An Overview of Renewable Energy Desk Activities for Power Grid Operations and Planning

Many countries around the world are setting up clean energy targets to decarbonize the energy sector. On electric grids, meeting these targets involve deploying gigawatts (GW) of renewable energy resources such as solar, wind, and hydropower. In 2022 alone, five countries (European Union, United States, India, United Kingdom, and China) added 275 GW of solar and wind, according to the International Energy Agency[1]. As the share of renewable energy increases, grid operation practices need to be modernized.

Given their distributed nature, variable renewable energy (VRE) assets can have unique grid integration considerations such as decentralized and bi-directional power flow, fluctuating generation outputs, and increased forecasting errors. Therefore, grid operators need to modernize electricity systems and practices currently designed to serve large, centralized generation plants that deliver one-way power flow to customers.

Based on analysis from the National Renewable Energy Laboratory, this document summarizes how grid operators can address gaps in their planning and operations to maintain reliability as they pursue clean energy goals. When transitioning to higher renewable energy levels, many system operators configure a dedicated renewable energy desk to manage VRE resource operation. Establishing such a desk in the control room can be a key step in the modernization effort.

A renewable energy desk in a control room is a specialized hub focused solely on monitoring, predicting, and managing the influx of energy from renewable sources. While a control room has many desks, such as those dedicated to generation or transmission, a dedicated renewable energy desk is mainly focused on variability and weather dependence, which is not crucial for conventional generation sources such as coal or hydropower. The key renewable energy desk functions and requirements described in this report include:

- **Monitoring VRE:** Keeping track of the output from renewable energy facilities
- **Operational management:** Adjusting the operation of renewable energy sources in real time to optimize efficiency and reliability
- **Grid integration:** Ensuring that the renewable energy generation is effectively integrated into the power grid, balancing supply and load
- **Forecasting and planning:** Using data and predictive models to forecast energy production from renewable sources
- **Communication and coordination:** Working with other sections of the control room, as well as external entities, for coordinated energy balance

The specialized desk can help stabilize the system by ramping up VRE generation when needed and curtailing output when needed. As part of creating the renewable energy desk, a grid operator will be able to address several gaps, listed below and in **Figure 1.**

1 "Renewable Electricity – Renewables 2022 – Analysis - IEA." n.d. IEA. https://www.iea.org/reports/renewables-2022/renewable-electricity.

