Myth Busters Newsletter

Issue 1 **October, 2016**

Editorial Message

With the ratification of the Paris Agreement, India has promised to achieve 40% of its installed power capacity from non-fossil fuel based energy sources and reduce emissions intensity by 33-35% from 2005-levels. It has also targeted 175 GW of Renewable Energy (RE) capacity by 2022. However, the RE potential in India is several times more. In fact, it is safe to say that RE is not limited by potential. Therefore, the rapid reduction in RE cost provides the opportunity for India to go even beyond the present 175 GW target and have RE as mainstream energy source.
Achieving such ambitious targets will need concerted action and commitment by the industry and all stakeholders at the national, regional and the state level.

However, there exist myths and perceptions which restrict the mainstreaming of renewable energy in the country. Some examples of common prevailing myths are the following: RE is expensive, it requires too much land, it will lead to instability in the transmission grid, etc.

This newsletter series is an attempt by the Shakti Sustainable Energy Foundation (SSEF) and the Center for Study of Science, Technology and Policy (CSTEP) to break some of these myths and perceptions by sharing objective analysis and evidence-based research. The newsletter will be sent out every two months. Each newsletter will feature an identified myth and address it through relevant information such as research-based articles, interviews with notable experts, and links to relevant Indian and international readings. Our hope is that this newsletter will provide the policymakers, academics and industry with high quality policy relevant inputs and facilitate RE capacity addition in the country.

This first issue is an effort to capture the 'flexibility aspects of coal power plants to meet the variability in power systems'. The presented research suggests that coal based power generation plants have the capability to be flexible, which is necessary for effective integration of variable renewable energy with the grid. However, such flexibility is currently not exhibited by such plants.

We hope that this issue stimulates thoughts around the policy, market, and regulatory structures that enable flexible behaviour from (operators of) power plants. We would be happy to receive your feedback and on the newsletter. We also encourage you to share your suggestions on other important topics which could be addressed in the forthcoming issues of this newsletter.

- *SSEF & CSTEP*

Article

Coal Power Plants cannot Operate Flexibly to meet the Variability in Power Systems with High Penetration of Renewable Energy

India has bold goals for Renewables that raise several considerations for future grid planning and operations. The unique attributes of renewable electricity generation in contrast to conventional generation such as coal, are its non-dispatchability and its geographical availability.

These two attributes exacerbate the existing problems with the grid.

There exists a myth on coal's limited flexibility to balance the inherent variability in Renewables in context of their integration in India. This myth can be easily busted by simulating a real-time power system operation through the use of economic generation dispatch modelling tools. The most widely recognised tool for such analysis is the Unit Commitment Model (UCM). UCM analyses grid flexibility in its full context by measuring the curtailment risks for high levels of Renewable penetration into a portfolio of conventional generation. UCM simulations do so by accounting for the following techno-economic aspects of power plants and grid:

- Renewable profiles and its correlation with load to arrive at the net load
- Physical characteristics of power system
- Institutional characteristics

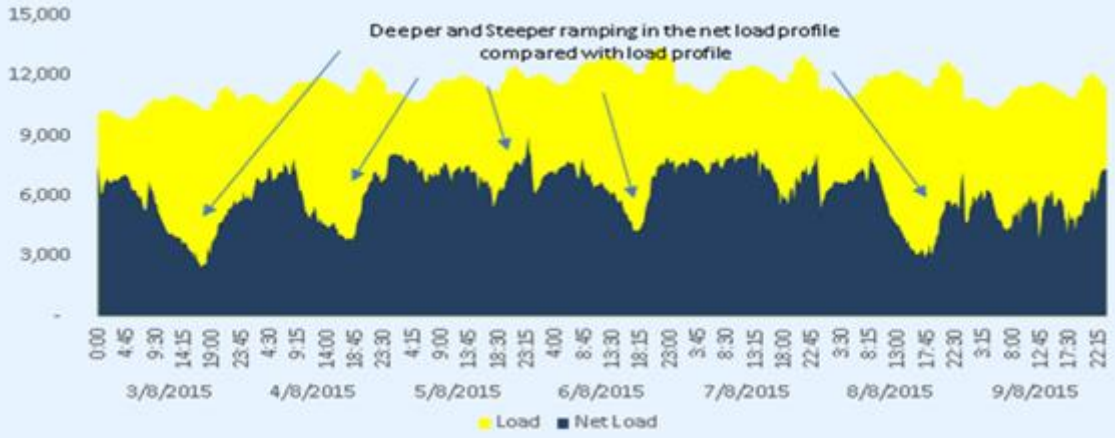
It is well known that wind curtailment in Tamil Nadu has gone up substantially in recent years. In 2015 grid accepted only ~7 BUs compared to ~11 BUs in 2012[1]. The reduction in grid acceptance could have been potentially addressed with the use of coal cycling. This can be demonstrated by using UCM for a representative week, considering the conventional generation portfolio in Tamil Nadu, plus a load and renewable profile that reflects different combinations of variability and magnitude.

