INTEGRATING RENEWABLE AND GRID MANAGEMENT

Chinmoy Sarkar *AddL. GM (EMD) NTPC Ltd.*
D-03 PTS NTPC Kahalagaon, Bhagalpur Bihar
Mb. 9431609665; Email- csarkar@ntpc.co.in

Shadab Alam Khan, *Manager (EMD), NTPC Ltd.*
C-07 PTS NTPC Kahalgaon, Bhagalpur Bihar
Mb.9473196545; Email- sakhan@ntpc.co.in

Indian power industry is going through tumultuous change. With the coming of renewable energy resources and its steady development, India's energy mix is changing and throwing many challenges to integrating renewable energy into the grid. The share of renewable in electricity mix is expected to increase from 13.5 percent in 2015 to 20 percent by 2022. The government has set an ambitious target of 175 GW of installed renewable energy capacity by 2022. Though it is welcome from the energy security and environment point of view, it will through up new challenges to the grid management. The problem of grid management will emerge due to variable, intermittent and uncertain nature of renewable energy resources. This is sum up as volatility of renewable. Due to this volatility of solar and wind power and its increasing share in electricity mix, balancing load and generation, managing voltage, frequency and reactive power have become increasingly difficult and challenging which needs to be addressed.

Owing to the various facts, solar energy is getting momentum. The capital cost of the solar PV plants (based on benchmarks determine by CERC) has plumbed between 2012-13 and 2016-17 from Rs 100 million to Rs 53 million per MW. Meanwhile tariff for solar power plant have declined significantly from Rs 12.5 per unit in 2010-11 to Rs 4.34 per unit in 2015-16 (as discovered through competitive biddings)

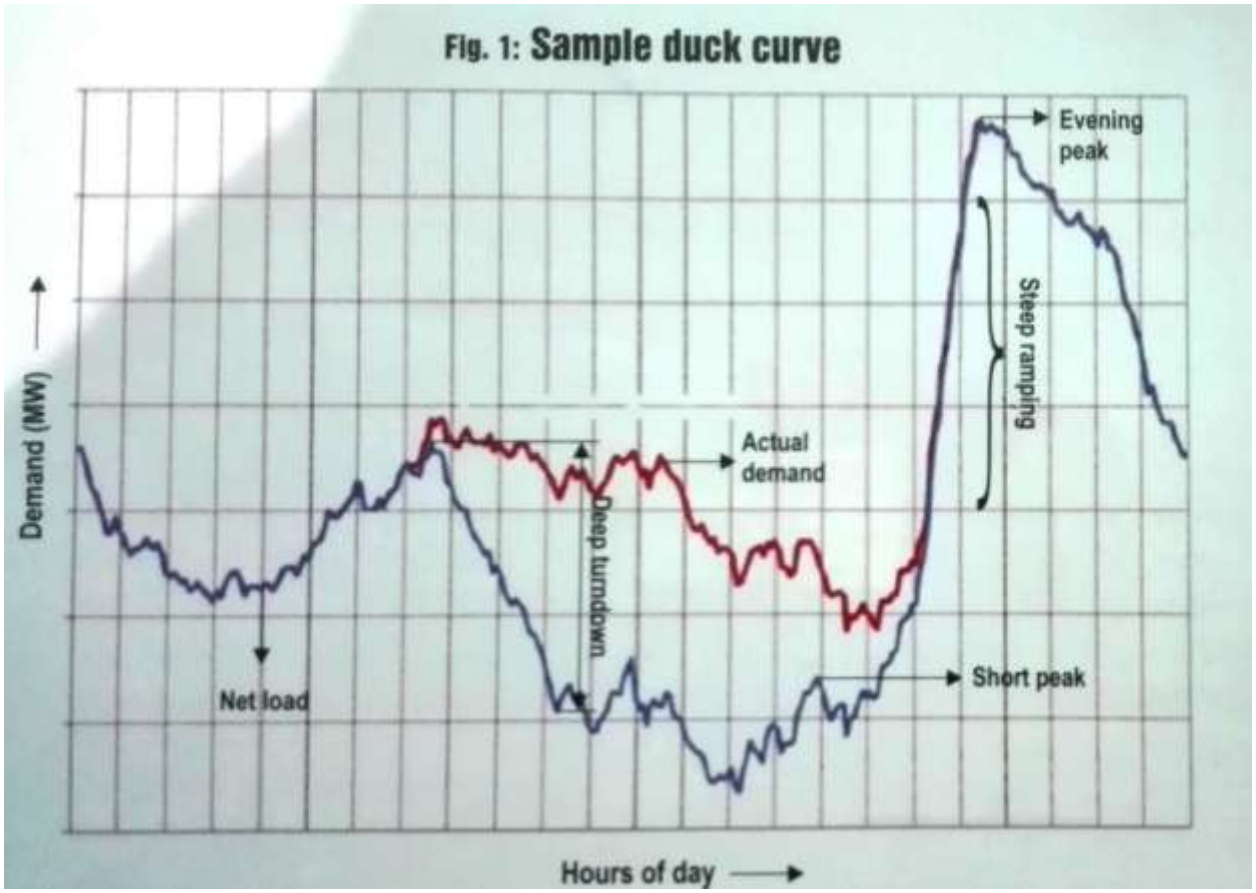
Further, if solar energy penetration is high, there will be major backing down of thermal power during the day. It will also have to ramp up very quickly when the sun sets, giving rise to risk of curtailment, unless systems are backed up properly in terms of storage or having enough flexibility to draw energy from other sources. This is owing to the fact that thermal power systems cannot ramp up so quickly, which will lead to commercial and maintenance challenge.

