research objectives

Due to the regulatory framework of the carbon emission reduction and initiatives to operate a sustainable business, large consumers like Sainsbury have installed a large number of demand response assets like combined heat and power generators to save electricity cost while limiting their carbon emission. The thesis proposed strategies to rise the large consumers’ profit margins by leveraging their demand response assets. This is achieve by:

- Sourcing the opportunities for large consumers to cut down the electricity bill
- Quantifying the opportunity cost of different alternatives
- Investigating the cost reduction ability of different demand response assets
- Proposing strategies for large consumers to reduce the electricity procurement cost
- Researching the impact of price fluctuation

Opportunities: revenue streams and cost reduction practices

Conventionally, most of the electricity demand is settled in long-term forward contract to secure the electricity price. Wherein, short term demand will be offered and bid in the power exchange market in a prompter time scale. Any imbalance between the market supply and demand caused by the uncertainty between the market prediction and actualities will be addressed by the Balancing Mechanism (BM) and associated reserve and frequency response services. After the delivery of the electricity, the penalty will be imposed on those who have a discrepancy between the scheduled electricity flow and the actual electricity transition.

Revenue Streams

- Short Term Operating Reserve (STOR) Reserve capacity for balancing the system demand uncertainty
- Enhanced Frequency Response (EFR)
- System frequency maintenance service which provides service within 1 second or less
- Firm Frequency Response (FFR)
- System frequency maintenance service which provides service within 2 seconds to 10 seconds services
- Balancing Mechanism (BM)
- Tender for increasing or decreasing the demand

Cost Reduction Practices

- Energy Arbitrage Charging battery at low electricity price and discharge it at high price
- Energy Export Exporting the electricity to the grid
- Flexible procurement allocation Purchase the energy from power exchange market to get the advantage of fluctuation of the electricity price

Conventional strategy framework vs Proposed strategy framework

Case Study: Sainsbury Leicester North Store

Analysis was performed under the following scenarios to deliver the insight of different strategies:

- Business As Usual (BAU) scenario
- Programmed CHP operation strategy
- Proposed Electric Procurement Strategy
- CHP scenario
- CHP with ESS Storage System scenario

Optimal Strategies

Optimization models used price data from past three years to calculate the electricity cost at a best case scenario. The optimization results showed the minimum cost the store can get.

Baseline Strategies

Preliminary analysis had revealed some common features for proposed strategies to reduce the electricity cost. These features working as baseline will not change with the alteration of revenue streams and practices.

Performances of the proposed strategies

The sensitivity analysis studies the impact of the price change in the profitable revenue streams and energy import sources on the total electricity procurement cost.

Key findings

- The proposed baseline strategies are efficient in reducing the electricity import cost
- The ESS system can significantly reduce the electricity cost
- The top 3 approaches in reducing the total electricity cost are Energy arbitrage, STOR and BM, which have potentials to reduce 54%, 51% and 50% of the total cost
- The profit of revenue streams is sensitive to the change of the price, whereas the change of the importing price has little effect on the total electricity cost

References