The flexibility of various generators was assessed through the UCM for its ability to quickly adjust to the net load shape while meeting the technical constraints. The objective was to understand the cycling capabilities of coal by focusing on its techno-economic characteristics only, without considering any restraints owing to regulation, commercial aspects, etc.

The UCM results revealed that the grid has the capability to support Renewable penetration ranging from a minimum of 12% to a maximum of 62% of the generation mix without any loss of load or curtailment in Renewables (Figure).

Higher Renewable penetration only increased the load following requirements for coal. The entire conventional generation portfolio acted together as a pool to provide the ramping requirements and the flexibility for balancing the variability in Renewables.

Figure:* Comparison of *Variability* in *Load and Net Load* for a representative week of August *(MW)



It is evident that coal has sufficient underutilised flexibility to integrate Renewables with cost-effectiveness. The current regulatory and operational practices restrict access to existing flexibility in coal which leads to curtailment of Renewables. A certain amount of coal cycling is already prominent in states, but higher Renewable penetration exacerbates cycling frequency. This increases the risk of plant wear and tear in addition to lower fuel efficiencies at partial output levels. Therefore, coal cycling needs to be supported with appropriate compensation.

[1] TNERC, KPMG Research

A few specifics of the constraints imposed by the extant regulatory and operational practices for access to flexibility in coal and possible resolutions are:

- Scheduling closer to the real-time operation.
- Regulatory interventions are required to incentivise flexibility in the existing conventional generation fleet. Flexible Generation Obligation on states with high Renewable penetration should be explored.
- An efficient mechanism through which the grid operators both at the state and regional levels have access to capacity reserves should be evolved.
- Finally, states should assess the economic trade-offs between additions of new generation capacity for balancing Renewables or pay higher to the existing coal fleet to meet the demands of its integration.

Integrating Renewables in a reliable and affordable manner needs an unprecedented change. The conventional wisdom about the limitations of coal in Renewable integration needs to be better understood. To this end policymakers should formulate new rules and regulations for increasing the role of coal cycling in integrating Renewables.

For the full report click here

- *Analysis conducted by KPMG*

Interview

Shri Gireesh B. Pradhan,
Chairperson, CERC

Q. ***What are some possible frameworks through which coal power plants in India could be incentivised to behave flexibly?***

A. A perfect power market assumes load to be met at all costs, and the various generation sources are stacked based on their merit order and dispatched to meet the load. The load - dependent as it is on various factors like weather condition, agriculture and industrial needs, festivals etc - is variable in nature. The generation sources including coal based power plants therefore need to flex to adjust to variability of load. Similarly, the power generation using renewable energy sources is intermittent and variable in nature. This also requires coal based thermal generation to cycle to effectively accommodate the variability of RE power. Under a cost plus regime, the framework to incentivize flexible operation of coal plants could entail - lowering technical minimum while compensating for any additional costs due to cycling; facilitating these plants to provide ancillary services in a market set-up, while assigning premium to more efficient and flexible plants with faster ramp rates; enabling implementation of secondary frequency control through Automated Generator Control (AGC) with appropriate compensatory mechanism in place.

Q. ***What are the regulatory interventions necessary for such frameworks to develop and become robust over the next few years?***

A. CERC has amended the IEGC, providing for technical minimum of 55% in case of thermal generating units with corresponding compensation mechanism for deterioration of heat rate, auxiliary energy consumption and oil support in excess of normative parameters.
CERC has also notified regulations on Ancillary Services with the objective of supporting both "Regulation Up" and "Regulation Down" services. This is a first step to provide the grid operator with an instrument of frequency control while utilizing un-requisitioned surplus (URS) capacity in

central generating stations. Regulations aligned with this are required at the State level, and CERC is working via the Forum of Regulators (FOR) to facilitate this.

