

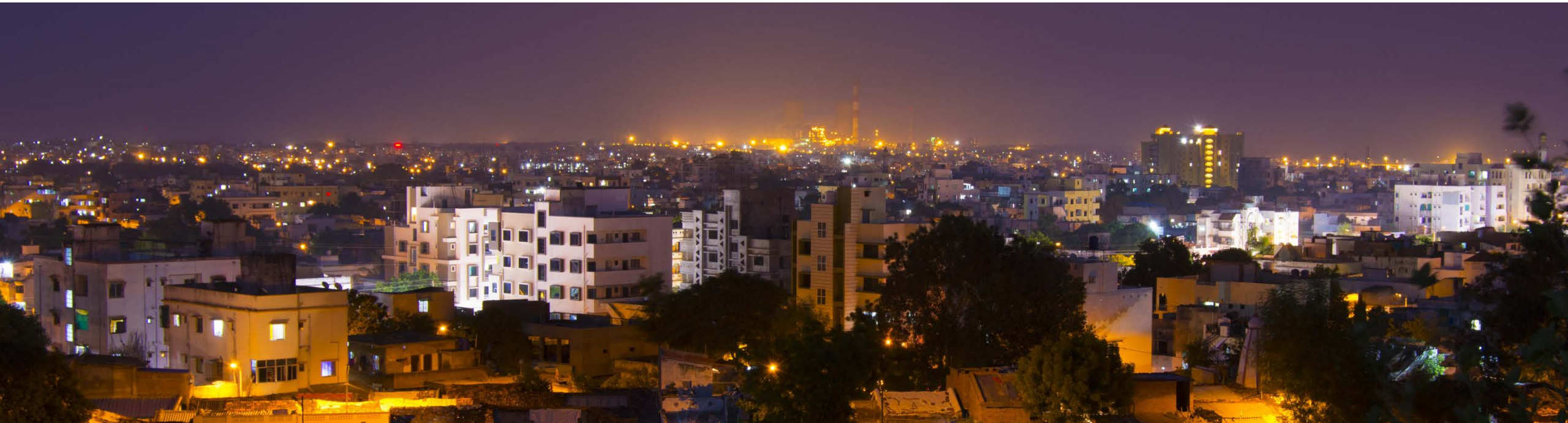


# Tangible Solutions for Grid Operation Upgrade

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Asia Clean Energy Forum 2024

June 6, 2024



# The USAID-NREL Partnership

## USAID-NREL PARTNERSHIP STRATEGIC PILLARS

*Provision of demand-driven technical assistance through USAID Mission engagements, global knowledge platforms, and project implementation*



### ADVANCED & FRONTIER POWER SYSTEMS

*Utility-scale clean energy generation, transmission, distribution*



### INNOVATION & GRID INTERACTION IN BUILDINGS

*Energy efficiency, distributed generation, storage*



### ELECTRIC MOBILITY & SUSTAINABLE TRANSPORT

*Electric vehicles, charging infrastructure, hydrogen*



### INTEGRATED ENERGY SOLUTIONS

*Holistic energy sector scenario planning, impact assessments, and programming*



### JUST ENERGY TRANSITIONS

*Gender equity, air quality, resilience, job creation, energy access – foundational to all USAID-NREL activities*

### BEST-IN-CLASS ENERGY DATA & ANALYTICS



# Countries Making RE Targets

Renewable capacity expansion investments accelerated 85% over the last five years.

By 2022 renewable capacity mix:

- China : 36%
- European Union: 35%
- Global: 28%
- United States: 26%
- India: 8%



