Grid Connectivity and Intra/Inter state Transmission of RE : Issues in India

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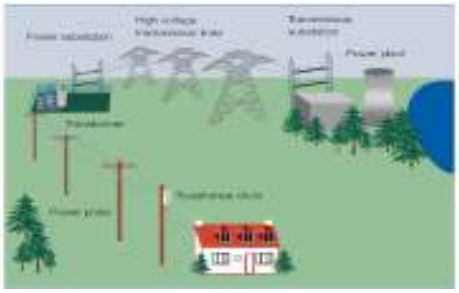
Introduction

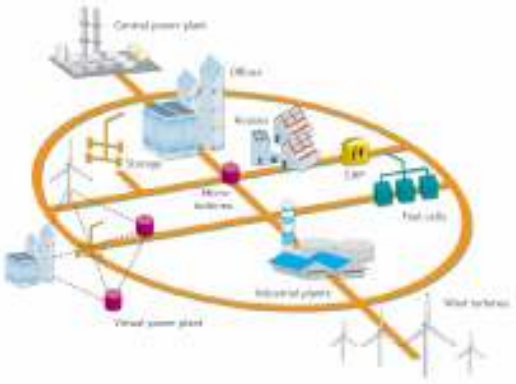
- At present, in India the grid connectivity issues are with wind energy compared to any other form of RE.
- **Other forms of RE are small in capacity and gets embedded into the distribution system.**
- Conventional electricity supply chain has to accommodate the renewable energy at different stages, depending on the capacity.



Conventional Electricity Supply Chain

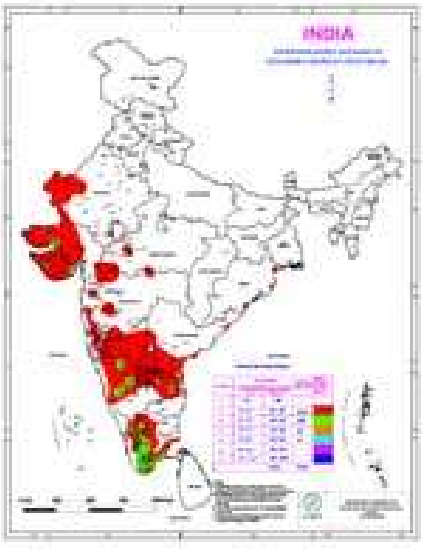
Introduction – Contd..

- The future vision of electricity supply chain is smart and intelligent grid, which will have RE embedded at distribution networks and is more challenging.



Introduction – Contd..

- Wind energy in India has reached a threshold wherein it is no longer embedded within the local system.
- **This calls for adequate transmission system to evacuate to the load centers**
- The transmission system is to be designed such that there is no congestion in the network at any operating condition



Wind potential map in India - IWTMA

Issues

- The wind generation in India is maximum when the local demand in the system is less due to cooling effect and reduced agricultural demand.
- **Sometimes, the hydro generation is also maximum during this season with good monsoon**

State-wise Wind Power Installed Capacity In India - IWTMA web site		
State	Gross Potential (MW)	Total Capacity (MW) till 31.03.09
Andhra Pradesh	8968	122.5
Gujarat	10,645	1566.5
Karnataka	11,531	1327.4
Kerala	1171	27
Madhya Pradesh	1019	212.8
Maharashtra	4584	1938.9
Orissa	255	-
Rajasthan	4858	738.4
West Bengal		1.1
Tamil Nadu	5530	4304.5
Others		3.2
Total (All India)	48,561	10242.3

Issues

- In addition there are issues in some States which makes it difficult to exploit the full potential of RE generation
- **This calls for a transmission system which not only evacuates the power from wind farms but also transmit to neighbouring states or regions.**

Intra State Issues

Tamilnadu - Issues

- In this state maximum RE generation has been connected.
- **The RE location is far from the load centers leading to congestion in transmission system around Udumalpet and Tirunalveli/Madurai region.**
- The capacity factor of RE at the grid level is close to 80% and hence this should be considered for designing transmission system
- Major regions - Muppandal, Tirunalveli Coimbatore/Udmalpet
- **Pooling at 400 kV level is preferred to mitigate network constraints**
- Backing of wind during high wind season has reduced with commissioning of few 220 kV and 400 kV substations.

Karnataka

- In Karnataka the major areas of RE are Chitradurga and Gadag for Wind generation, South & North Canara region for mini hydel and Bio mass spread in northern Karnataka.
- **RE generation is maximum during end of May to October. This leads to congestion in the 220kV system around Gadag and Chithradurga area.**
- When the RE generation is maximum in Southern region, the outlet for the power flow towards other regions are limited. This would continue till the end of 11th plan

Maharashtra - Issues

- In view of high demand in the State there is no major transmission issues for evacuating Wind generation except over-voltage scenario in some pockets
- **The major issue in the State is on ROW which is very critical in Konkan region**
- Most of 400 kV and 220 kV stations planned in 11th plan are getting delayed, causing poor grid connectivity for evacuation of RE/wind energy.