Going forward there has to be a broadening of the ancillary services by introducing a market, enabling all generators to participate and provide the entire gamut of ancillary services would further encourage coal based thermal generation to become more flexible. Regulatory intervention is also required for deployment of secondary frequency control through AGC, as well as better operation of primary frequency control through governor modes of operation. Thus, primary and secondary response must be a major priority.

Q. ***What would be the adjustments required in structures for generation (or bulk procurement) tariffs as well as consumer tariffs to accommodate "flexible" coal?***

A. In India, especially at the interstate level, the capacity charges for a generating station are assured on attaining the target availability. The requirement of flexing – which has a bearing largely on PLF - therefore does not affect recovery of fixed charges of a generating station so long as it is available up to the desired level. Going forward, we could, however, think of facilitating differential tariff for generation based on time of day and location, thereby enabling a price indicator based on value of power in a particular situation. Time-of-day tariff would require that generation is provided with dynamic tariff linked to time-of-day generation, i.e. generation at peak / off-peak hours. As a sequel, the end consumer tariff should also reflect the ToD generation tariff. As we put higher premium on reliability and 24x7 power supply, the consumer tariffs should reflect the cost of supply.

Q. ***How could India develop its power markets to enable flexible behaviour of coal power plants?***

A. Short-term transactions have to be made more efficient, while intra-day markets have to become more vibrant as we march towards higher flexibility on the generation side. CERC has enabled 24x7 power markets and intra-day transactions, but the friction in the process needs to reduce so as to enable shorter delivery time-frames. Discoms and SLDCs have to manage their power procurement and balancing over shorter time duration i.e. we have to move towards shorter gate closures.

Interesting Reading & References

Newspaper/Blog Articles

A true reform in coal industry is possible only if the government implements free-market principles that currently exist only on paper. The article chiefly elucidates the inefficiencies that is prevalent in the distribution chain, transportation and effects of artificial control on pricing by government entities and offers solutions that could propel the industry towards fair, free market.
http://www.vccircle.com/infracircle/coal-sector-reforms-arrived/

Coal continues to be the predominant energy fuel for two Asian countries, Japan and India. As the former is looking towards alternatives for nuclear energy, the latter stresses its needs for high end technologies for cleaner energy fuels. The possible energy cooperation between the two could help in achieving these missions.
http://www.business-standard.com/article/news-ani/coal-to-remain-important-mainstay-fuel-for-india-and-japan-s-energy-plans-115042900893_1.html

Increase in electricity demand is met with an expected surge in India's clean coal capacity with many mega power projects adopting supercritical technology. Uncertainty in power reliability would only add to the significance of coal contribution. However, fluctuations in international coal markets and government's energy policies may have an impact on the enactment of clean coal technologies.
http://www.business-standard.com/content/b2b-manufacturing-industry/india-to-add-100-gw-clean-coal-capacity-between-2016-and-2025-115031600152_1.html

Reports

This link leads you to an abstract on the report, "Damage to Power Plants Due to Cycling". It provides an introduction along with the necessary background. The various objectives, approach and results of the study are also briefly cited.
http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001001507

The principle aim of this study is to "define and quantify the costs directly associated with cycling baseload coal generator output as a result of wind generation levels and curtailing wind generation at times to avoid certain excessive system bottoming events".
http://www.uwig.org/11M-710E_WindInducedCoalPlantCycling.pdf

The paper chiefly cites experiences from a Coal Generating Station (CGS) in North America. It demonstrates the flexibility of coal plants and suggests various modifications to operating procedures. It also endorses the idea of valuing coal in an increasingly low-carbon energy system upon replication by other coal plants.
http://www.nrel.gov/docs/fy14osti/60575.pdf

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Mythbusters newsletter series will identify 1 myth per issue and try to dispel the same through analyses, articles, conducting interviews of experts, providing reference to name a few. This is a joint venture of Shakti Sustainable Energy Foundation (SSEF) and Center for Study of Science, Technology and Policy (CSTEP). The issues will also have relevant partners who will help in conducting the various analyses.

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