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INDIA EXAMINES U.S. STRATEGIES FOR INTEGRATING WIND & SOLAR

STUDY TOUR ON VARIABLE RENEWABLE ENERGY FORECASTING, GRID BALANCING AND SCHEDULING

May 2017 – Through funding from the U.S. Agency for International Development (USAID) Greening the Grid (GTG) project, five Indian officials participated in a five-day study tour of various U.S. utilities and system operators. The delegates examined U.S. approaches to enabling the economic dispatch of renewable energy, expanded coordination in operations, and resource flexibility.

California Public Utilities Commission (CPUC) Stephen St. Marie (Policy and Planning Analyst) and Rajan Mutialu (Senior Analyst, Policy and Planning Division) with the GTG delegation. CPUC shared their experiences with the energy imbalance market (EIM) and the impacts of distributed generation on the system.



India plans to deploy unprecedented levels of renewable energy (RE) on its power grid – 175 GW installed capacity of

renewable energy (RE) by 2022, up from 43 GW currently. Further, India's Nationally Determined Contributions (INDC) extends this ambition to 40% non-fossil fuels-based electricity generation capacity by 2030. This will greatly reduce the economy's carbon intensity and strengthen energy security. Compared to conventional power, however, India's key RE options are more variable, less predictable and often further from demand centers. Experience in other systems with high solar and wind penetration has shown that when penetration of RE reaches significant levels, the power grid faces challenges to the reliability and affordability of electricity. Critical to integrating VRE into the power system is rigorous analytical support to identify grid stability issues, options for optimizing dispatch, and sources of potential flexibility.



Mr. P. Murugavelan (right) from the Tamil Nadu state's transmission corporation discusses how Texas handles the evacuation of power from high wind penetration with ERCOT's Sandip Sharma, Manager Operations Planning.

India's future success in expanding renewable energy requires the country to plan and maintain grid stability and reliability, while promoting flexibility throughout the

power system. To support this goal, market systems must operate unimpeded, energy generation and load must be balanced in concert throughout the grid, and generation forecasting and scheduling must be supported by real or near real-time monitoring.

USAID/India is assisting the government of India in integrating large scale, variable renewable energy (VRE) into the existing power grid through a five-year Greening the Grid (GTG) initiative. GTG strives to help India meet its ambitious renewable energy targets. As part of this initiative, USEA organized this study tour comprised of regulators, policymakers and system operators.



Portland General Electric (PGE) Larry Bekkedahl (Vice President, Transmission & Distribution) (left). PGE is installing 38MW of storage systems to provide reserve support to its balancing area having 3500 MW peak. The state regulator approved the investment after pilots demonstrated potential for improving grid frequency stabilization support, RE integrated micro-grid simulation, voltage support through reactive compensation from inverters, and non-operating reserve support.

STUDY TOUR OBJECTIVES

The objectives of this study tour were to create a platform for peer-to-peer dialogue to allow U.S. system operators, regulators, policy planners, and representatives from utilities to share experiences and lessons-learned with their Indian counterparts.

Issues discussed included:

1. Renewable energy integration, specifically balancing, storage, and demand-side approaches
2. Challenges of implementing various grid code and reliability standards
3. U.S. models for regional transmission planning, dispatch and markets
4. Real-time monitoring using advanced control technologies to allow coordination from central headquarters for more efficient dispatch of renewable energy generation



GTG delegation meet with the Oregon Public Utility Commission to discuss the regulator's role in renewable portfolio standard (RPS) implementation, integrated resource plans, and regional coordination in the effort for V integration.

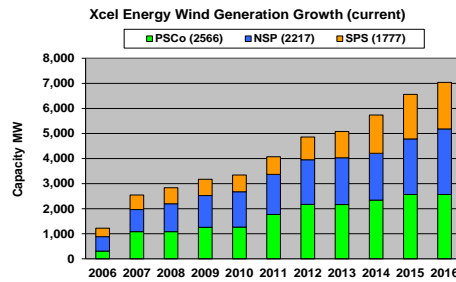
NEXT STEPS

The western United States and India share a number of similar characteristics in their respective power systems. The western U.S. operates 39 separate balancing areas, similar to India’s system of each state operating its own grid. Both India and the western U.S. have high renewable energy targets. Many of the western U.S. utilities have large coal fleets. And both India and the western U.S. systems perform on a least variable cost basis. Because of these overlaps, the western U.S. shares many of the same challenges as India.