*Image from Getty Images 1263390635*

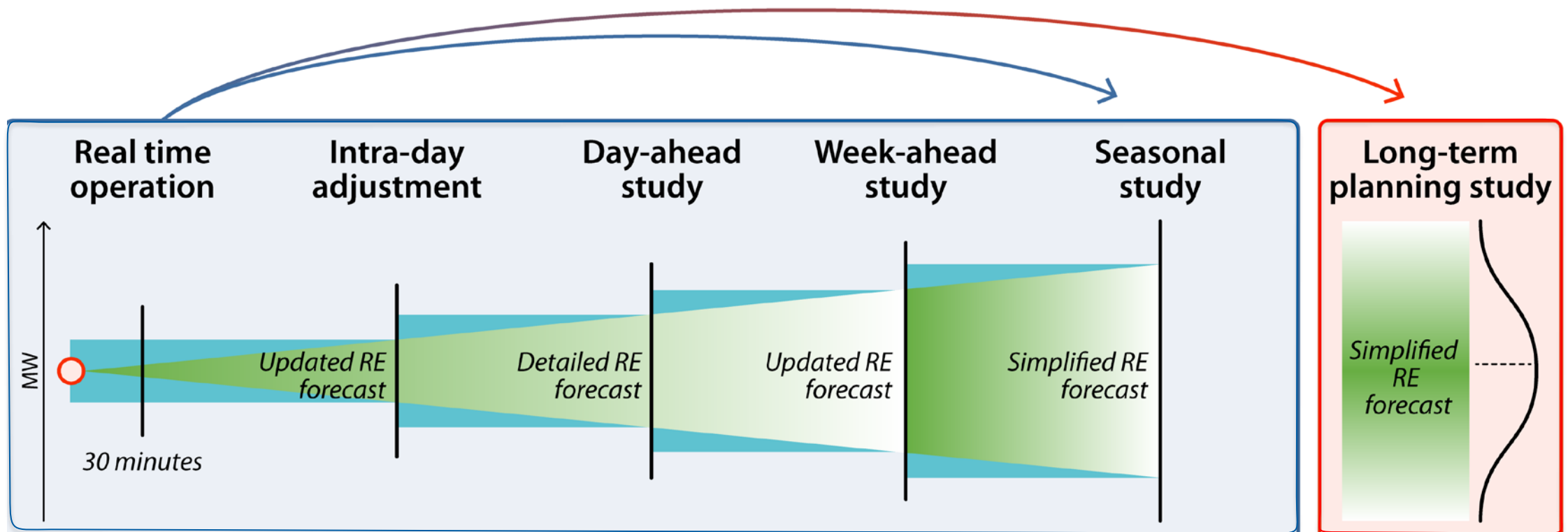
## **2022-2027 targets:**

- World net zero by 2050 targets plan for renewable capacity addition 3777 GW
- Accelerated renewable addition target will add renewable capacity 2950 GW
  - China: 1190GW
  - European Union: 450GW
  - United States 360GW
  - India: 217GW
  - Brazil: 83GW
  - Other Countries: 650GW

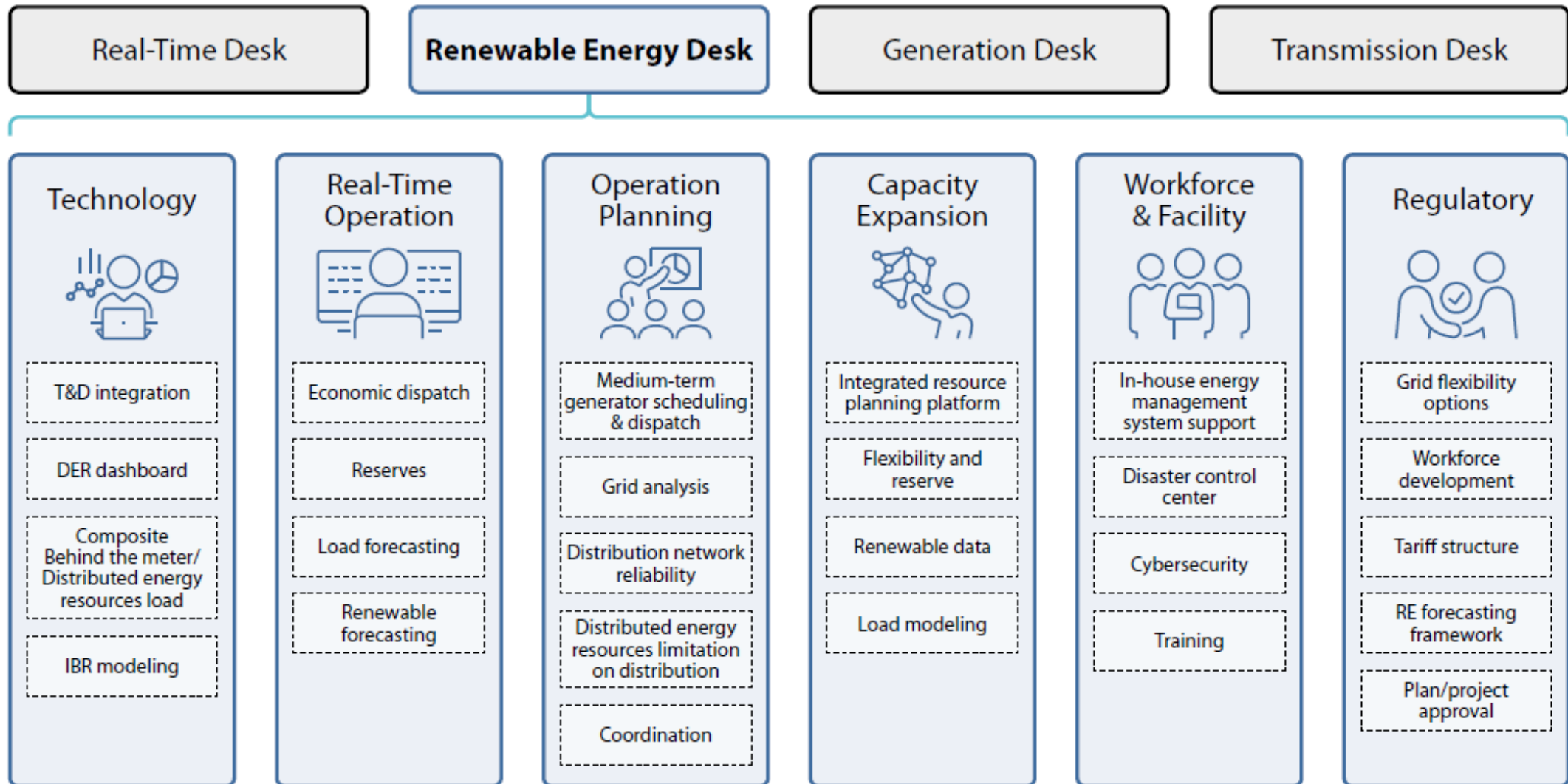
# Power Grid Planning with Higher Renewable Share

