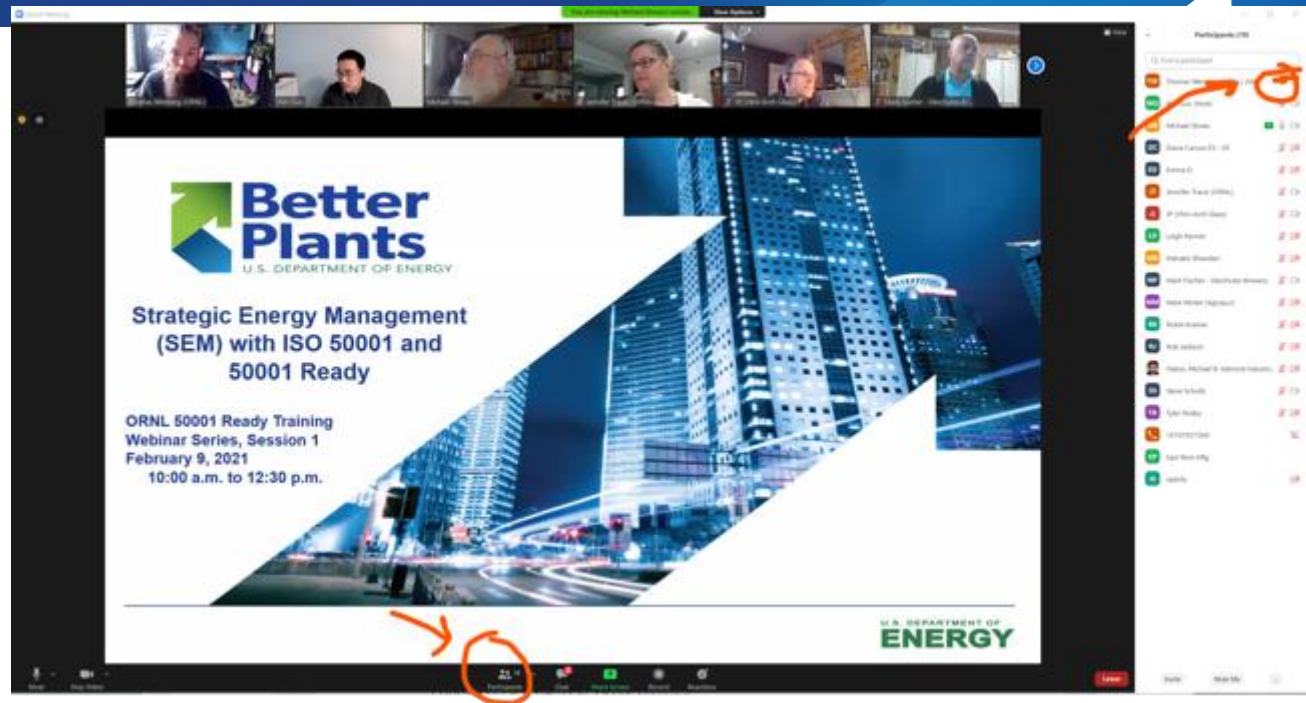
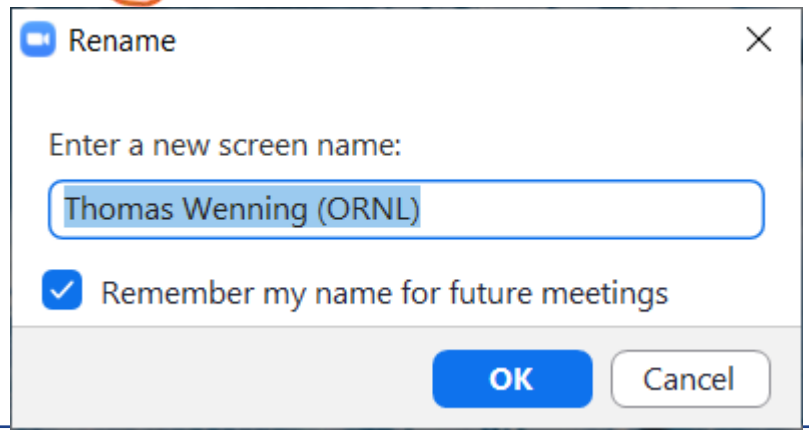
Rename Yourself to be your Real Name (Company Name)

1. Click on Participant list
2. Go to the right and hover over your name
3. Select “More” & “Rename”
4. Enter your company name in brackets
5. Turn on your camera ☺





Better Plants®
U.S. DEPARTMENT OF ENERGY

Virtual Training: Renewable Energy Contracting Options and RECs

Understanding The U.S. Electricity Markets And Procurement Roadmap

Session #2
August 12, 2025
10:00am – 12:00pm EST

U.S. DEPARTMENT OF ENERGY

General Information

- Schedule: Every Tuesday (Aug 5th – Sep 9th) morning @ 10am ET
- Sessions will be recorded
- We want these VT to be interactive!
- We're hoping you finish the VT with some big progress
- There will be homework – just try your best!
  - "You'll get out what you put in!"

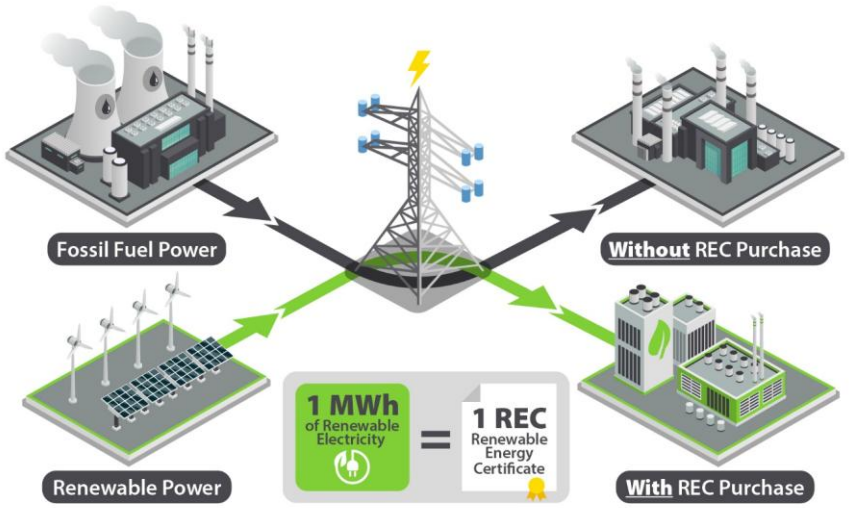
Links:
https://bptraining.ornl.gov/
http://betterbuildingssolutioncenter.energy.gov/better-plants
https://measur.ornl.gov

Training Overview

1. 08/05: Fundamentals Of Renewable Electricity And Emissions Inventory
2. 08/12: **Understanding The U.S. Electricity Markets And Procurement Roadmap**
3. 08/19: Purchasing Renewable Electricity: PPAs, VPPAs, and Other Supply Options
4. 08/26: Navigating Voluntary Electricity Markets
5. 09/02: Purchasing Renewable Electricity: Best Practices and Success Stories
6. 09/09: Renewable Electricity Supply Options: Financing Models and Strategies

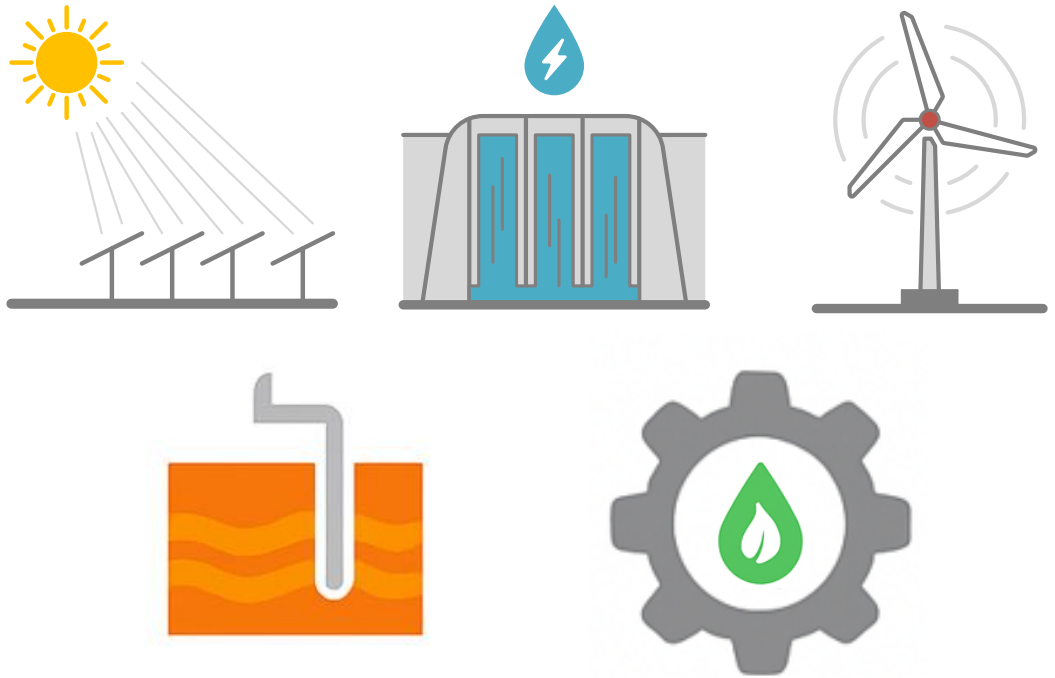
Review of Session #1 Homework

- Which of the following best defines a Renewable Energy Certificate (REC)?
  - A government license for installing solar panels
  - ✓ A tradable, non-tangible energy commodity representing proof that 1 MWh of electricity was generated from a renewable resource
  - A contract between utilities and consumers
  - A carbon offset from forest conservation



