Policy and regulatory issues in the context of large-scale grid integration of renewable energy in Gujarat

Executive summary

Introduction

Renewable energy contribution in terms of its installed capacity in India has reached about 12% of the total installed capacity. The total electricity generation from renewable energy sources in 2011–12 was around 5.5% of the total power generation in the country. Around 97% of the installed renewable energy capacity is grid-connected and off-grid power constitutes a small share. The growth in renewable energy is due to the results of various policy thrust, incentives, and schemes for the deployment of RE. Specific targets have been set for renewable energy, such as 20,000 MW of solar capacity addition target by 2022 under JNNSM and total RE addition target of about 30,000 MW capacity during the twelfth five year plan. The National Action Plan on Climate Change (NAPCC) envisages a dynamic renewable purchase obligation target of 10% at the national level for 2015 with an annual increase of 1%, so as to reach around 15% by 2020.

The 17th EPS report projected that the total electricity demand of India by the end of 12th Plan will be 13,92,066 MUs and by the end of 13th plan it will be 19,14,508 MUs. Corresponding renewable energy generation requirement to meet 17% national RPO is estimated to be 325466 MUs. Considering the fact that wind and solar energy are the main renewable energy source having huge potential in the country and all other renewable energy sources are limited, it is established that by 2021–22 the total renewable installed capacity should be 136,097 MW out of which 98,555 MW is estimated to be wind energy and about 20,000 MW is estimated to be solar energy.

The large grid infrastructure required to take this large scale variable renewable generations brings lot of issues and challenges, such as investment needs, division of institutional responsibilities, handling right of way issues, challenges in development of scheme for proper management and schedule of generation, interstate RE power transmission and trading arrangements, etc. The Energy and Resources Institute (TERI) undertook a study for identifying the issues and challenges faced by Gujarat and the way forward to tackle these issues.

Objectives of the study

The objectives of the study were:

1. To identify the policy and regulatory concerns related to the development of grid infrastructure for large scale renewable energy development in Gujarat.
2. To recommend possible technical, policy, regulatory, institutional, and market measures that can be adopted by relevant agencies to enable aggressive renewable energy deployment in the state in the next ten years.

Renewable energy development scenarios for Gujarat

Gujarat has been developing its renewable energy capacity through various conducive policies, which have attracted various private sector investments mainly in wind and solar power projects. The commissioning of about 600 MW solar power project by the year 2011-12 is an example of the same. This was due to state's initiatives through the progressive solar power policy and the development of solar parks. Wind power installation has already shown an upward trend in the last few years. Gujarat Energy Development Agency has set a target of about 4400 MW renewable energy capacity addition in the state during 12th Five Year Plan. There is a very high scope for the development of renewable energy in the state. Since the state has lot of wind and solar

energy potential, it is believed that Gujarat will contribute significantly in meeting the national RPO targets specified under the National Action Plan for Climate Change (NAPCC). To understand the level of renewable energy capacity which the state would be having by the year 2021-22, the installed capacity projections in the state has been made based on following four different scenarios:

- *Business as usual (BAU) scenario*: This scenario considers RE capacity addition to occur as per the GEDA targets.
- *5% of integrated RE potential scenario*: It is assumed that the small hydro, biomass, and waste to energy projects will be developed as usual as per GEDA targets. Wind and solar power projects will be developed up to5% of the potential estimated by TERI in its report titled Integrated Renewable Energy Resource Atlas of Gujarat, 2012.
- *10% of integrated RE potential scenario*: It is assumed that the small hydro, biomass, and waste to energy projects will be developed as usual as per GEDA targets. Wind and solar power projects will be developed up to 10% of the potential estimated by TERI.
- *NAPCC RPO target scenario*: It is assumed that the small hydro, biomass, and waste to energy projects will be developed as usual as per the GEDA target, considering their limited potential. Solar power capacity will be 50% of JNNSM target, i.e., 10,000 MW solar capacity in Gujarat by 2021-22. Wind power installation will be as per the percentage of potential estimated by CWET, i.e., about 35% of the total wind power installation in Gujarat to meet the national NAPCC RPO.

