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ADVANCING CLEAN ENERGY DEPLOYMENT WITH BETTER RESOURCE PLANNING: THE CASE OF JHARKHAND

Launched in 2019, the Partnership to Advance Clean Energy – Deployment (PACE-D 2.0 RE) is a flagship program of the United States Agency for International Development (USAID) with India's Ministry of New and Renewable Energy to help national and state partners develop an enabling environment for faster and more cost-effective deployment of renewable energy. PACE-D 2.0 RE worked with the Government of Jharkhand to develop tools and methods that can help the state distribution utility, Jharkhand Bijli Vitran Nigam Limited (JBVNL), create medium- and long-term resource plans, optimize power purchase costs, and boost uptake of renewable energy.

CHALLENGES IN RESOURCE PLANNING

JBVNL is a public entity of the Government of Jharkhand that distributes power to different customer categories across the entire state. In 2020, Jharkhand experienced 9,365 million units (MU) of demand (compared to the 12,214 MU projected). The state's total installed generation capacity is 21,944 MW, with an energy mix dominated by coal (65 percent), hydro (18 percent), wind (15 percent), and solar (2 percent). Power purchase makes up around 77–80 percent of the total cost of JBVNL's entire distribution business.

Traditionally, the distribution utility based its medium- and long-term resource plans on compound annual growth rates and historical data trends. Such methods did not consider the new drivers (such as demand-side management, electric vehicles, and behind-the-meter distributed energy resources) and other factors causing demand to vary. This often causes them to overestimate demand. With power purchase generally guided by the demand forecast, misestimation burdens JBVNL with financial strain and leads to higher tariffs for consumers.

The utility wants to optimize and manage surplus/deficit power purchase, looking to volatile renewables as a low-cost candidate. A sophisticated but easy-to-use software could equip JBVNL to overcome these challenges.

THE BRIGHT IDEA

JBVNL partnered with PACE-D 2.0 RE to develop a tool that would not only help harness variable renewable energy (which is now more economical than conventional energy), but could also accommodate the demand impact of cutting-edge innovations such as grid-level storage, electric vehicles, and distributed energy resources.

The team conducted a gap analysis and found a clear need for high-end software, scientific methods, and sophisticated artificial intelligence (AI) algorithms to project demand accurately and optimize power procurement. Products already on the market were either cost-prohibitive or not tailored to the realities of India's resource planning, which call for demand forecasting, resource mapping, and power procurement optimization. India needed a tool that was user-friendly, had state-of-the-art simulation and visualization capabilities, and would be freely available for distribution utilities across the country.

Together, PACE-D 2.0 RE experts and JBVNL engineers developed a tool that met each of these needs in 18 months. JBVNL engineers participated in developing system requirement specifications, collecting data, developing use cases and test cases, procuring hardware, training staff, and finally conducting factory acceptance testing for each module of the software before its deployment.

ABOUT DISCOM REPOSE

DISCOM Renewable Energy Procurement Optimization and Smart Estimation (REPOSE) is a sophisticated, interactive, robust, and dynamic software with a comprehensive set of advanced methods for forecasting demand, integrated resource mapping models, and power procurement optimization technology built into three modules.

Figure 1: DISCOM REPOSE landing page

The software helps distribution companies (DISCOMs) forecast demand; plan their generation mix from available, retiring, and upcoming resources; and optimize future purchase costs.

DISCOM REPOSE provides hourly, weekly, and yearly visualizations of demand and resource adequacy (type, amount, and time) over a ten-year horizon.

The tool is flexible: utilities can use any of the modules on its own or all three for integrated planning. Users can review different scenarios by varying the generation mix. The plans optimize resources to lower costs, maximize renewable energy, and reduce emissions.

KEY BENEFITS

With DISCOM REPOSE, JBVNL is now equipped with AI-driven statistical and scientific methods to estimate demand in an uncertain environment. Using deterministic and probabilistic methods, the utility can create medium- and long-term power plans to address real-time demand and increase renewable energy penetration. JBVNL is also in a better position to revisit its power purchase costs and future contracts. Outcomes include:

A. DEMAND FORECASTING

Using the first advanced algorithms of their kind in India, the demand forecasting module simulates each consumer category by applying the best-fitting statistical and scientific methods. These may include trend analysis, compound annual growth rate, econometrics, ARIMA, ANN, and partial end use. The software selects the best fit after considering future year growth, R2 (the statistical index), and standard error. DISCOM REPOSE enriches its forecast by adding the impact of policies, demand drivers (such as electric vehicle penetration, open access, LEDs, or distributed energy resources), and transmission and distribution losses over the next ten years.

With these inputs, the module produces annual and monthly demand projections and an extrapolated hourly demand profile.

Figure 2 shows an hourly demand profile that will be used in resource optimization for up to ten years. The profiles help JBVNL determine its demand and energy sales for the monthly peak and the spike and duration of the peak.