Review of Session #1 Homework

- Which of the following is considered a renewable electricity source?
  - Natural gas
  - Coal
  - ✓ Wind
  - Nuclear



Review of Session #1 Homework

- Scope 2 emissions often relate to:
  - Onsite fossil fuel combustion
  - Purchased electricity consumption
  - Vehicle fleets
  - Landfill waste

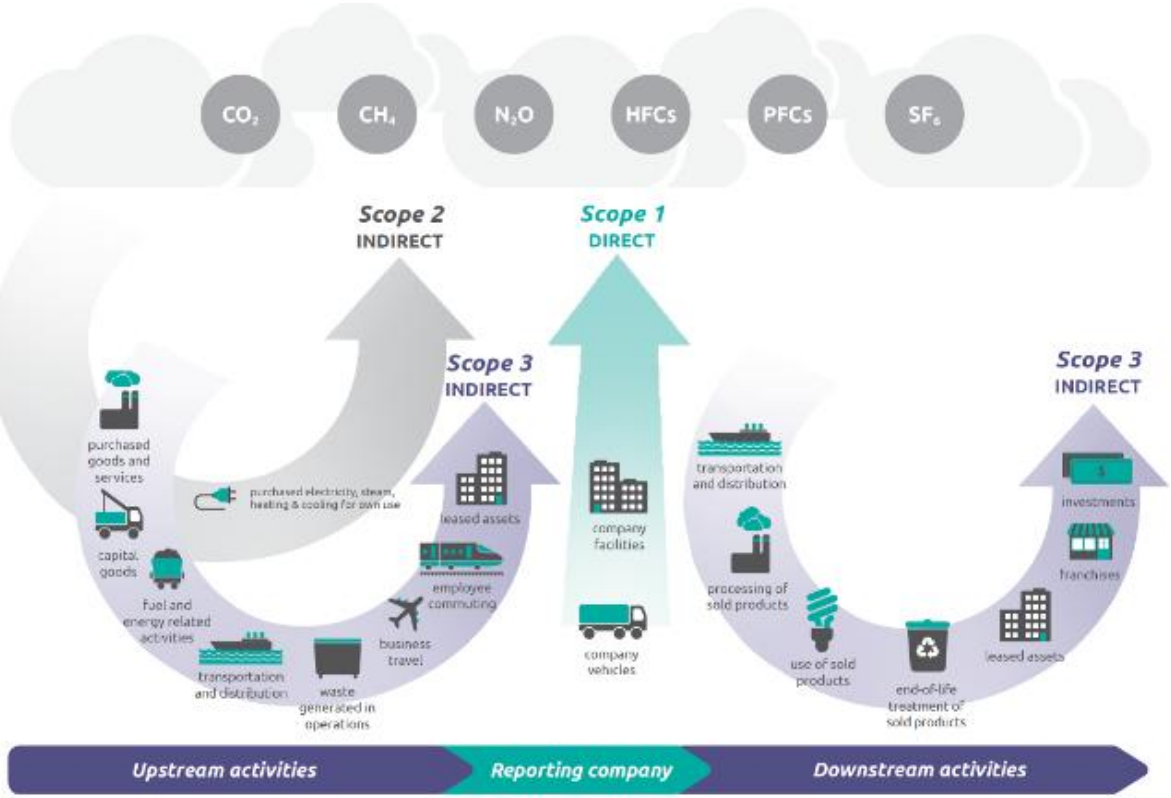


Image Source: GHG Protocol

Review of Session #1 Homework

- Why is an emissions inventory important for an organization?
  - To track production investments
  - To identify and manage GHG reduction opportunities
  - To meet investor tax demands

Review of Session #1 Homework

- What unit is commonly used to report GHG emissions?
  - Gallons
  - Kilowatt-hours
  - Pounds
  - ✓ Metric tons CO_2e

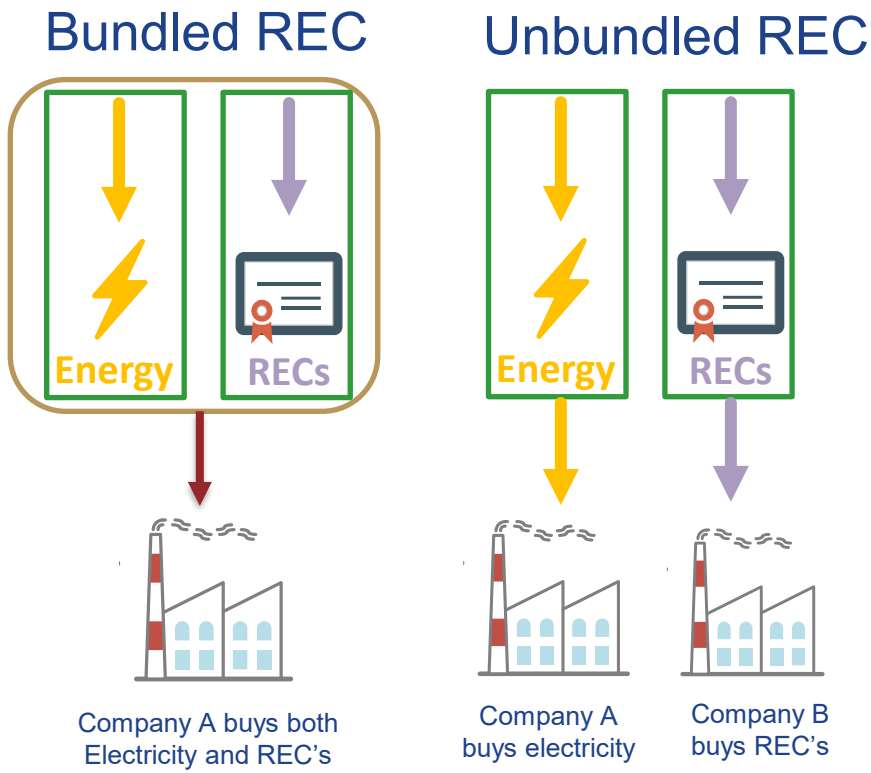
$$CO_2e(ton) = \frac{(CO_2\ emissions + (25 * CH_4\ emissions) + (298 * N_2O\ emissions))}{1000}$$

Review of Session #1 Homework

- What is the first step in creating an emissions inventory?
  - Buying offsets
  - Defining the organizational boundaries
  - Reporting to the EPA
  - Contacting utilities

Review of Session #1 Homework

- What is the key difference between bundled and unbundled RECs?
  - Bundled RECs include both energy and capacity, while unbundled only include energy.
  - Bundled RECs are sold with the underlying electricity, while unbundled RECs are sold separately from electricity.
  - Unbundled RECs are used only for solar energy.
  - There is no difference between them.



Review of Session #1 Homework

- One Renewable Energy Certificate (REC) represents the environmental attributes of __One (1)__ megawatt-hour(s)/MWh of renewable electricity.

Poll Time!

Week 1 Poll: Question 1

- What is the biggest internal challenge you're facing while navigating procurement?
  - Limited Data/Visibility
  - Complexity with utility contracts
  - Lack of internal expertise
  - Not involved in procurement decisions

Week 1 Poll: Question 2

- Do you consider additionality (funding new renewable projects) a priority in your procurement decisions?
  - Yes
  - No
  - Depends, specify

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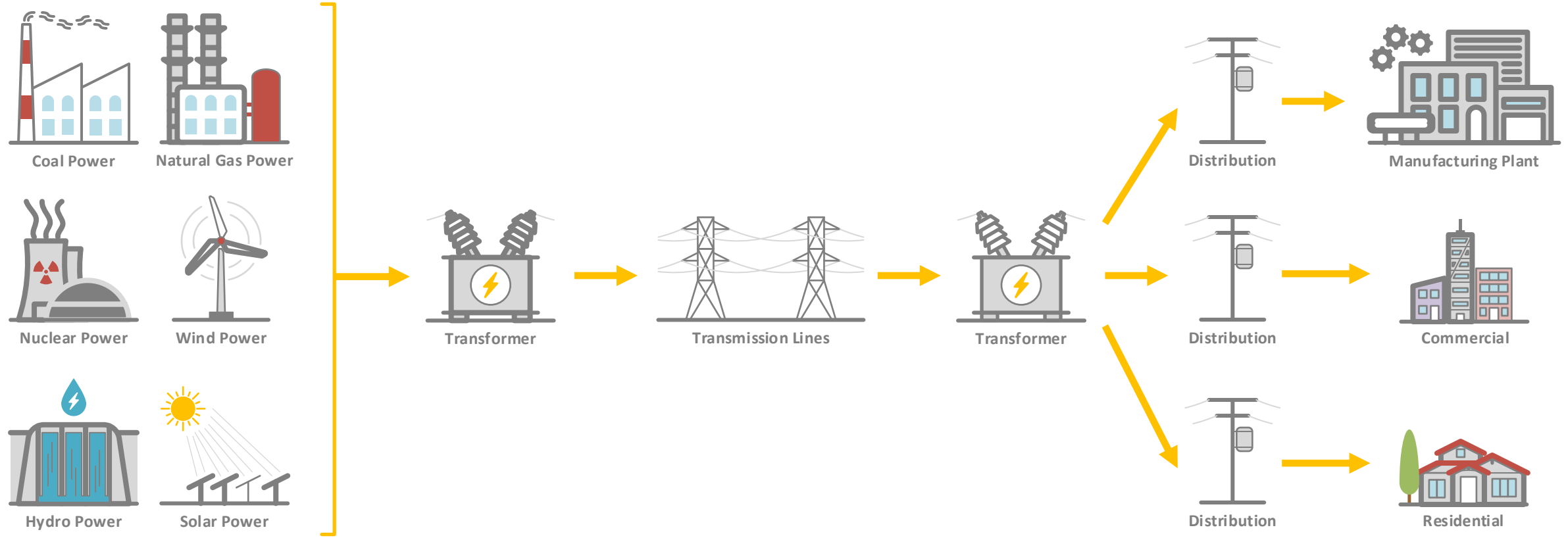
Understanding the U.S. Electricity Markets and Procurement Roadmap