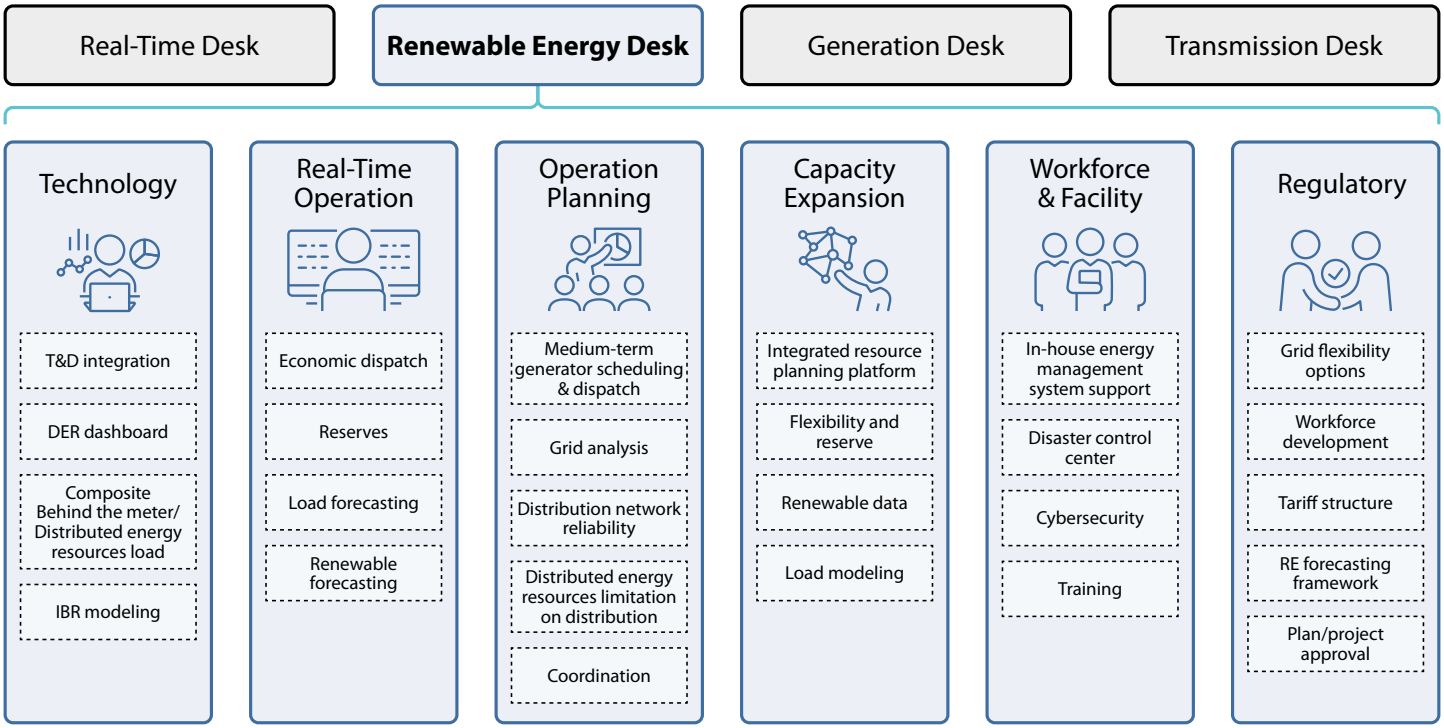

Figure 1. Renewable energy desk supporting pillars

Advanced Technology to Provide Renewable Energy Desk Monitoring Tools and Data

By using advanced forecasting algorithms and technologies, a renewable energy desk can anticipate renewable generation outputs based on a multitude of factors, with weather conditions being a paramount influencer. Technologies to support this functionality are listed below:

- Development/testing environments
- Vendor warranty of hardware/software
- Ability to securely interface with other corporate/distribution data sources
- No single point of telecommunication failure.

Real-Time Operation to Manage a Reliable Renewable Energy Desk

A renewable energy desk can tackle numerous challenges associated with the integration of substantial amounts of variable generation at the transmission level and demand response at the distribution level. To support transmission and distribution integration, the renewable energy desk could coordinate among transmission system operators, distribution system operators, and power producers. Technologies in the control room can support architectural characteristics such as scalable, modular, and interoperable applications. With the technology, the renewable energy desk monitors grid operations effectively, conducts sound decision-making, and controls the power balance between generation and demand. A real-time control room operation typically has the following features:

- Intraday, hourly, and subhourly forecasting of VRE interval load with confidence band
- VRE forecasting and weather forecasting tools integrated with real-time applications
- Dashboard showing reserve, ramp up/down flexibility, peaking units, and curtailment
- Real-time unit commitment and economic dispatch
- Advanced training systems.

Operational Planning to Integrate Renewable Energy Desk with Flexibility

A system control center's operational planning is carried out with various tools. Probabilistic forecasts of VRE generation and load at multiple time resolutions will inform operational decisions about generator maintenance planning, scheduling, and economic

dispatch to meet consumer load and grid ancillary service requirements. Key operational planning includes the below elements:

- Annual and seasonal planning with simplified renewable energy forecasts for hydropower, wind, and solar to inform hydropower and thermal coordination decisions, maintenance, and fuel stock planning
- Month-ahead planning with simplified updated renewable energy forecasts to inform daily hydropower budgets and other storage planning
- Weekly planning with updated renewable energy forecasts to inform hydropower and other storage, baseload power plant schedules
- Detailed day-ahead renewable energy forecasts for unit commitment or generator scheduling, considering the uncertainty of the forecast
- Intraday renewable energy forecasts to adjust peaking power plant schedules
- Hour-ahead forecasts to revise short-term generator scheduling, transmission use, and any other trading arrangements with neighbors, according to the uncertainty level of weather forecasts
- Subhourly forecasts for generator dispatch decisions, with control room operators assessing reserve requirements, how to handle ramps, requirements of peaking plants, and other factors.