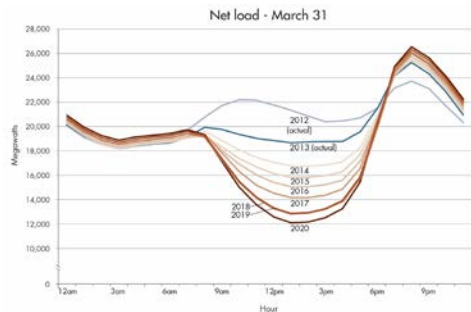
The delegation observed a number of practices in the U.S. that may be beneficial to apply to the Indian system. Below are a few take-aways that were judged as the most relevant:

Renewable Penetration and Economic Curtailment

- To gain greater control of the grid, it may be beneficial for India to change RE power purchase agreements to a dispatchable model.
- Inter-state trading of renewable energy would expand the balancing area and help avoid curtailment.
- All future RE supply should include interconnection standards mandated through a grid code, including automatic generation control and synthetic inertial response.
- Future rooftop solar installments should include interconnection standards that contain real-time tracking of solar generation through smart solar meters and net/gross consumer meters. This will ensure the distribution utility and the system operator have greater visibility of the impacts of distributed solar on the system.



Robert Staton, PSCo Control Center Manager, Xcel Energy met with the delegation to discuss Xcel’s strategies towards maximizing value of renewable energy.



California Independent System Operator (CAISO) Clyde Loutan (Principal, Renewable Energy Integration, Market and Integration Studies) and Abhishek Hundiwale (Lead Engineering Specialist, Market Validation and Analysis) explain California’s duck curve - In, a graph of commercial-scale electricity generation over the course of a day that shows the timing imbalance between peak demand and renewable energy production.

Planning Considerations with Renewable Energy

- India may want to create a unified planning and operation of all inter and intra state transmission to ensure optimal planning and reduce barriers to trading.
- India's planning standards and criteria need to be overhauled to include resource adequacy, system margins and the need for flexible generation mix.

Coordinated System Operations

- Indian states can collaborate to expand coordination by sharing reserves in day-ahead and intra-day. This will lead to efficiency gains and easier balancing over larger footprints.

RE Forecasting & Faster Dispatch

- Given the variability of wind and solar generation, India should consider transitioning to 5-minute dispatch.
- Accurate forecasting of variable renewable energy generation is essential.
- The country needs to install automatic generation control (AGC) and optimized economic dispatch based on data input.

Flexing of Coal Power Plants

- Coal plants, while not ideal, can be dispatched as a flexible generation source.

Central Electricity Regulatory Commission (CERC) Secretary SK Jha (right) at PacifiCorp's system control room. PacifiCorp has recently joined the energy imbalance market to expand its balancing footprint to accommodate higher levels of renewable penetration. PacifiCorp has also proven very effective in maximizing its use of its coal fleet for balancing.



INDIAN PARTICIPANTS

1. Mr. SK Jha, Secretary, Central Electricity Regulatory Commission (CERC)
2. Mr. Avanish Kr. Mishra, Director, Department of Economic Affairs (DEA)
3. Mr. UK Verma, GM (I/C), National Load Dispatch Centre, Power System Operation Corporation Ltd. (POSOCO)
4. Mr. R.V Dilip Kumar, SE, Karnataka Power Transmission Corporation Ltd.
5. Mr. P. Murugavelan, Assistant Executive Engineer, Tamil Nadu Transmission Corporation Ltd.

U.S. PARTICIPATING ORGANIZATIONS

1. California Independent System Operator
2. California Public Utilities Commission
3. Electric Reliability Council of Texas
4. Oregon Public Utility Commission
5. PacifiCorp
6. Portland General Electric
7. Xcel Energy



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