Indraneel Bhandari
Oak Ridge National Laboratory

U.S. DEPARTMENT OF ENERGY

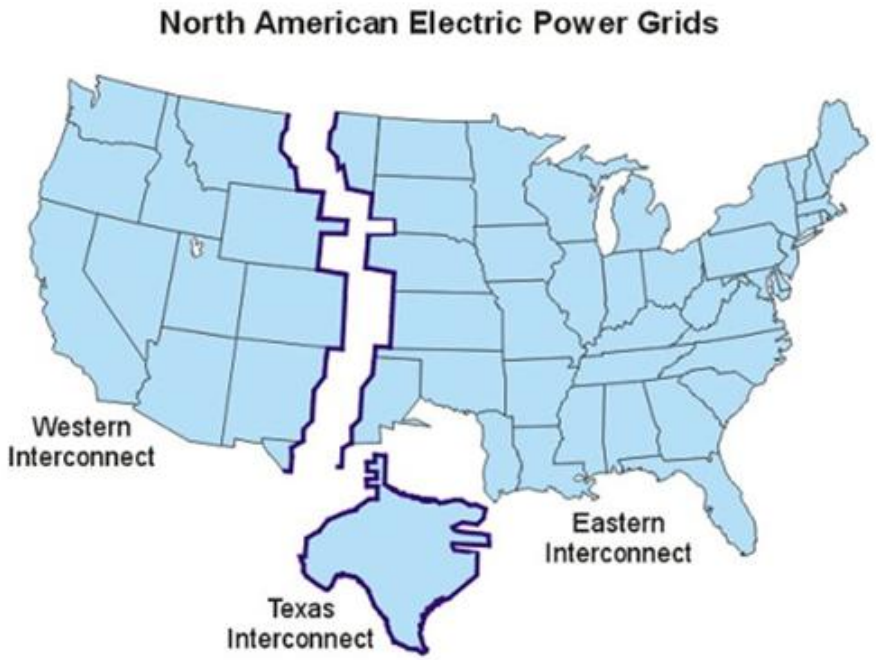
Electricity Generation in U.S.



Electric Grid

The US has three large power grids:

- The Eastern Interconnection
- The Western Interconnection
- The Electric Reliability Council of Texas (ERCOT)



The US has more than 60 balancing authorities:

- Manage operation within specific geographic area
- Either utilities, power marketing administrations (PMA), or a group of utilities (entities such as RTOs and ISOs)

Balancing Authorities Across the U.S.

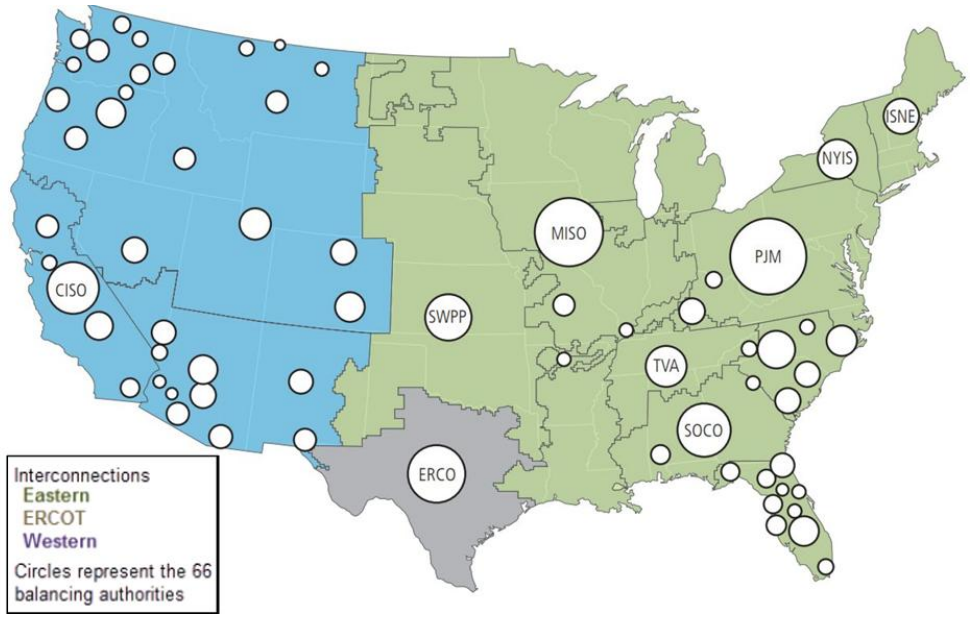
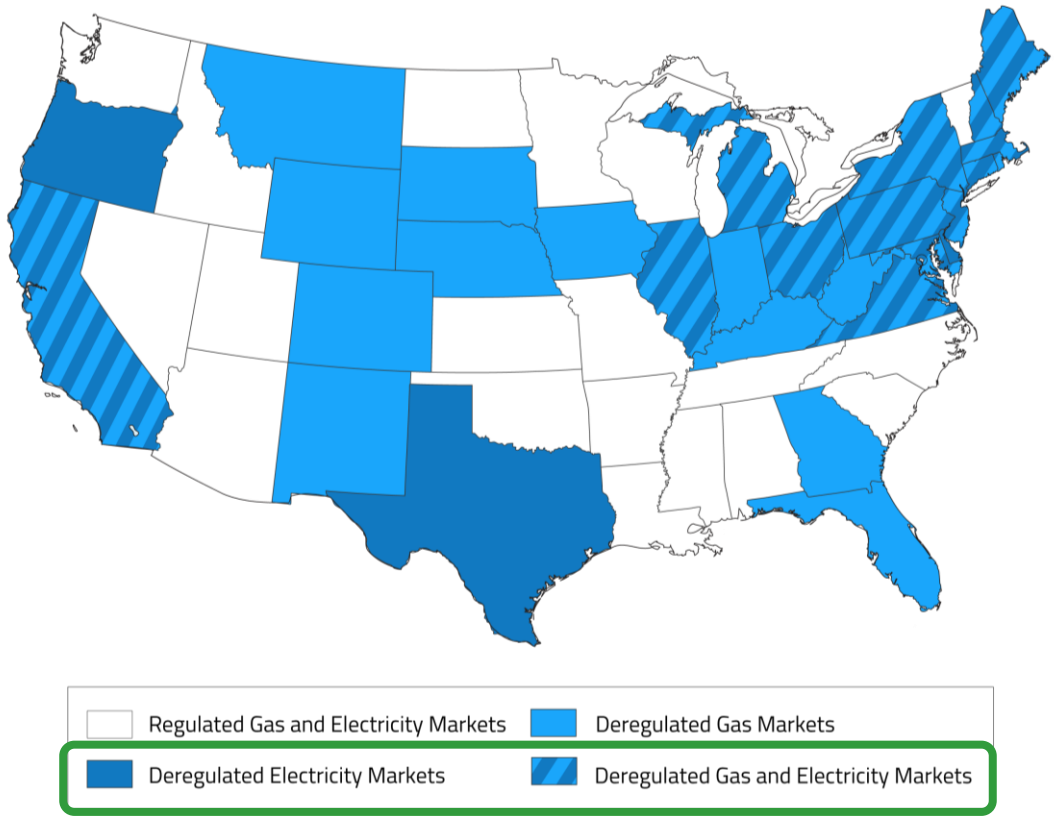