Planning and operating a power grid involves various levels of decisions, which are informed by multiple tools and data.

## Capacity expansion for grid services



# Renewable Energy Desk Supporting Pillars



# RE Desk for Power Grid Operator and Stakeholders

## System Control Center

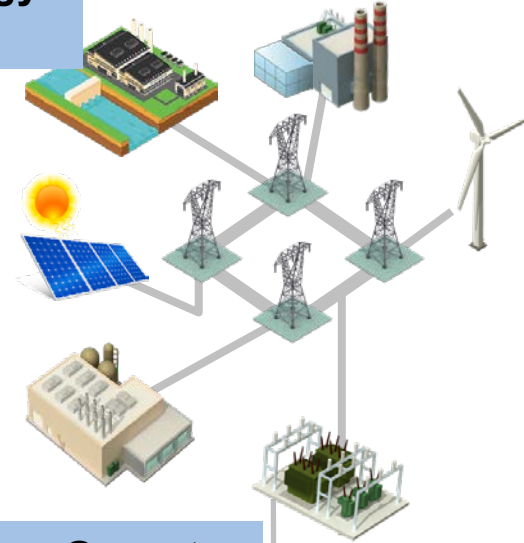


- System operation planning
- System operation
- Communicating with bulk system

## Renewable Energy Desk (RE desk)

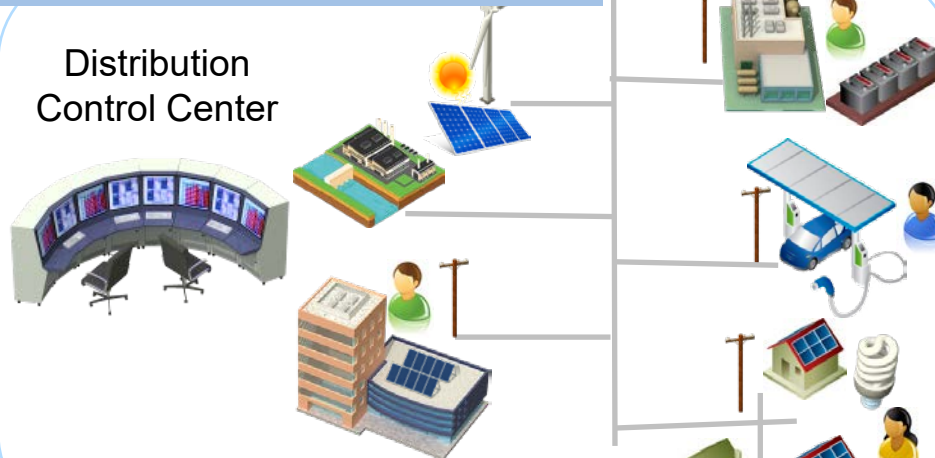


## Bulk Energy System



## Distribution System Operator

### Distribution Control Center



## Regulator

Regulating grid expansion and operation