There are aspects of volatility associated with renewable energy. One is short term impact on the grid in the time frame of milliseconds to minutes. The medium term aspect looks at the time frame of days to months, which calls for efficient balance of load and generation. The long term aspect deals with a period of five to ten years. Currently most of the attempts that are being made to address the issue of renewable energy volatility cater to the first aspect. The following are foreseeable steps that need to be taken care to address the volatility in comprehensive ways which requires concerted effort across the industry.

FLEXIBLE OPERATION

The integration of renewable energy has created the need for flexibility. The accompanying figure illustrates the how increase solar penetration impacts power system operations and can lead to steep ramp up and deep downturns and short peaks in the system. It depicts a sample load curves and a net load curves (known as duck curve), where the net load represents the demand that must be met through the conventional generation. As renewable generation keeps varying , the demand for conventional generation also changes with it. The wide gap in the belly of the duck curve indicates the need to reduce

conventional power generation due to an increase in renewable generation. Meanwhile, a steep rise in the demand at the neck needs to be matched with an increase in conventional generation.



Source: Ministry of Power, GoI

Flexible generation options

Gas station

Gas power plants are very flexible as they can be ramped up and down very quickly. However, these plants are relatively expensive as compare to the other sources of generation. This make them ideal to be used as the peaking units at times of maximum power demand. Gas power plants in India are also facing fuel availability issues and hence cannot effectively contribute towards balancing the grid

Hydropower station

India has an installed hydro capacity of about 43GW, of which only 28-29 GW are only available for to meet peak demand. This is mainly because multipurpose nature of hydro projects, with the water releases required for irrigation

Coal base plants

Coal-based generation is also a major source of reliable power for safe and stable grid operations. Start-up and shut-down on the same day, capability of load following and running at minimum generation levels with gas support, automatic generation control capacity, and operating at sliding pressure, which increase

efficiency at part loads, are the attributes that define a flexible coal generation. Future thermal power projects needs to be design with greater emphasis on the above attributes

It has been observed that many thermal stations are reluctant to back down their generation as per schedule to below 70 percent of their maximum continuous rating (MCR). However, as per the central electricity authority (CEA) technical standards for construction of electrical plants, the design of coal based power plants must have the minimum rate of loading or unloading of 3 percent per minute above the control load (50 per cent MCR). Designing plants as per above technical standards will help thermal plant being ready for flexible operations ensuring grid stability.