Image Source: EPA Green Power Markets

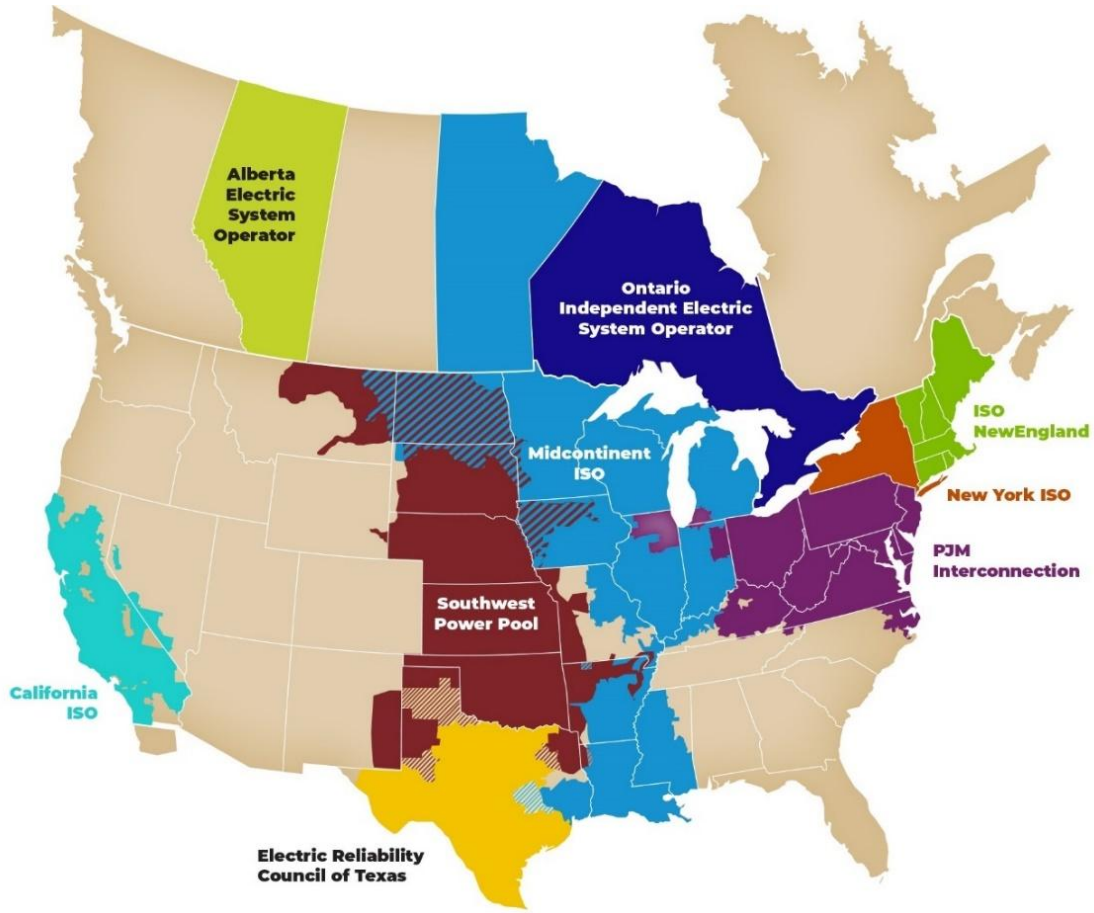
Image Source: DOE Energy.gov

Electricity Markets



Status of electricity markets by state

Note: States may be partially regulated/deregulated, regulated only in some utility markets, or deregulated for industrial consumers. Additional information is available at the American Coalition of Competitive Energy Suppliers

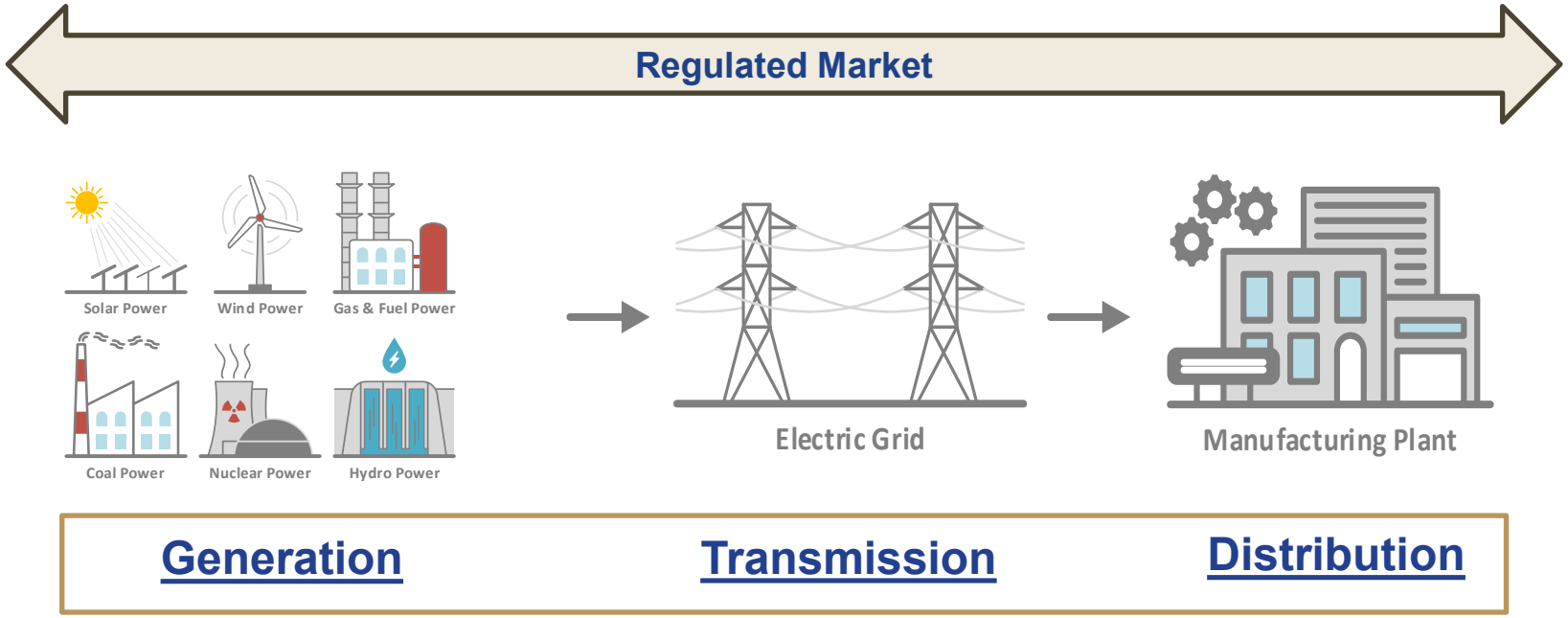


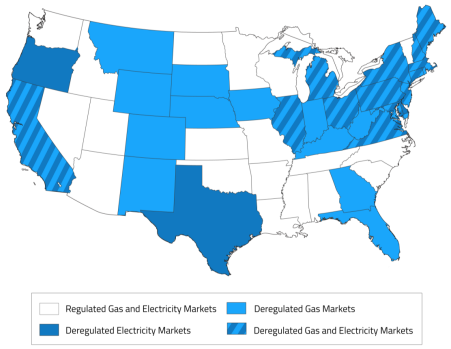
Wholesale electric power markets (ISOs/RTOs)
Source: ISO/RTO Council (IRC)

Image Source: Electric Choice https://www.electricchoice.com/map-deregulated-energy-markets/

Electricity Markets: How is Electric Power Distributed?

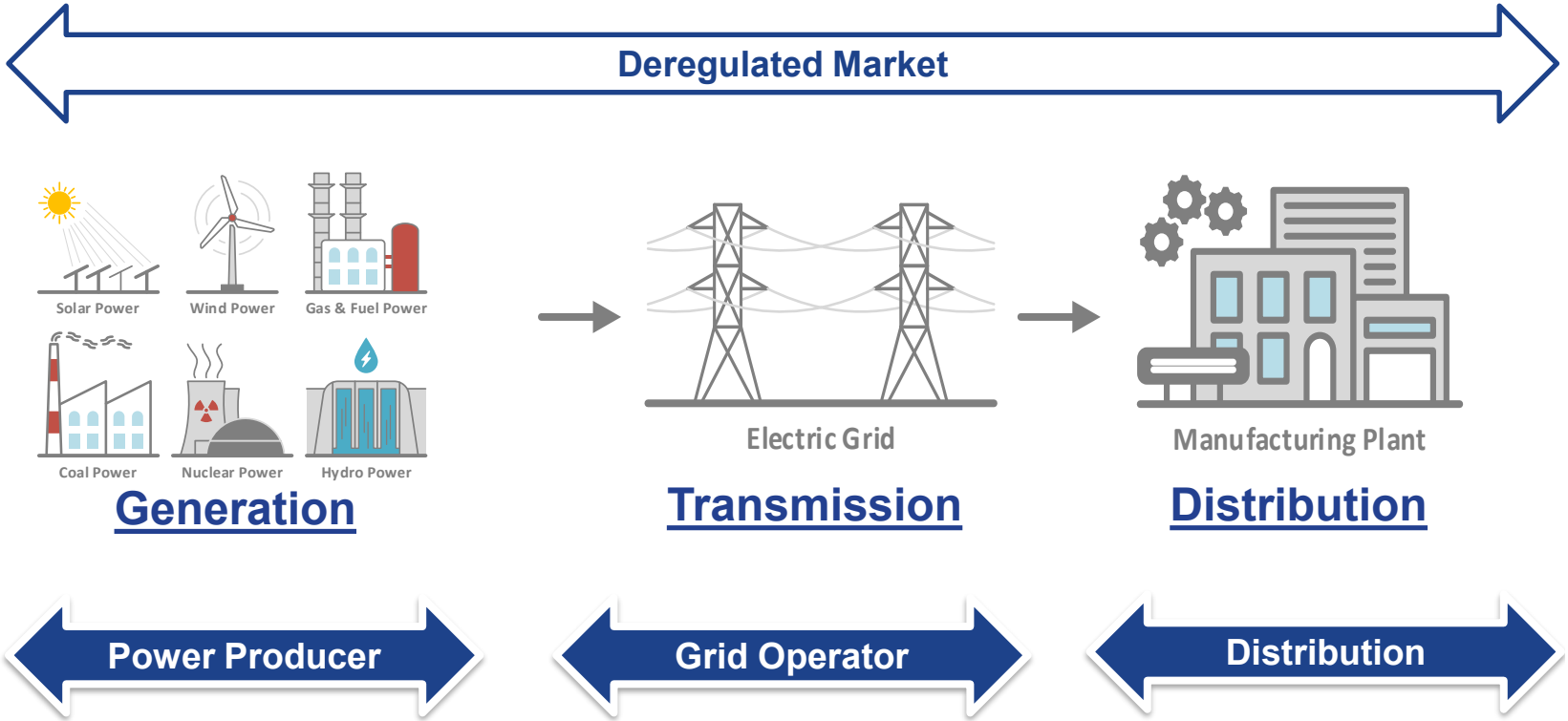
- Regulated Market: Utilities own all grid components

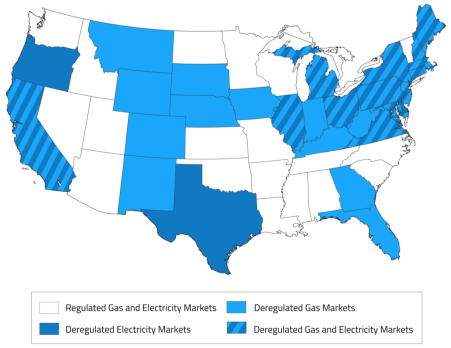




Electricity Markets: How is Electric Power Distributed?