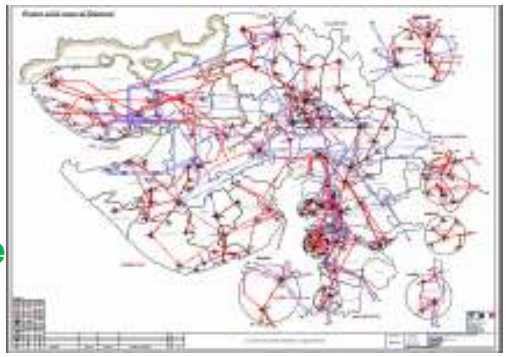
Maharashtra - Issues

- **Nasik Region :-** There is no 400 KV Substation or corridor available at Nashik even though it is concentrated with good amount of Wind Potential. **One 400 KV Sub-station is utmost necessary at Nashik with exclusive 400 KV line towards Padghe.**

- **Kolhapur Region :- Wind potential near Kolhapur to the tune of 250 – 300 MW can be tapped only if additional proposed 220 KV line from Talandge to Sawanthwadi is executed.**

Gujarat

- The wind generation is concentrated in few regions but the evacuation facility is inadequate.
- **In Kutch region, it is necessary to have additional 400kV facility to evacuate the wind generation**
- There is no new transmission capacity planned for wind power evacuation in the State



Gujarat Issues

- Gujarat state has recorded a restricted peak load of about 9335 MW with a unrestricted projection of around 12578 MW.
- **Total wind potential in the state is expected to be higher than 6500 MW.**
- Though Gujarat has been regarded as one of the most progressive State, the electrical infrastructure in the wind potential areas is very poor and the wind potential region are far from the load centres.
- Even though the potential availability, tapping is too poor because of huge infrastructure required to bring it to load center.

Gujarat Issues

Samana Region :

- Huge wind generation potential estimated to be around 1200 MW near Samana.
- **Utilities are reluctant to accord approval to evacuate full capacity due to the scarce infrastructure availability.**
- Urgent need is to construct one 400 KV Sub-Station at Samana connecting 400 KV DC or MC line from Rajkot to Samana & on 400 KV DC line to Jamnagar.
- This can be made as one of the largest Wind farm site on a plain land in India taking Gujarat a step ahead of Tamilnadu.

Gujarat Issues – Samana Region

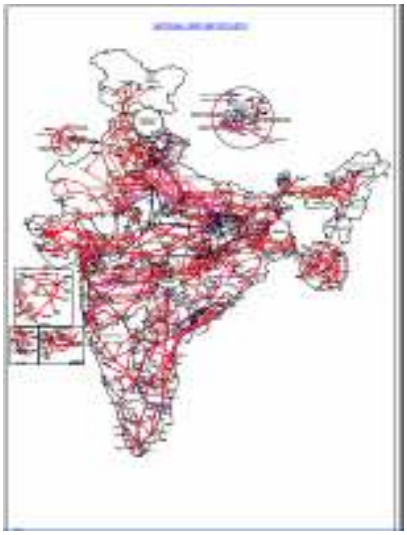
- There is lot of constraint to evacuate at 66 KV levels around Samana region because of lower size of conductors used.
- **Hence strengthening is utmost essential by replacing the presently available lower size conductors with higher sizes in the entire region.**
- Alternatively technical advantage can be derived by upgrading all 66 kV Subs-station with 110 or 132 kV system in the entire region which will result in reducing the transmission losses.

Rajasthan

- The wind generation is predominant in Jaisalmer and Jodhpur regions, where the load is very minimum.
- **Even though the 400 kV lines and substations are planned, coal based power plants are also coming up in the vicinity, which may lead to bottle neck in the wind power evacuation.**

National level - Issues

- All States do not have RE – wind potential.
- **Existing and planned Inter state and regional ties are sufficient to allocate the surplus wind in certain States to non wind energy States.**
- As it is mere displacement of power, but for local grid connectivity problems, few links, major issues are not foreseen.



Way Forward

Way forward

- There is a necessity to lay a clear guidelines for the grid connectivity and transmission planning for RE resources.
- **At present CERC is looking into the issue for grid code for the RE resources.**
- MNRE has formulated a committee for wind grid code and the draft report is uploaded for comments

Wind Grid code

- The major issues addressed in the wind grid code on Grid connectivity and intra/inter state transmission are
  - **Planning guidelines**
  - **Reactive power compensation**
  - **Connectivity code**