GRID PREPAREDNESS FOR RENEWABLE

The country has already started preparing its grid for large scale renewable energy integration by way of synchronous integration of the country's five regional grids into on central grid, operating at one frequency. Further, upgrades and retrofits (renovation and modernization) requires in plant areas such as boilers, turbines, and control and auxiliary systems for enhancing the flexibility of power plants. This is crucial because the intermittency and volatility associated with high solar and wind power penetration which have increase the need for flexibility in power system and back up capacity. However, there is alternative view that we should first look at offgrid and microgrids as the preferred options for scaling up the share of renewable in the total electricity mix, rather than integrating them with the central grid.

DISCOMS READINESS

The government's Ujwal Discom Assurance Yojna (UDAY) aims to improve the financial health of the discoms. The scheme consist of four principal components- interest cost reduction, improvement in operational efficiency, reduction in power purchase costs and enforcement of financial discipline. The overall savings potential from the scheme is estimated to be over Rs 2 trillion. If UDAY works, there are signs that it will, the power demands once again rise in the country. Currently, there are power plants that are operating at very low plant load factors (PLFs) due to low demand from the discoms owing to their poor financial health. The current average PLF level is 60 per cent. With UDAY, the financial conditions of the discoms is expected to improve and increase in demand. However, a major operational challenge that is likely to emerge is with regard to choosing between the backing down of thermal power and renewable power.

STORAGE SOLUTIONS

Energy storage solutions are critical to even out the generation profile of renewable. These solutions can use the energy generated during off-peak hours to cater to peak time loads and eliminate the curtailment of renewable energy during periods of excess generation. However, storage cost at present are prohibitive, and there is need to look at other alternatives. One possible medium-term solution is to utilize the country's natural gas potential to ensure grid stability. An alternative grid balancing mechanism that is working well in other countries is demand response (DR). DR programmes are implemented by electric power utility with government support, to bring changes in consumer's electricity consumption pattern, usually to reduce or shift peak load demands. These programmes are a reliable way of efficiently managing peak load shortage as they emerge rather than having to resort to costly storage systems.

LOAD BALANCING

With increase share of renewable energy in India's electricity mix, it is imperative to formulate robust scheduling and forecasting mechanisms to improve the visibility of the quantum of renewable power that

is to be injected into the grid and kind of ramps to be expected. From the generator's perspective, scheduling and forecasting enables the interstate sale of power, and seamless transaction in the market.

India has already put in place a framework for wind scheduling and forecasting, and is likely to soon come up with the same for solar. With regard to grid security and resource adequacy during operations, the Central Electricity authority (CEA) has recommended establishment of renewable energy management centers (REMCs), which would be responsible for forecasting of renewable power. The CEA has recommended that REMCs should be collocated with respective load dispatch centers at the state, regional and national levels with hierarchical coordination. For maintaining the load generation balance , the state will have to coordinate with the REMCs.

CONCLUSION

With the changing generation portfolio and the volatility associated with it, integrating renewable and consequent grid management becomes imperative. The role of coal-based plants is shifting from that of meeting base load to that of balancing the grid and meeting peaking requirements. This has put duress on the existing plant which requires well thought out process of flexible operations with regard to gas based plant, hydro plants and coal based plants. Integrating renewable grid management requires concerted efforts across the power value chain. The success of UDAY scheme, discoms preparedness, storage solutions, scheduling and forecasting is essential element of this effort. On the regulatory front to, the CEA and Central Electricity Regulatory Commission are developing standards (REMCs and renewable purchase obligation RPO) and regulations for incentivizing flexibility in conventional generation which will go a long to integrating renewable and ensuring grid stability.