Based on these scenarios, the projected RE installed capacity, electricity generation, and the RE penetration (out of total energy demand of Gujarat that is projected as per 17th EPS report) are mentioned infigures below.

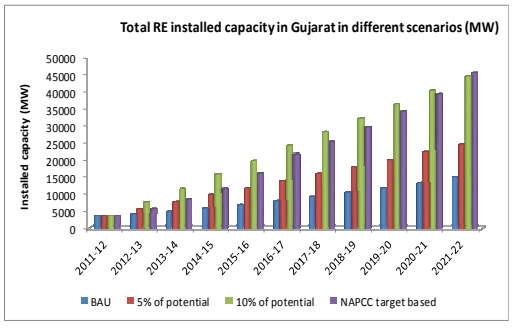


Figure 1: Projected RE installed capacity in Gujarat for different scenarios

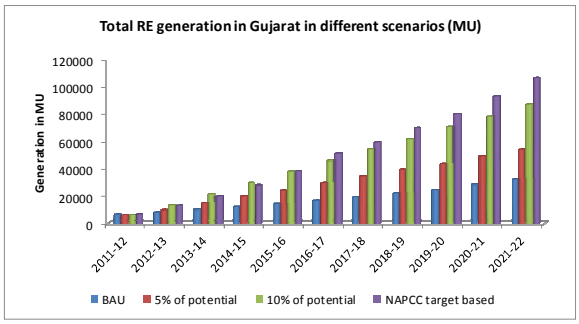
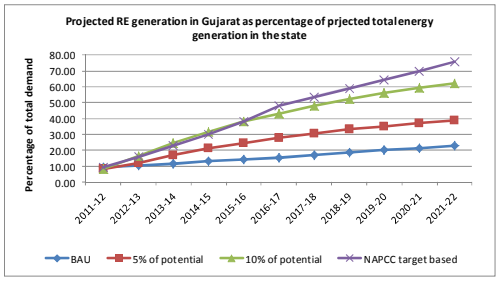


Figure 2: Projected RE generation in Gujarat for different scenarios

Figure



3: Projected RE generation as % of total energy generation in Gujarat for different scenarios

Based on the above projections, it is observed that the quantum of renewable energy installation in Gujarat will be huge. Gujarat will experience a power surplus situation and it will require large grid infrastructure to transmit the power within the state as well

as outside the state. This will require mechanisms for the interstate trading of renewable energy, proper scheduling of RE generation, etc. Associated issues that the state will face are listed out in next section.

Issues and challenges in large scale grid integration of renewable energy

Various literatures show that the large scale renewable energy generation, mainly wind and solar energy, when integrated with the grid brings lot of technical challenges and issues in the operation and management of the grid system. These technical problems are mainly related to power quality and its balancing, which include voltage and frequency variations, reactive power imbalance, harmonics and flickers reverse power flow, etc. The impact of these variations depends upon the size of the renewable energy projects, grid capacity, and the voltage level at which the RE project is interconnected with the grid.

To handle the technical integration and operational issues, there are various technological advancements and integration methodologies available for the grid systems, which once implemented would help in making grid strong enough to withstand the large variability of renewable energy. Some of these are (a) deployment of synchrophasor technology, i.e., PMUs/WAMS (b) using STATCOM devices (c) development of flexible generation, ancillary services, spinning reserves, and storages (d) renewable energy forecasting for proper scheduling e) better demand side management, etc.

The deployment of these systems and methodologies is not that easy and poses policy, regulatory and financial challenges. Based on the study carried out for Gujarat, the issues found after various interactions with the stakeholders, such as GETCO, SLDC Gujarat, GERC, GEDA, solar and wind power developers, research institutions, distribution utilities, etc., are given below.