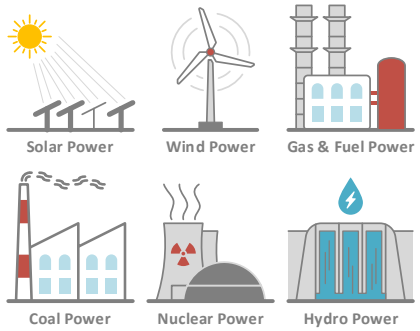
- Deregulated Market: Generators and distributors may be separate entities



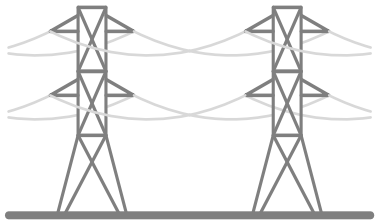


Electricity Markets: Wholesale and Retail Components

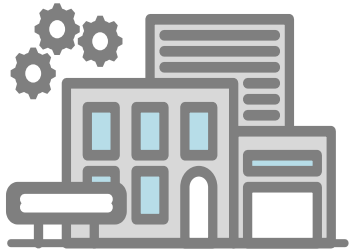
- Wholesale: sale of power between generator and market operator
- Retail: sale of power between providers/utilities and consumers



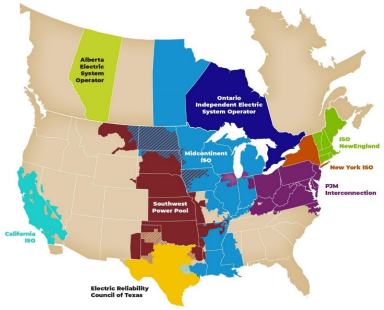
Generation



Transmission

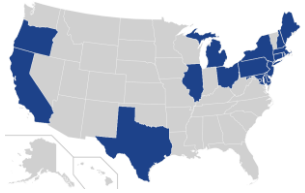


Distribution



Wholesale (colored)

Retail (blue)

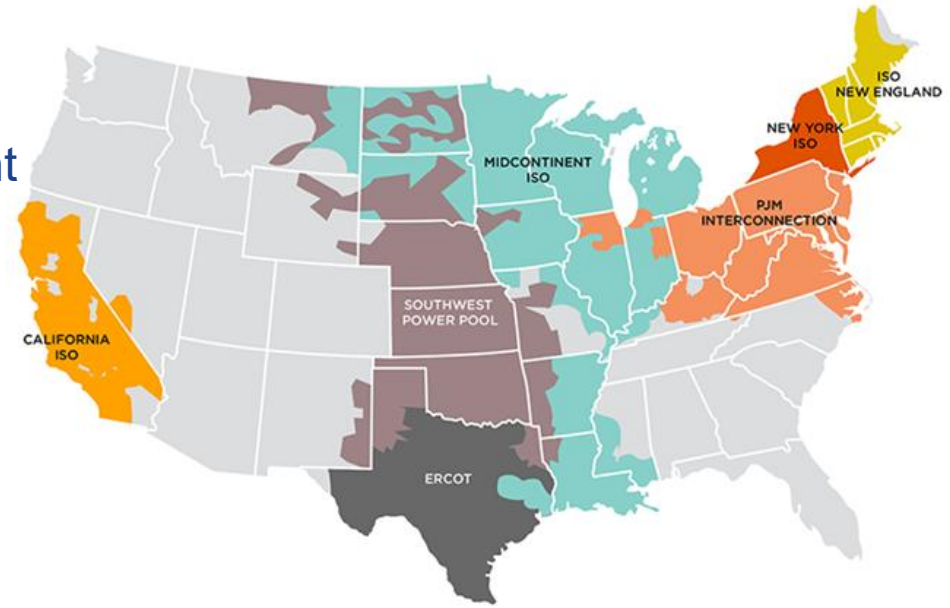


Electricity Markets: Wholesale

- Wholesale: sale of power between generator and market operator

- Regulated Power Market (Gray)
  - Electricity generation is directly controlled by utilities
  - State public utility commissions (PUCs) provide oversight and ensure price stability

- Competitive Power Market (Colored)
  - Independent Power Producers sell into wholesale markets (managed by RTO and ISO)
  - RTO and ISO coordinate supply and distribution
  - Utilities and retail electric providers (REPs) buy power and resell power and provide final delivery



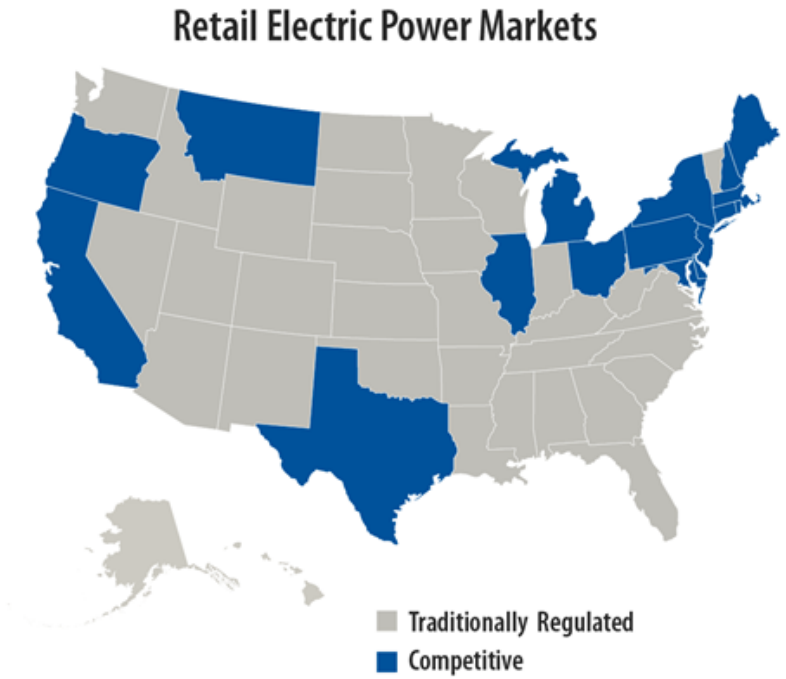
Seven ISOs/RTOs operate in the U.S. serving more than 60% of the national load in 34 states and Washington, DC

Electricity Markets: Retail Market

- Retail: sale of power between providers/utilities and consumers

- Regulated Retail Market (gray)
  - Consumers must buy electricity from their local utility
  - Limited choice (utility's offering)

- Retail Choice Market (blue)
  - Consumers can purchase electricity from providers, other than their local utility
  - Can choose between competitive power products from many providers