## System Operator

Capacity expansion planning  
Renewable development  
Renewable procurement

## RE Development Institute

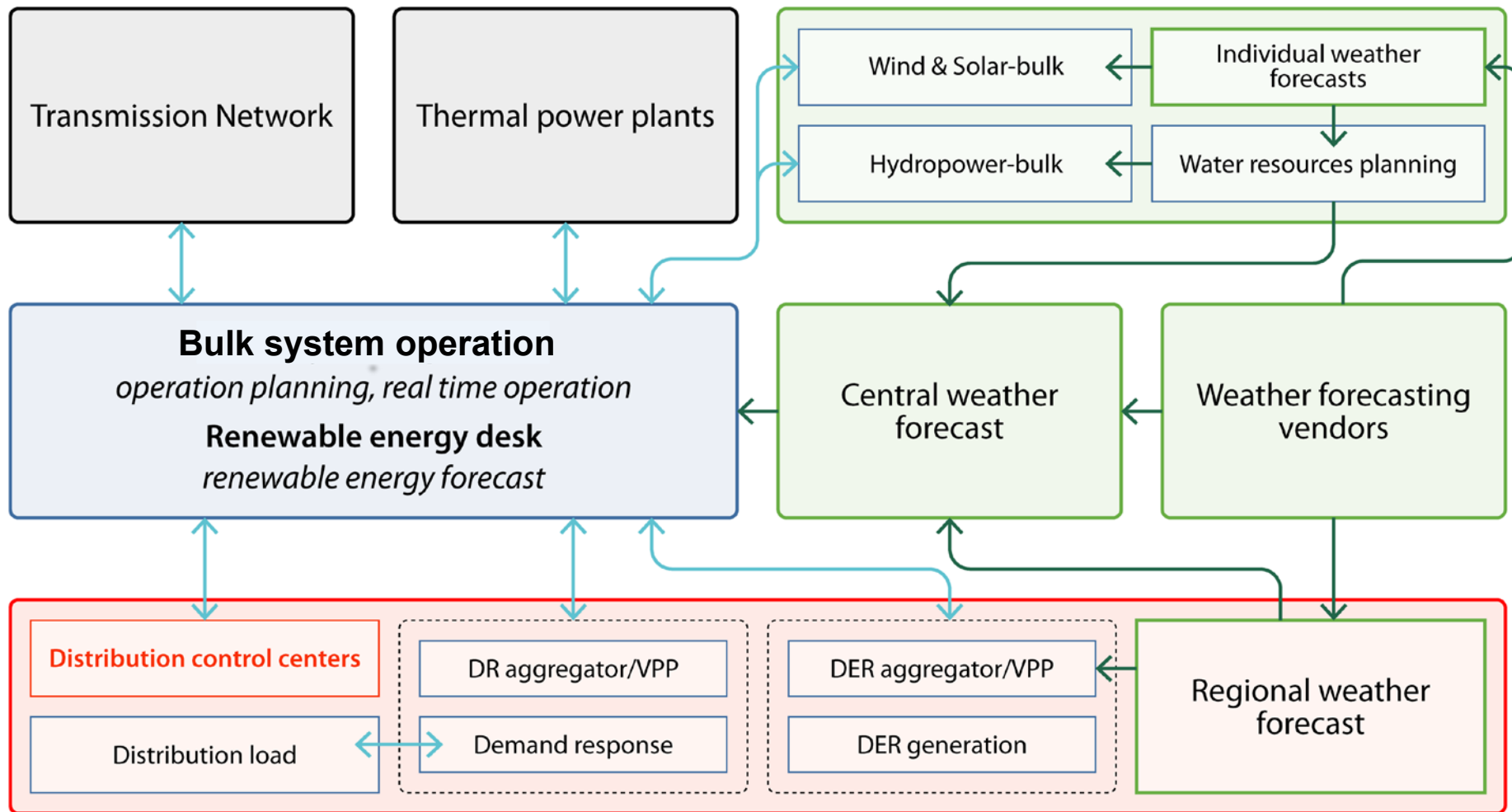
Renewable development  
Renewable data

## RE Developer

Renewable development

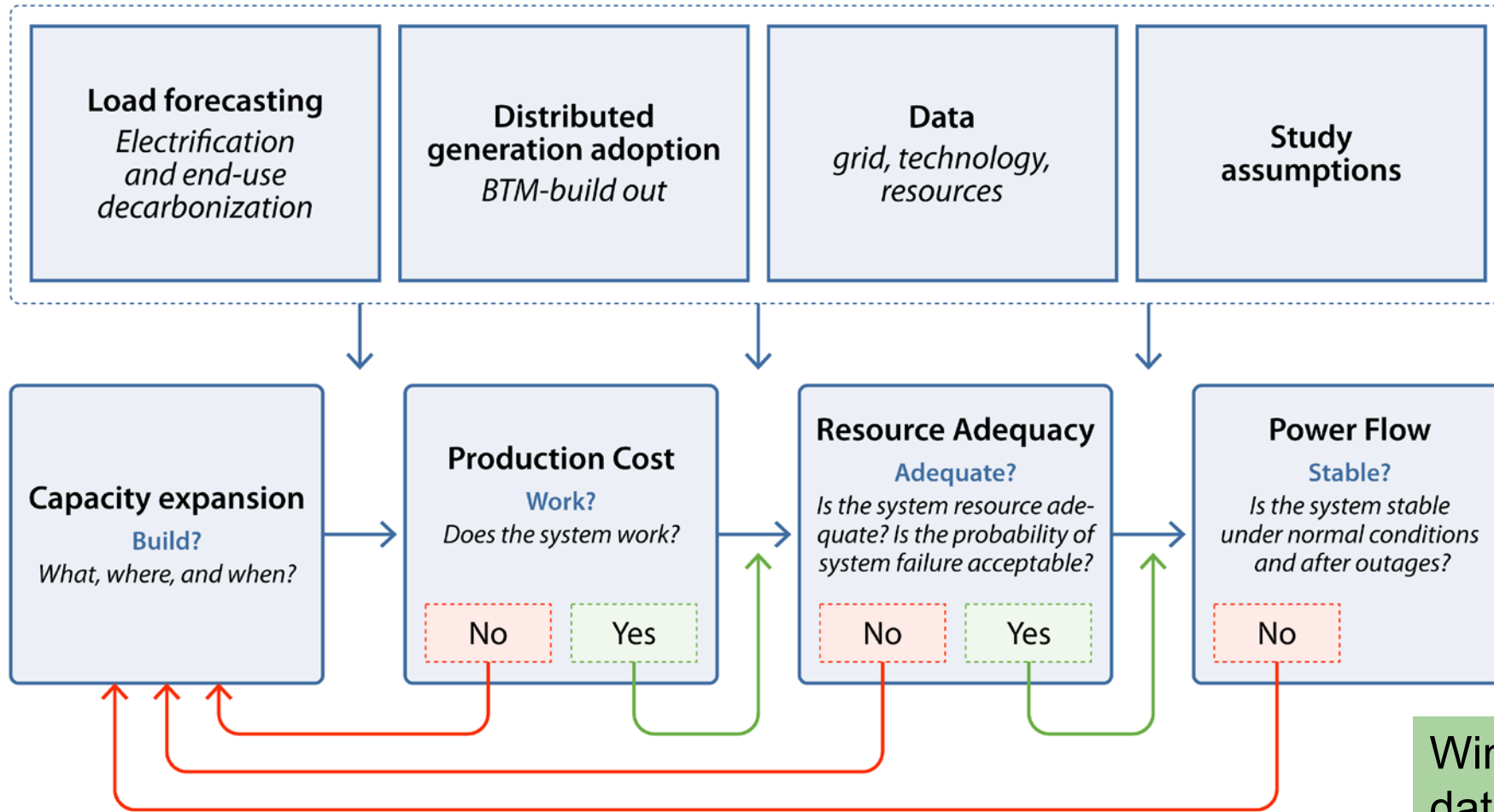


# Operation Planning with Renewable Energy Desk



Operation planning framework with weather forecasting various spatial and temporal resolution

# Planning Framework to Support High RE share



Wind and solar resource data, hydropower water use, load and electrification, new technologies, and grid data are crucial elements