Policy, regulatory and commercial issues

The state government, including the distribution companies and transmission utilities, has its own concerns relating to commercial implications of evacuating large quantity of these highly variable energy generations. The power generators also have different set of concerns relating to the policy and regulatory aspects of large scale renewable energy integration with the grid. These concerns, identified on the basis of stakeholders' consultations, are summarized below.

1. The transmission utility is concerned about the high cost involved in the development of the grid system with advanced equipment and long distance high voltage transmission lines, and in extending the grid network to the remotely located renewable power generation stations. Their concerns pertain to: (a) Funding these investments; (b) Recovery of these investments: Whether it could be recovered through increased transmission charges or these are supported by the state/central grant.
2. The distribution licensees are reluctant to purchase the variable RE generation at higher tariff.
3. SLDC is considering few gas power plants as spinning reserves, but there is an issue of the high per unit cost of generation from these plants in case they are kept operational for only a small amount of time.
4. The UI charges being paid by the state government due to the import of power from the grid in case of sudden fall in the solar/wind energy generation, ultimately increases the effective cost of electricity from these sources.
5. Since the Discoms have to meet the RPO target, they first want to buy the electricity at the feed in tariff rate, rather than buying the variable energy at average power purchase cost and then buying REC from market to fulfil their RPOs. The power producers, on the other hand find the option of selling power at average price and

then selling REC in the market to get better financial returns. This leads to ambiguity in signing of PPA.

6. For REC mechanism, the state's (especially the RE rich state) concern would be that it has to develop the vast grid infrastructure for evacuation of RE power.
7. Higher penetration of RE may also lead to power quality issues for the state's grid infrastructure, hence, state may have to absorb poor quality of power due to large RE potential available.
8. Concerns for the state governments regarding funding arrangements for the large scale grid infrastructure development.
9. No defined mechanism for the ancillary power market and the payment mechanisms. Further, the cost intensive technologies, required to be maintained for handling variable RE source, would impact the increase of the retail electricity tariff, so it will again be the burden to the state government.
10. The Government of India, through IEGC-2010, has made scheduling of wind power mandatory for the wind firms installed after January 2011.There are various concerns related to it due to the fact that the accuracy of the wind forecast models available today are not satisfactory. Further to these, there are uncertainty about how the scheduling will be applicable for the wind farms connected to a single sub-station in which there are few already commissioned (before January 1, 2011) wind turbines and few will be commissioned later.
11. SLDC Gujarat says that, it can take the task of setting up of a state level RE data management centre, for which the process and concept preparation has already been started, but today there are no experts available with SLDC who can understand the forecasting of renewable energy. Hence, there is a need to build capacity. Sources of funds for setting up the centre and operational costs are some other concerns.
12. Another concern of SLDC Gujarat regarding the RE data management centre and forecasting was that the developers do not provide the plant specific data as well as the real-time data from their wind farm, without which it would not be possible to forecast. Hence, there is a need for regulations to guide the wind farm developers to provide the desired project specific data to the SLDC/RE data management centre.

Analysis of grid codes

The study also analysed the grid codes in terms of some important technical specifications for renewable energy projects, which must be followed for safe and stable operations of the grid systems. It is observed that the IEGC–2010 as well as GEGC–2004 do not elaborate on the following: (a) fault ride through requirement; (b) active power restoration; (c) voltage control; (d) energy balance; (e) reactive power compensation; (f) active power and frequency control, etc.

IEGC refers to the CEA grid connectivity standards for any technical requirement and it is found that CEA has these aspects covered in the draft grid connection standards for renewable energy. It is therefore important for CEA to come out with the final grid connection standards for renewable energy, which can be referred to by the state as well as by the central grid code.

Recommendations and plan of actions

Recommendations for future RE deployment and safe integration of renewable energy in the Gujarat state grid as well as the national grid are broadly categorized as: (a) appropriate renewable energy generation forecasting; (b) co-ordinated project development, grid planning, and grid strengthening; (c) creating flexible capacity, spinning reserves, and ancillary services market; (d) properly defining RE grid integration standards and regulations.