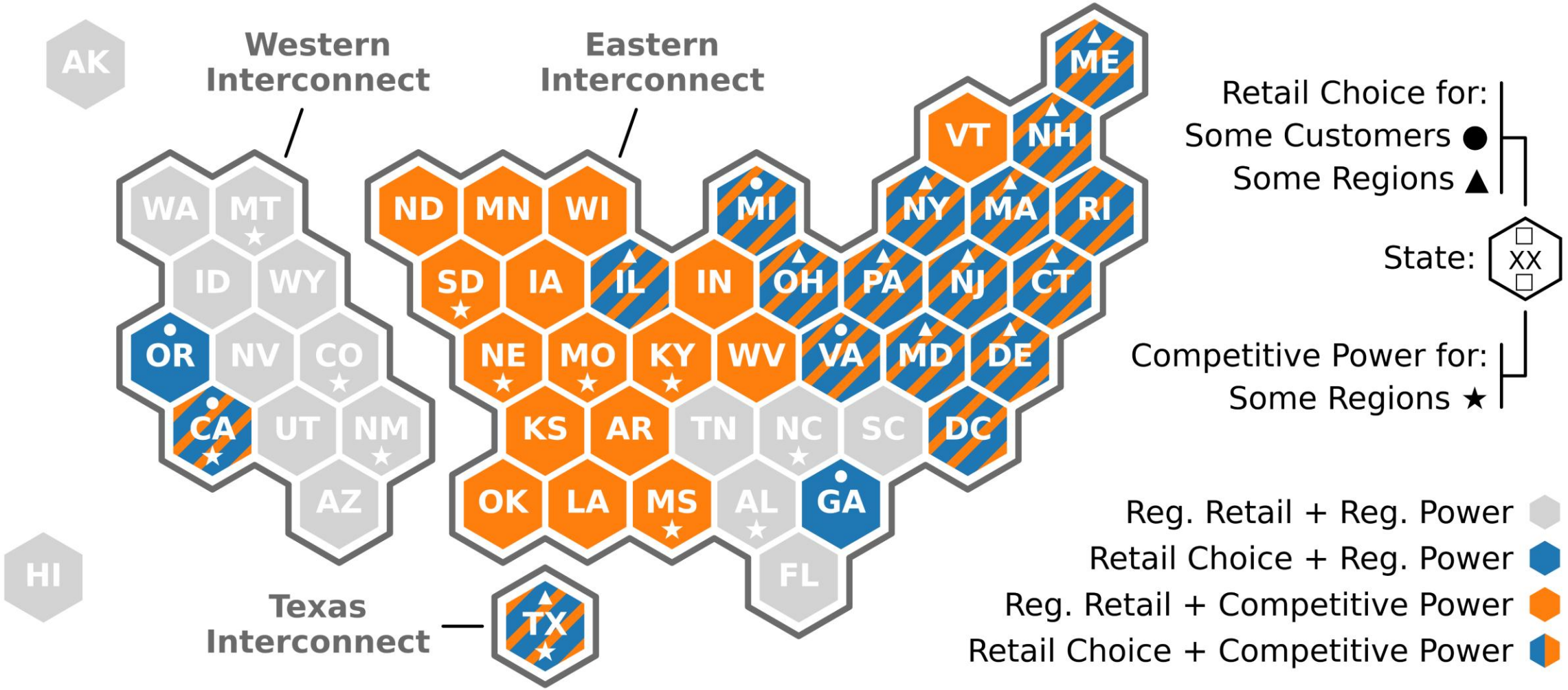


Seven ISOs/RTOs operate in the U.S. serving more than 60% of the national load in 34 states and Washington, DC

Image Source: EPA Green Power Markets

5 Minute Break

Location Matters



How Does Market Price Electricity?

Types of Electric Energy Markets (RTO/ISO):

- Day-Ahead Energy Markets (DAM)
  - Electricity scheduled one day in advance based on demand forecasts
- Real-Time Energy Markets (RTM)
  - Adjusts electricity supply every 5–15 minutes to match real-time conditions
- Capacity Markets
  - Ensure future electricity supply reliability (Longer term; up to 3 years ahead)
- Ancillary Services Markets
  - Maintain grid stability and reliability
  - Reserves, voltage support, black start, frequency regulation, etc.

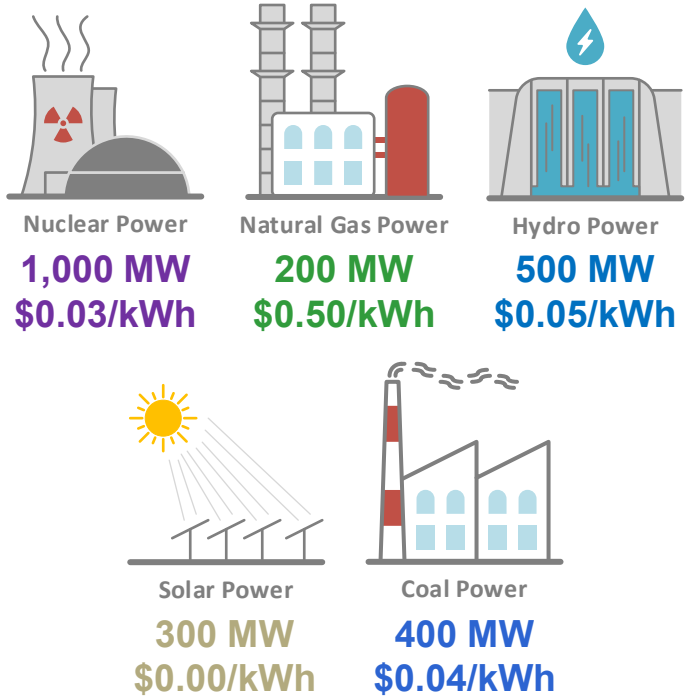
Image Source: FERC, An Introductory Guide to Electricity Markets Regulated by the Federal Energy Regulatory Commission

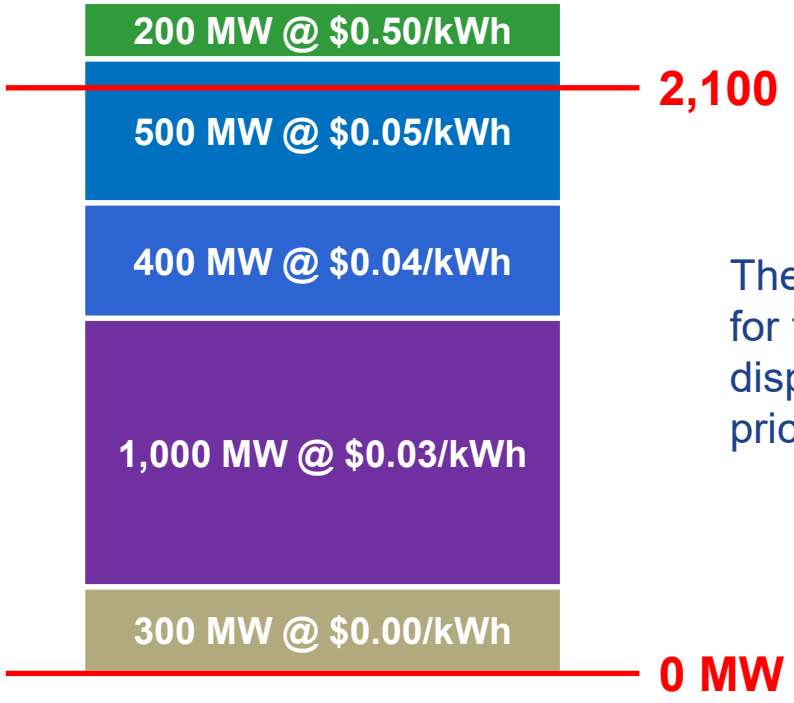
How Does the Market Price Electricity?

- Demand forecasts estimate required power for each hour of the day (DAMs)
- Let's say the utility calls for 2,100 MW of demand for a given hour

Highest-priced resource that is needed sets the price for everyone

Bids from Producers:





The Market Clearing Price (MCP) for this auction is $0.05/kWh. All dispatched bidders receive this price for their energy.