**Integrated modeling framework**

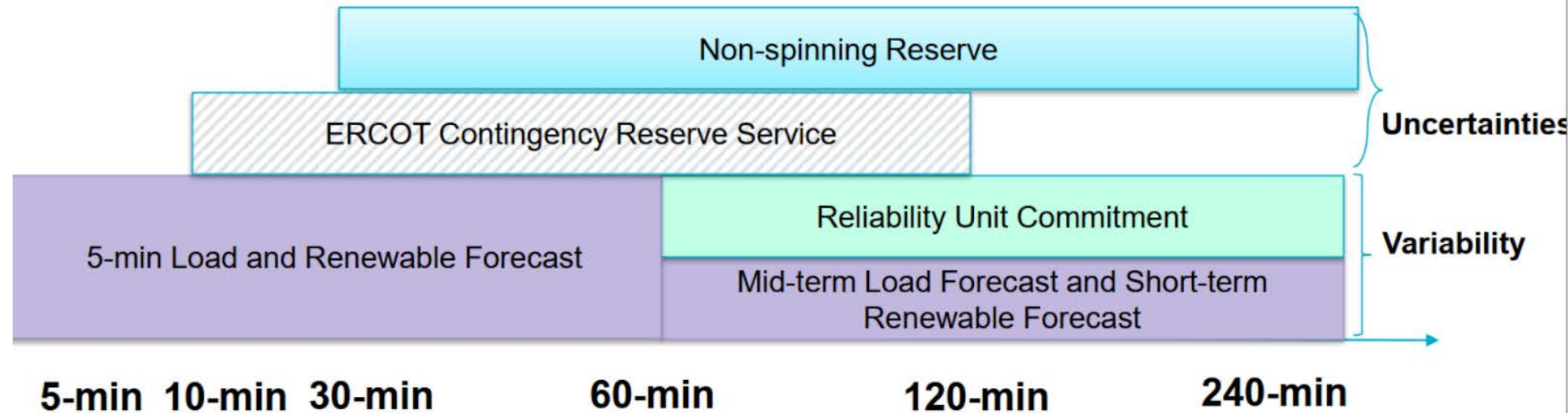




# Reserves to Meet Variability and Uncertainties

Estimating multiple reserve types:

- Reserves from online or offline generators (spinning and non-spinning reserves)
- Event or non-event response (contingency and normal operation)
- Time to respond (regulation reserves, load following and flexibility, replacement reserves)
- Currently, power grid has small % of net load as spinning reserve from conventional power plants
- Reserves estimations need to consider renewable energy forecast errors



Reserve monitoring display of renewable energy desk (from ERCOT )