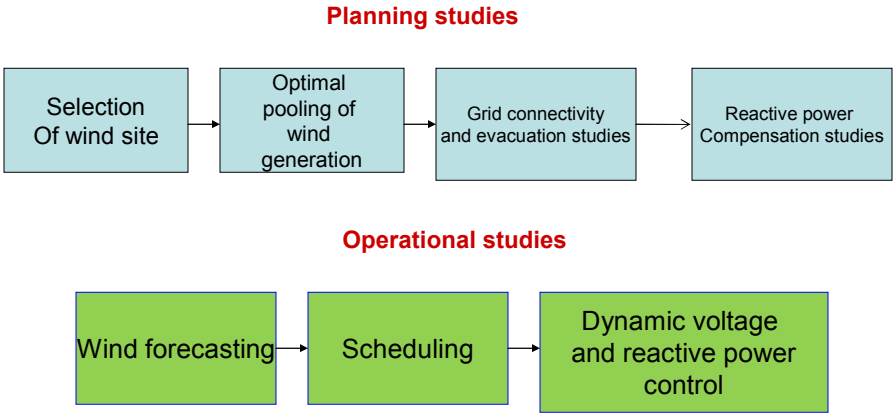
Planning Guidelines

- The transmission system shall be adequate for various wind generation and load scenarios.
  - System Peak Load with High Wind Generation
  - System Light Load with High Wind Generation
  - Local Light Load with High Wind Generation
- **Maximum wind generation capacity to be considered for the study**
  - 100% capacity factor for wind farms connected below 66kV.
  - Minimum 90% capacity factor for wind farms connected at 66kV or 110 kV or 132 kV.
  - Minimum 80% capacity factor for wind farms connected above 132 kV

Planning Guidelines

- The line loadability of transmission lines can be increased for evacuating wind power during high wind season in cases where other alternatives are prohibitively expensive affecting viability of the renewable energy project.

Nature of studies – Grid interconnection



European Wind Integration Study and its Relevance to India to over come grid integration issues

Task #1: Present situation and market aspects

- **Wind development**
- **Regulatory and market frameworks**
- **Incentive schemes**
- **Grid code development**
- **Grid planning practices**
- **Influence on interconnections**

Task #2: Base Case Scenarios

- **Base case and initial scenario setting**
- **Market model selection**
- **Report on scenarios and Exchange schedules**

Task #3: Risk analysis

- **Congestion list including n-1 analysis**
- **Frequency control risks**
- **Transient stability risks**
- **Economic risks for TSOs and market participants**

Task #4: Risk Mitigation

- **Need for grid reinforcements**
- **Need for reactive power compensation and voltage control**
- **Wind forecasting systems**
- **Load following for power plants and demand side management**
- **Capacity assessments and curtailments**

Task #5: National grid aspects

- **Uniform/harmonized grid code requirements**
- **Financial incentive schemes**
- **Market models**
- **Energy storage use and development**

Large scale distribution - Smoothing studies

- **One study that can be of most relevance is to analyze the wind power data for one year from all sites to arrive at the apparent smoothing effects**
- **This data can be injected into National grid model to simulate the one-hourly (15 minutes block??) scheduling and dispatch of power plants to meet the demand.**

Large scale distribution - Smoothing studies

- **Simplest forecast adopted can be next hour wind generation is same as previous hour generation, which gets updated on hourly basis through SCADA.**

- **Output of such model will be to determine the amount of fossil fuel saved over one year, with adequate spinning reserve maintained to ascertain no loss of load.**

Power System Stability studies

- To determine what future operational and power system security issues could arise, the extent of these impacts and to ascertain whether there may be a fundamental limit to the amount of wind generation that could be supported

- The study reveals the impact of various quantum of wind power in the grid on system stability

- Long term stability limits can be arrived with the help of PV curves.

Power Evacuation and Grid connectivity issues

Transmission line loading limits to be considered in the system study

- During the high wind season, the ambient temperature is less. Further wind will help in higher heat loss due to radiation.

Network safety margins are presently calculated based on long term power ratings

- **– 30 minutes safe rating is significantly higher**
- **– 5 minutes safe rating is higher again**
- **Provided power returns to safe long-term level after this period**

The dispatch engine can use this additional short term capacity to carry peak load

Sensing of local wind and temperature conditions for each stretch of line informs accurate rating calculations - Intelligent grid !!!

Installed capacity and capacity factor in power evacuation study

- No diversity or minimum diversity at lower voltage levels (11 and 33 kV levels).
- Some of the utilities conduct the planning studies with 60% of wind turbine installed capacity as wind generation.
- Not acceptable for wind power evacuation from a specific plant.
- Need to ascertain the capacity factor to be considered at different voltage levels on case to case basis, say
  - 220 kV 80% of installed capacity
  - 66/110/132 kV : 90 % of installed capacity
  - 33 kV and 11 kV :100% of installed capacity

Conclusions

- Once the commitments to harvest the RE and to utilize it exists, grid interconnection issues will not arise.
- **It is proved at various levels in elsewhere that the infrastructure required to accommodate the conventional power generation into the grid is much higher than RE.**
- System studies as per the grid code and newly being formulated wind/RE code will enable to overcome specific issues.

Thank You