Day Ahead Prices

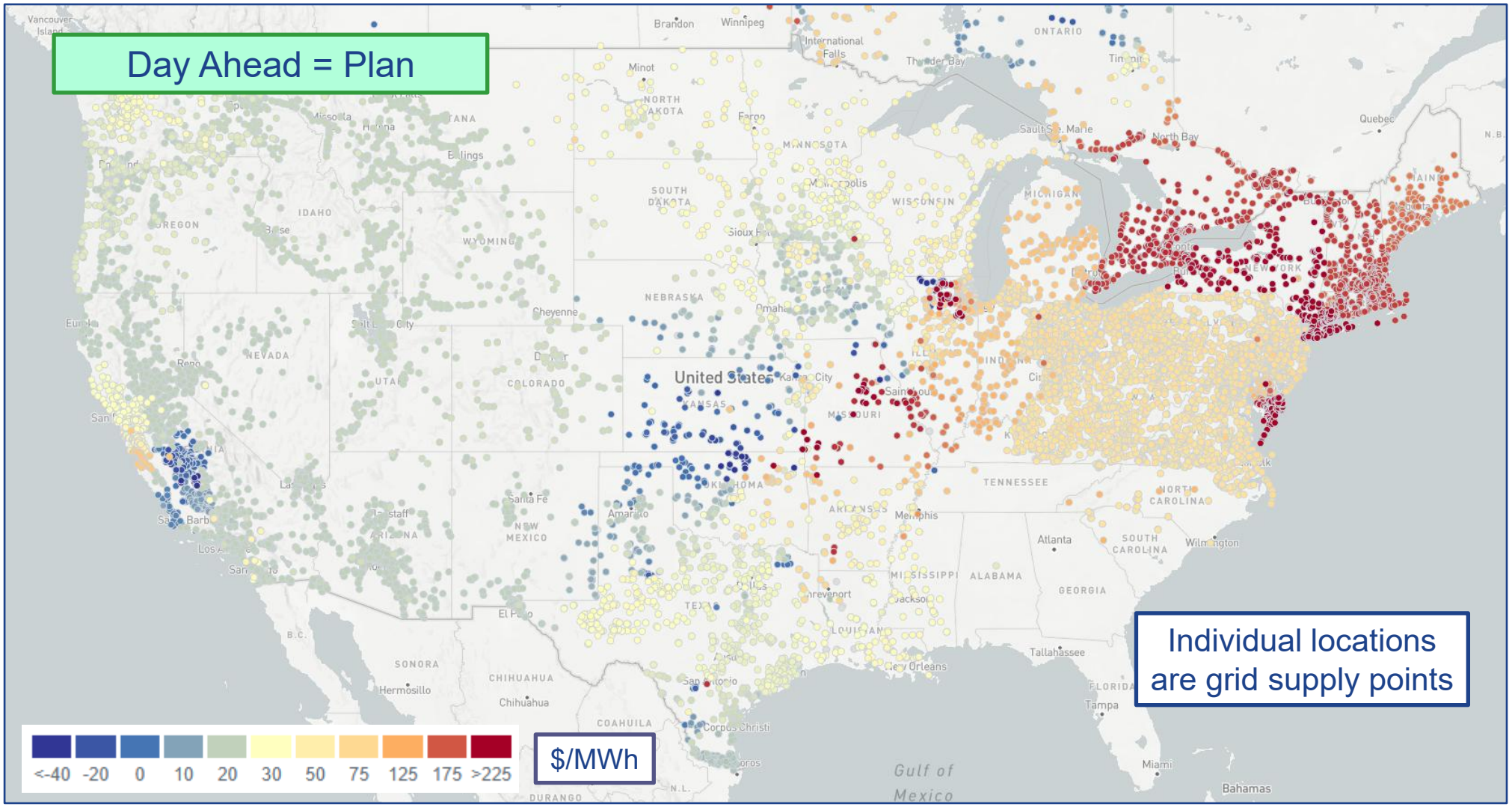


Image Source: Gridstatus.io

Real Time Prices

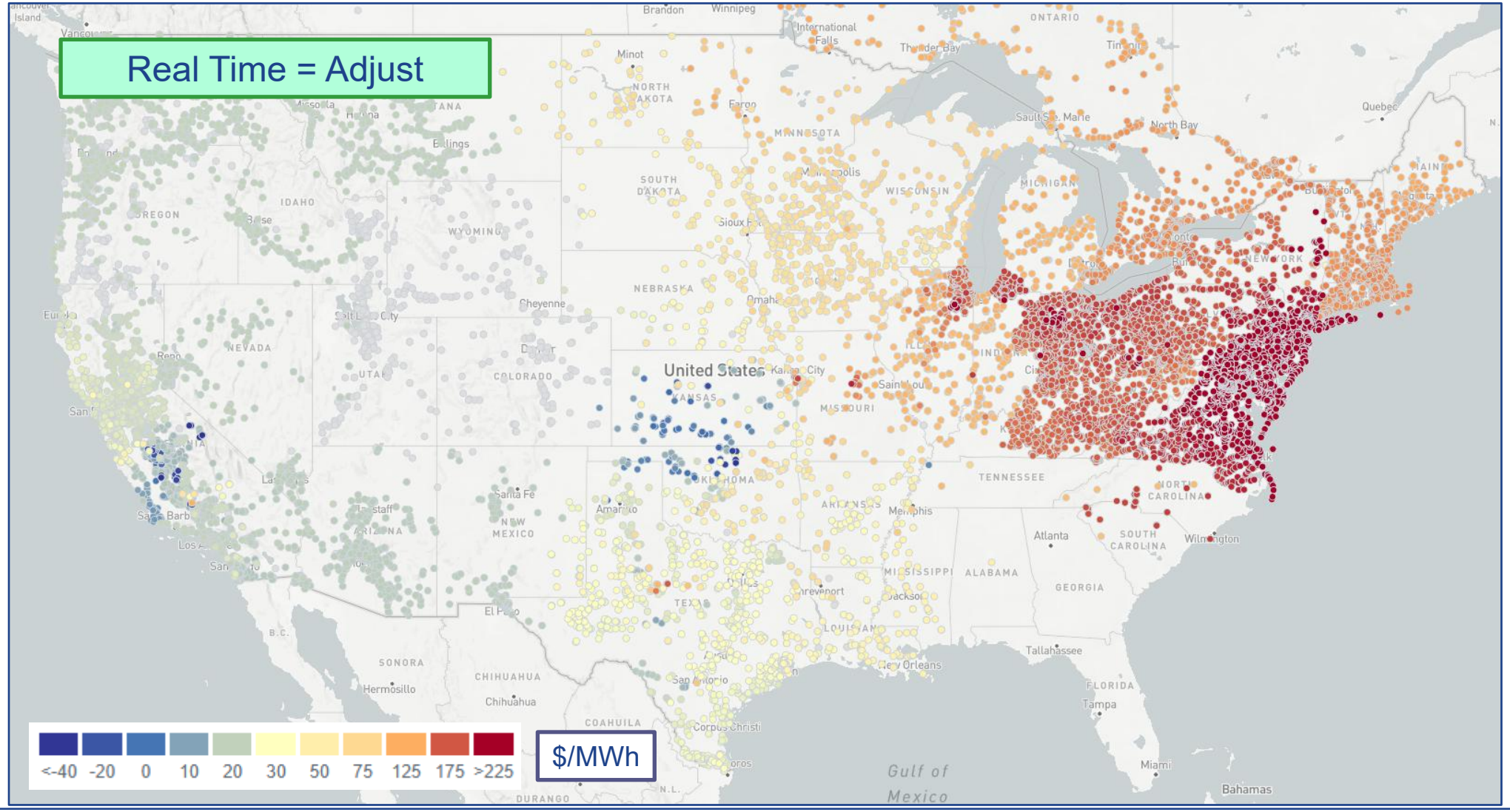


Image Source: Gridstatus.io

Locational Marginal Price (LMP)

Locational Marginal Price or LMP

- Key component of the wholesale power markets
- Wholesale price of electricity at different locations, referred to as **nodes**
- Constrained to within transmission network
- **Fluctuate** on an hourly basis
- Benchmark pricing signals

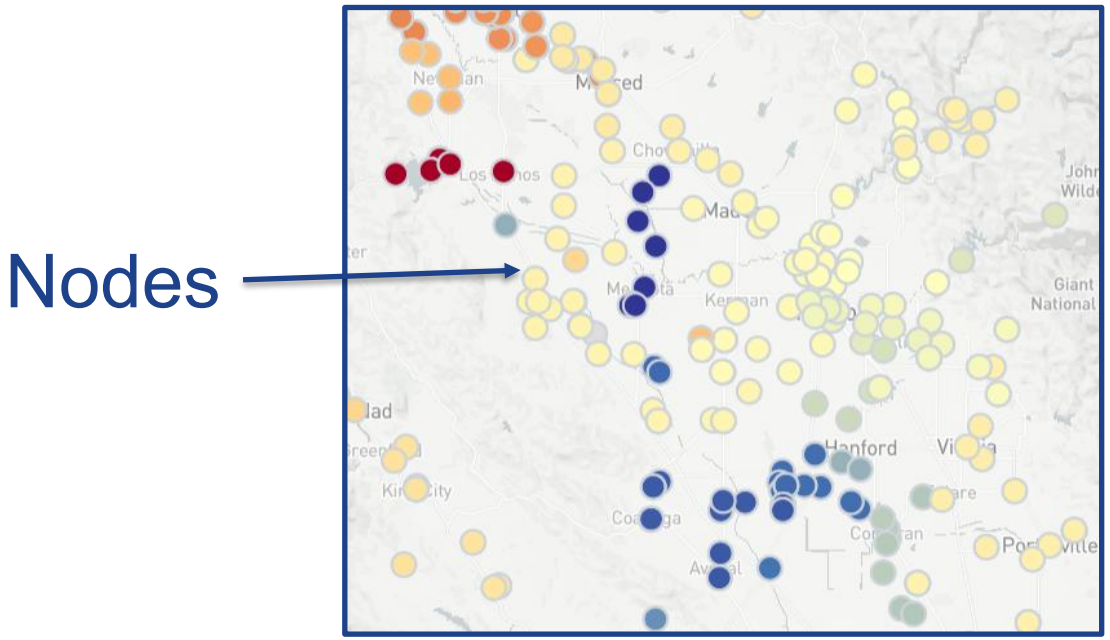
The LMP (Locational Marginal Price) reflects:

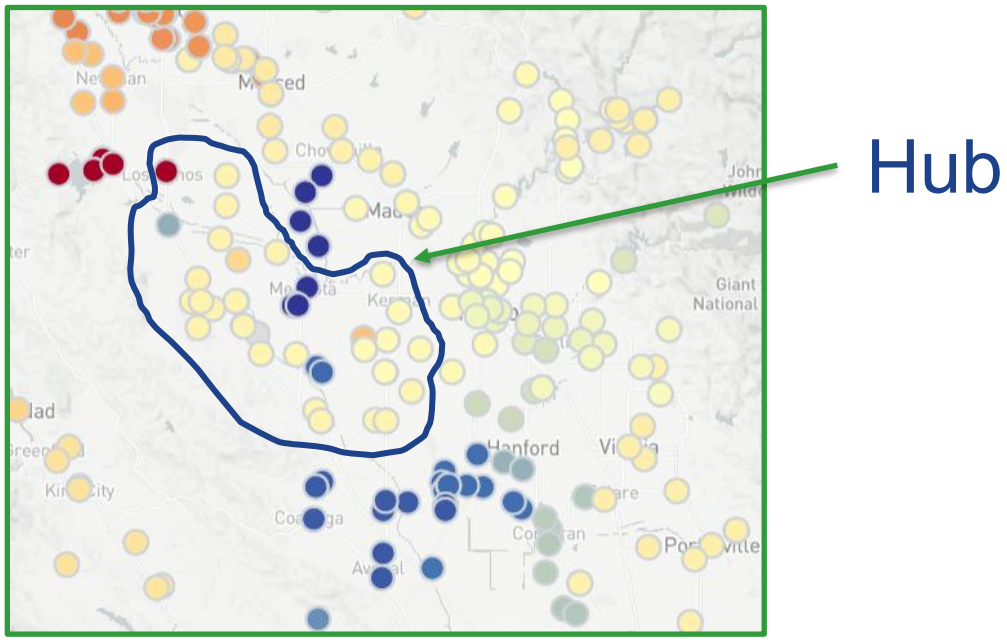
- Generation cost
- Delivery cost
- Transmission constraint cost at a specific location