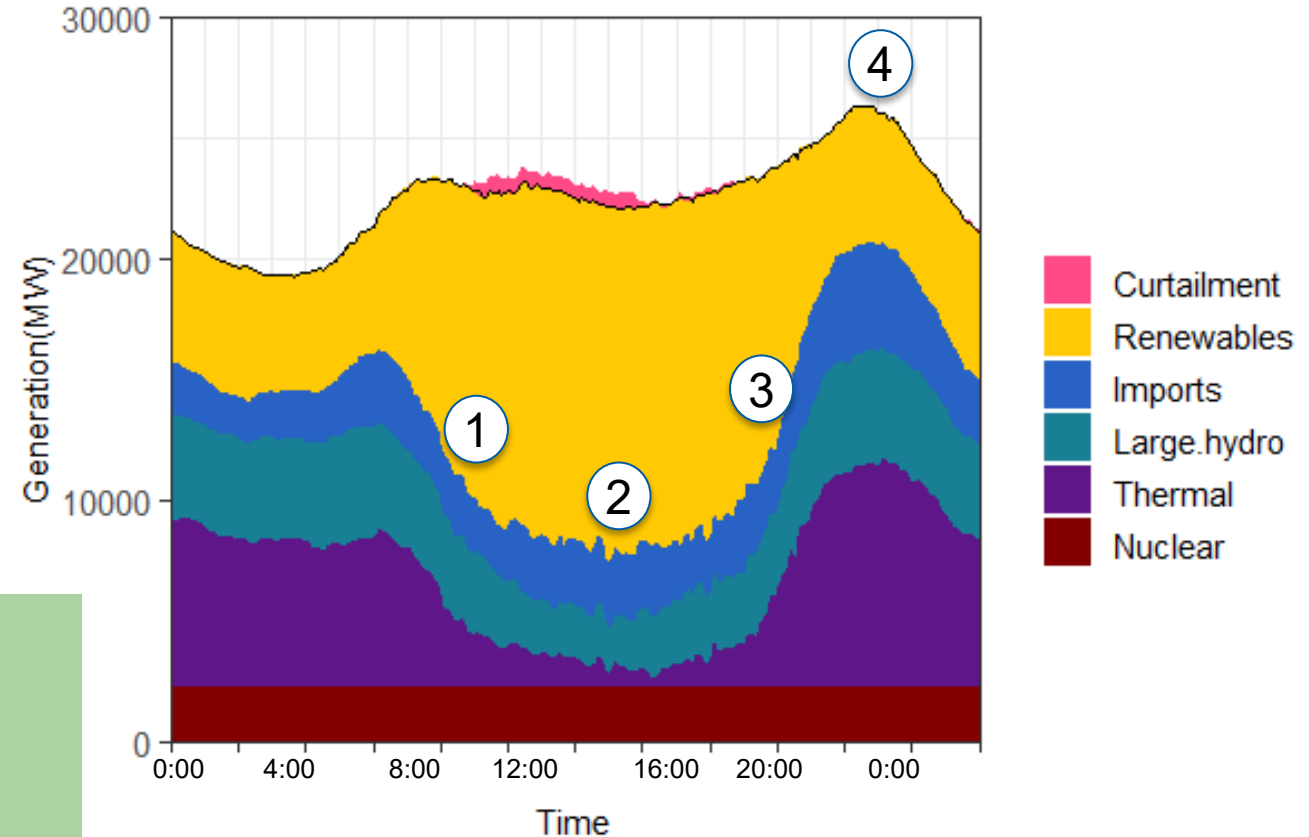
# Grid Flexibility Assessment

- Higher renewable share requires additional flexibility to balance system variability
- Comprehensive assessment of current and planning horizon using an integrated modeling framework is a starting point.

## Flexibility options/technologies

- System operation practices
- Demand response
- Flexible generation sources
- Transmission network improvements
- Storage options

