CASE STUDY: ESS INTEGRATION TO AVOID WIND CURTAILMENT

Objective

To avoid wind curtailment and analysis of multiple revenue streams for Energy storage integration with a wind firm situated in the state of Tamil Nadu.

Background

Installed capacity of the wind farm is considered as 20MW. Due to high seasonal fluctuation of wind, there is a high curtailment at different feeders at different hours. Most of the curtailment happens from 11 PM to 5 AM. Based on generation, different seasons have different levels of curtailment. In the higher windy months from June to October generation is higher; as a result curtailment is also higher. But in other seasons from November to April (low windy season), curtailment is also lower.

Curtailment per turbine varies from 1200 MWh to 1800 MWh for different feeder lines.

Solutions

We have analyzed various ESS applications for the wind farm in Tamil Nadu, India using hybrid storage solutions that involve a longer duration storage technology such as NaS battery with 6-7 hrs of discharge capability and a short duration Li-Ion battery with 15 min of storage capacity.

Analysis

Due to variations in wind power generation, the conventional generation needs sudden ramping or backing down. Tamil Nadu state grid faces problems with evacuation of this power particularly during off-peak hours when the demand goes down. There are also regulatory constraints of not dispatching more power than the scheduled power. As a result the wind farms in the region are advised by the state load dispatch center to back down wind power output during off peak season. Data provided suggests that the wind power curtailment takes place for 4-6 hours during the off peak season.

Figure 1 shows average daily forced curtailment for the wind plant across feeders for the year 2013-14.

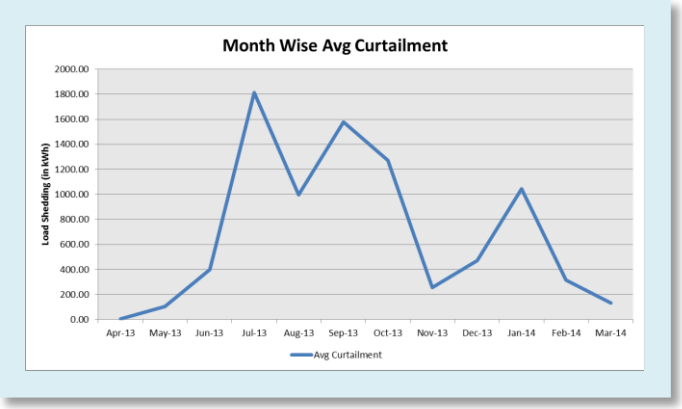

Figure 1: Average daily curtailment/ feeder

REVENUE STREAM ANALYSIS

For Energy storage integration, Utilization of multiple value streams is the key to get maximum value out of the assets. Under current regulations in India, there are few value streams which can provide revenue for energy storage, but in future multiple value streams could generate higher revenue for the project.

So under current regulatory framework, there are few applications which can provide revenues from ESS integration.

Case I: Based on existing market mechanics

- ❑ Capture of curtailed wind power: Both NaS and Li Ion will be used for this.

Case II: Potential revenue streams but need some changes to existing market rules

- ❑ Working as a Peaker using NaS
- ❑ UI optimization through Scheduling using Li-ion

ECONOMIC EVALUATION

To avoid wind curtailment, CES has evaluated hybrid solutions for ESS integration with two technologies under consideration - One is Lithium Ion, short duration storage and other one is Sodium Sulphur (NaS), long duration storage.

Longer duration storage could be used for capturing lost wind revenues from curtailment immediately. At the same time, with minor changes in regulatory

structure, it could also be used for converting wind farm output to firm power. Bust since there is some regulatory uncertainty about this structure, we have considered this revenue stream as future revenue.

Similarly for short term application, currently there is no viable revenue stream. CERC had come up with RRF mechanism notification in July, 2013 which had a provision for scheduling of wind power. It also had a provision of imposing penalties beyond 30% deviation from the schedule. But, due to heavy resistance from the stakeholders, CERC has withdrawn the commercial part of the notification. At present, wind power generators are required to schedule the power. With the new Government having plans to go aggressively on RE front, there needs to be some disciplinary mechanism in place to control the RE power variations and make the grid stable. CERC is planning to come up with some alternate mechanism shortly.

PROJECT ECONOMICS

In Case (1), under existing regulatory provisions, curtailed wind power captured and sold under Feed-in-Tariff PPA price by storing it with hybrid storage system provides only 1% return on capital (ROC). Hence this option is not commercially viable. Below we analyzed case (2), where project is feasible with higher IRR.

Project Economics				
	Technology used	NaS	Li-Ion	
	Applications	Working as a Peaker	UI Optimisation	
Technology Configuration				
	Power Rating	2.50	2.50	*MW*
	Duration	0.25	6	*hr*
	Energy Rating	0.625	15.00	*MWh*
	Efficiency	80%	85%	
	Capex (INR Crore)	72,50,000	10,00,000	*USD*
Outcomes				
		It captures curtailed power and sells at peak hours to commercial consumer	It tries to minimise penallty by charging and dischrging actual generation to balance frequency	
Potential Revenue				
	Expected Revenue	6,36,334	1,08,786	*USD*
Investment Matrix				
	Return on Capital (ROC)	9%	11%	
	Simple Payback Period	11	9	*years*

Table 1 : Economic Evaluation Results

Under option (2: A), instead of selling captured power at PPA price, selling at peak hours with higher commercial tariff may provide better return on capital for NaS Storage. With current cost of storage, it can provide 9% return on capital (i.e. ~11 years of simple payback). In addition to NaS storage, if we could add Li-Ion storage for another application (UI Optimization) then this hybrid ESS system can provide better payback.

The Option for UI Optimization (2: B) with short term Li-Ion battery is most attractive with ~11% ROC (i.e. ~9 Years of simple payback). But, as per PPA provisions all the power generated from the unit is tied up under PPA and any part of the power if provided to other entity can violate the terms and conditions of the PPA. The Forum of Regulators is discussing about introducing peaker tariffs. But it may take time for introduction.

Suitable financing options and lower interest rate will make the project financially feasible. With government regulations like AD benefits for the Project will provide better ROI to the developers.