Power grid operation with a high share of renewable energy requires additional flexibility. Additional measures would improve the power grid's flexibility. The following steps could be taken to improve system operation efficiency and operational planning capabilities:

- Inform system planning and reserve estimation with data on load and renewable energy variability
- Conduct detailed techno-economic analysis to identify system flexibility improvements that can help reduce costly curtailment of renewables
- Establish a modeling framework that exploits the full potential of current operation planning tools, introducing new tools if necessary
- Hire a weather forecasting vendor, if necessary, to include renewable forecast data at the central and individual power plant levels.

Capacity Expansion Planning and Renewable Energy Development

Grid operations benefit from comprehensive capacity expansion planning and a renewable energy development process based on detailed analysis, data, and regulations. On the other hand, delays in plan approvals and project implementation hamper efficient grid operation. Capacity expansion planning to achieve increasing renewable energy targets typically build on detailed modeling and analysis that includes uncertainty, new technology, grid resilience, and multiple scenarios. These studies would be guided by interdisciplinary expertise and renewable data analysis.

Renewable energy data is a critical issue in the planning, development, and renewable procurement process. Although multiple agencies participate in renewable data collection, grid operators need a central data management system. At the same time, renewable energy procurement is complicated by the approval and negotiation of power purchase agreement terms. Capacity expansion planning, renewable energy development, and procurement practices can be modernized with the following interventions:

- Establishing an integrated resource planning framework in capacity expansion planning
- Assessing and enabling options for system flexibility improvements and grid reserve requirements

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- Creating working groups and technical review committees to boost planning capabilities, enhance stakeholder engagement, and reduce delays
- Coordinating renewable data from multiple agencies, with a plan for investment in advanced technologies, training staff, and data management systems
- Evaluating renewable energy payment structures, considering project economics and curtailment risk
- Designing power purchase agreements that compensate renewable energy sources for various grid services.

Workforce and Facilities to Support a Resilient Renewable Energy Desk

Reliability—"keeping the lights on"—is an important goal and can be supported by a business continuity plan. For example, if a control center is damaged by fire, a disaster recovery plan can detail how to move operations to another location. If control room tools are being compromised by a cyberattack, control center resources could be available and able to resolve it as quickly as possible. A business continuity plan or disaster recovery plan can empower grid operators' workforces to respond in the case of an emergency and provide facility management to improve reliable operation. Key components of operational resilience are listed below:

- In-house energy management systems support
- Area and site redundancy
- Staff training on new hardware, software
- Cross-training of different staff roles
- Cybersecurity defense
- Staff training on power system planning.

Regulatory Support to Streamline Renewable Energy Desk Setup

Setting up a control room renewable energy desk typically involves collaboration with regulators such as policymakers and public utility commissions. Regulators can enable renewable desk setup, prioritize efficient grid operation, and minimize renewable curtailment. Below are some examples of activities that regulatory support would make possible:

- Renewable energy forecasting framework
- Grid flexibility options (demand response program, energy storage options)
- Renewable curtailment risk and tariff structures analysis
- A streamlined renewable desk hardware and software procurement process
- Research on renewable energy and the power grid (forecasting, technologies, grid analysis)
- Workforce expansion and training program.

Authors: Thushara De Silva, Seong Lok Choi, Adarsh Nagarajan, NREL

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Contacts

Adarsh Nagarajan, NREL
adarsh.nagarajan@nrel.gov

Miriam Croos Moraes, USAID Sri Lanka
mcroosmoraes@usaid.gov

Monali Hazra, USAID India
mhazra@usaid.gov

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