**Flexibility options beyond physical assets including - *demand side management.***

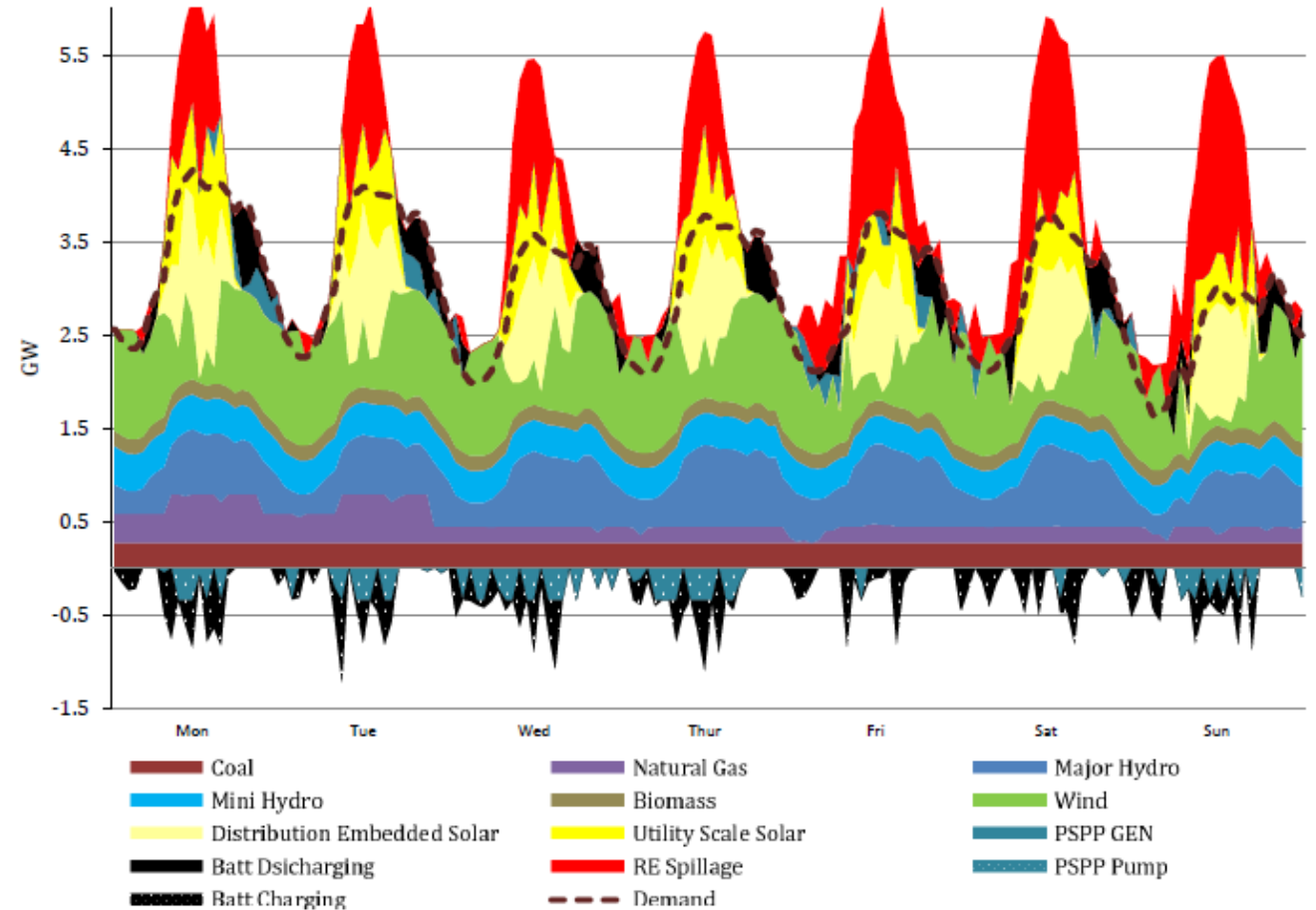


1. Downward ramping capability
2. Minimum generation flexibility
3. Upward ramping flexibility
4. Peaking capability

# Renewable Energy Curtailment Analysis

- Figure illustrates example from Sri Lanka capacity expansion studies
- System operator's capacity expansion plans indicate renewable energy curtailment in future years

Investment on grid flexibility options and reducing renewable energy curtailment can be analyzed as an economic problem



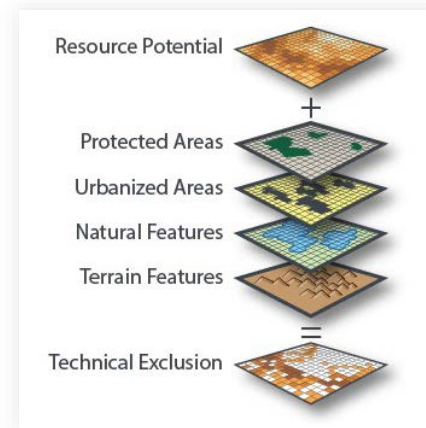
Sample weekly dispatch during high wind season (CEB, 2023)

# Overview of Renewable Energy Data Explorer

Web-based geospatial platform designed to provide access to renewable energy data



Visualizes geospatial data layers to facilitate informed decision making



Data and features are customizable at regional, country, and global scales



[www.re-explorer.org/re-data-explorer](http://www.re-explorer.org/re-data-explorer)

- Renewable energy data is crucial to enable renewable energy desk, renewable energy development and procurement
- RE Data Explorer includes multiple years of solar resource data and wind resource data of South Asian countries



# Summary and References

- Grid operation with high RE share involves technology upgrades, such as renewable energy desk
  - RE Desk has several pillars in addition to technology upgrades
  - Power grid planning studies inform renewable energy expansion and operation decisions