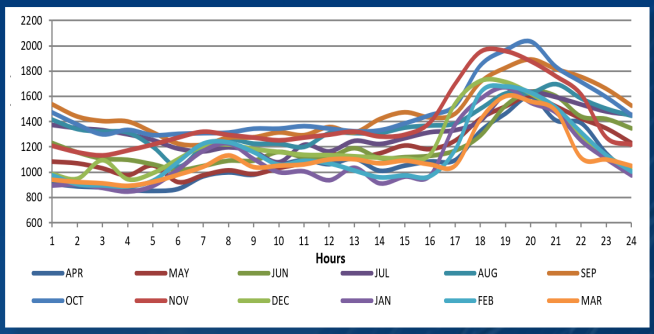

Figure 2. Forecasted hourly profile of the peak day for each month - FY 2021 (illustrative)

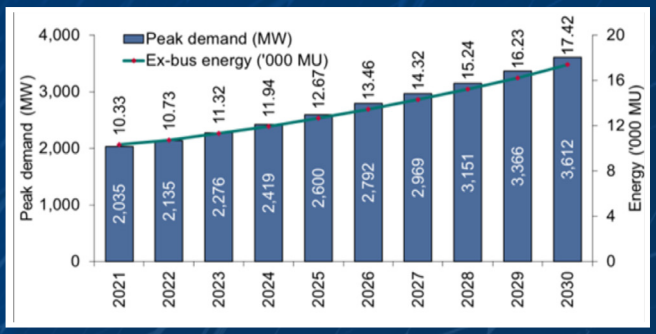

Figure 3: Figure 3: Yearly energy requirement (MU) and peak demand (MW) (illustrative)

In Figure 3, the software forecasts yearly energy requirement (MU) and peak demand (MW) for the utility.

B. RESOURCE MAPPING

Renewable energy is an attractive candidate to replace fossil fuels due to its lower cost and emissions. However, its variability and intermittency make it challenging to integrate into generation schedules.

By using Monte Carlo simulation techniques and mixed-integer linear programming algorithms, DISCOM REPOSE's resource mapping module optimizes generation commitments after considering each resource's technical and commercial constraints. It can balance a variety of types of resources, including thermal, hydropower, and variable renewables such as wind and solar.

JBVNL planners can study the seasonality of demand and take weather conditions into account when shaping generation strategies. Spanning several-year periods, this resource mapping also helps the team factor in when resources will retire and predict what new resources will be needed to balance the forecasted demand.

With such visibility, utility can better plan generation schedules and dispatches at hourly and weekly intervals, as indicated in Figure 4.

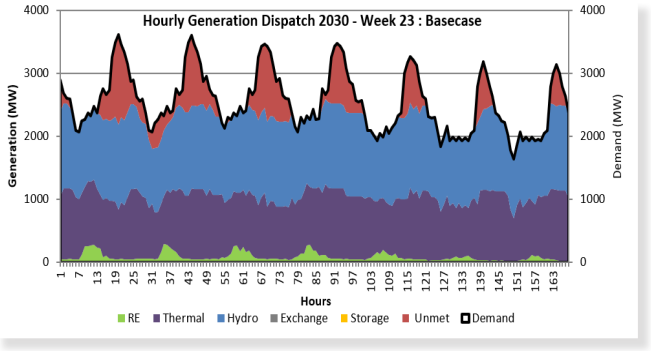

Figure 4: Hourly generation dispatch schedules (illustrative)

C. POWER PROCUREMENT OPTIMIZATION

Good demand forecasting and resource mapping tools let JBVNL keep a finger on the pulse of demand growth and how its portfolio can best meet that demand. However, the cost of procuring power is a colossal share of JBVNL's total distribution expense, so optimizing that cost is critical to financial sustainability.

JBVNL has surplus energy and reserves with existing built-up capacity, so it has to pay fixed charges for stranded capacity. Moreover, based on that capacity and future contracts, procurement is likely to cost around $8.6 billion over the next ten years. To use the stranded capacity and reduce costs, JBVNL can consider avenues such as adding a new customer category (electric vehicles), supplying power to other states, and postponing future contracts. DISCOM REPOSE generated several power plan options to better use resources and found that JBVNL's best path is to restructure upcoming thermal units' contracts by postponing their commissioning dates. REPOSE determined that JBVNL's power purchase agreement with Patratu Vidyut Utpadan Nigam Limited would significantly increase its thermal capacity, so it suggested restructuring and postponing Unit 3 to FY 2030. As a result, JBVNL will reduce its ten-year power procurement cost from $8.6 billion to $7.7 billion.

The REPOSE tool is helping JBVNL cut its power purchase cost by approximately 10 percent by suggesting options through which utility can better restructure their existing contracts.

EXPANDING IMPACT

JBVNL is using DISCOM REPOSE to recalibrate its long-term and medium-term plans, save on costs, and help drive new renewable energy (grid-connected solar, hybrid storage) in the state. The simulation is helping the utility:

- *Add 2,062 MW of thermal energy and an incredible 900 MW of renewable energy*
- *Maintain 37 percent planning reserves*
- *Reduce greenhouse gas emissions by 2.67 million tons of CO_2 in FY 2030*

To complement the tool, PACE-D 2.0 RE is amplifying utility planners' hands-on learning with DISCOM REPOSE trainings. The Government of Jharkhand is supporting institutional capacity-building for decision makers and implementers to use DISCOM REPOSE results effectively, which will help them create policies that successfully address Jharkhand's pressing energy needs. With this tool and its ongoing partnership with PACE-D 2.0 RE, JBVNL is on track to increase renewables penetration to meet India's ambitious renewable energy target by 2030.

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