  - Renewable data, workforce, regulatory are important pillars in efficient grid operation
- 
- Ceylon Electricity Board 2023. “Long Term Generation Expansion Plan 2023-2042.” Technical report. Colombo, Sri Lanka
  - Cochran, Jaquelin et.al., 2021. “LA100: The Los Angeles 100% Renewable Energy Study Executive Summary.” National Renewable Energy Laboratory, Los Angeles Department of Water & Power. <https://www.nrel.gov/docs/fy21osti/79444-ES.pdf>.
  - De Silva, Thushara; Choi, Seong Lok; Nagarajan, Adarsh 2024; “An Overview of Renewable Energy Desk Activities for Power Grid Operations and Planning” National Renewable Energy Laboratory. <https://www.osti.gov/biblio/2329431>
  - International Energy Agency, “Renewable Electricity – Renewables 2022 – Analysis and Forecast to 2027” <https://www.iea.org/reports/renewables-2022/renewable-electricity> Accessed, 1/1/2024
  - Brinkmen, Greg et.al., 2021, “The North American Renewable Integration Study: A U.S. Perspective” National Renewable Energy Laboratory. <https://www.nrel.gov/docs/fy21osti/79224.pdf>

# Thank you

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This work was authored, in part, by the National Renewable Energy Laboratory (NREL), operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the United States Agency for International Development (USAID) under Contract No. IAG-19-2115. The views expressed in this report do not necessarily represent the views of the DOE or the U.S. Government, or any agency thereof, including USAID. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

NREL/PR-6A40-89933