True cost of providing electricity

Hub vs Nodal Price

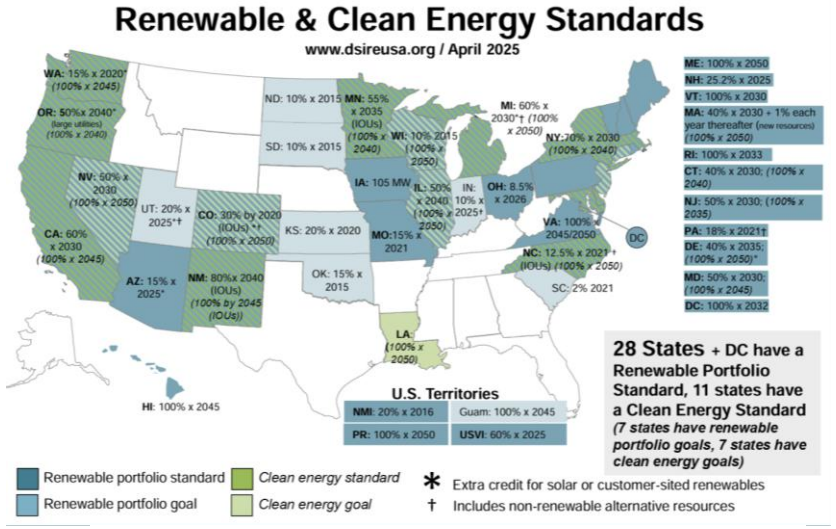
- LMP or Nodal Price
  - Nodes are different locations
  - Function of congestion, demand, price of energy, and other losses
- Hub Price
  - Collection of nodes
  - Intended to represent an uncongested price for electric energy





Policy and Market Factors

1. State Renewable Portfolio Standards
    1. Other State level targets
2. Federal Policies
    1. Investment Tax Credit (ITC) and Production Tax Credit (PTC)
    2. FERC Order 2222
    3. Public Utility Regulatory Policies Act 1978 (PURPA)
        1. Encouraging non-utility generation and clean energy development.
        2. Laid the groundwork for competition in electricity markets
3. Voluntary REC Markets
4. Other State Level Program and Incentives



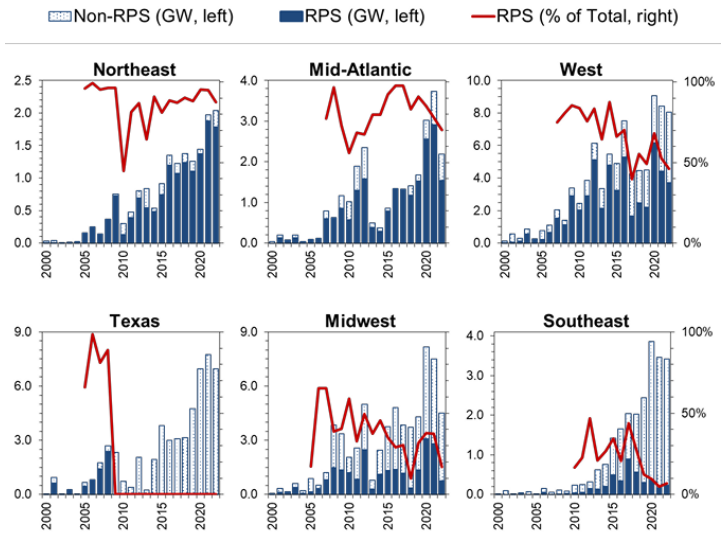
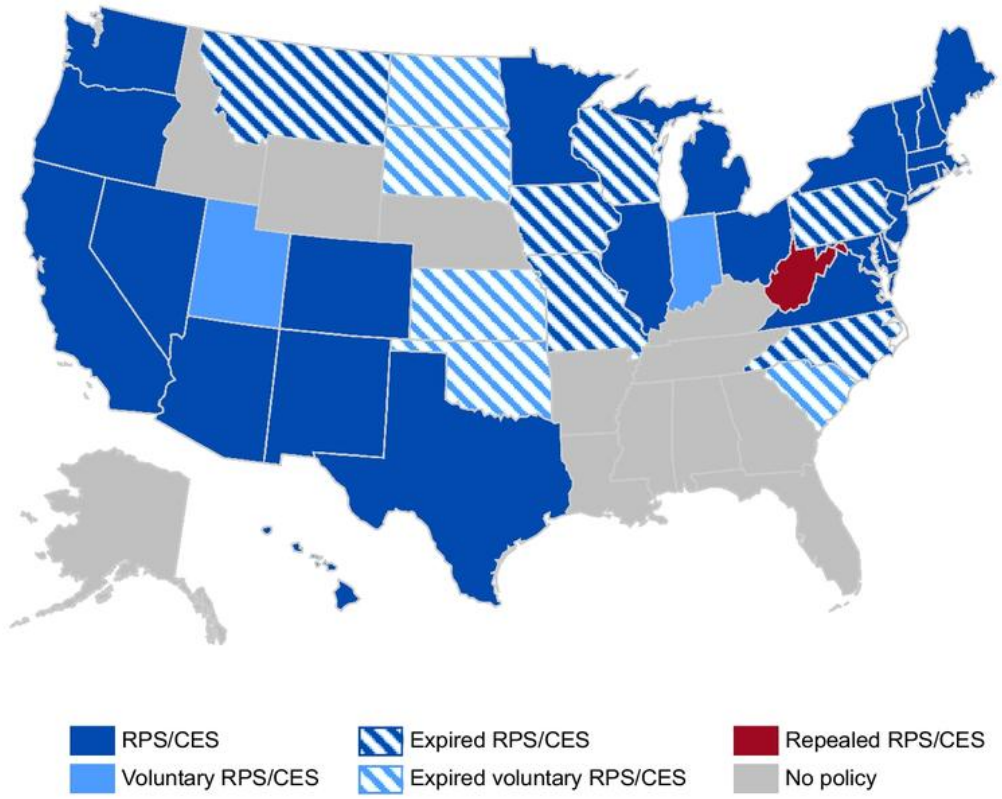


Image Source: https://www.dsireusa.org/

Lawrence Berkeley National Laboratory: U.S. State Renewables Portfolio & Clean Electricity Standards: 2023 Status Update

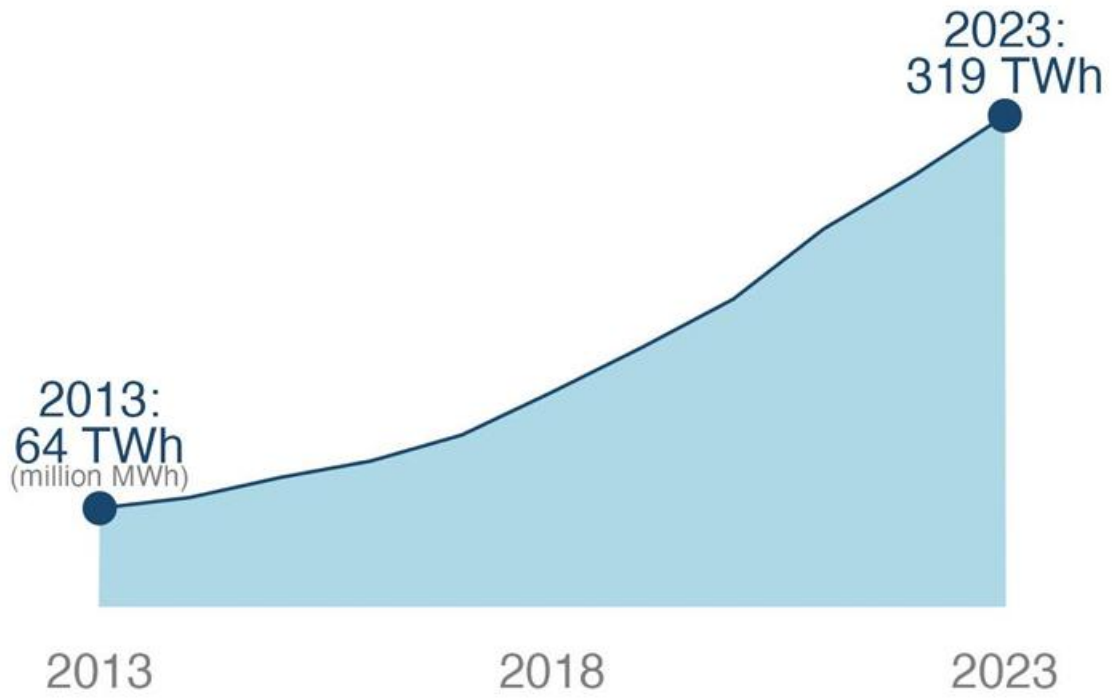
RECs Market

- Compliance Market
  - Utility companies must generate a certain percentage from renewable sources or purchase RECs
  - States with Renewable Portfolio standard (RPS)
  - High demand market
  - REC price is high
- Voluntary Market
  - No requirement
  - Utilities do not need to purchase RECs, but consumers can buy RECs
  - Low demand
  - REC price is low



Source: Kroeger, Grace & Burgess, Matthew. (2023). Electric utility plans are consistent with Renewable Portfolio Standards and Clean Energy Standards in most US states. Climatic Change. 177. 10.1007/s10584-023-03645-7.

Renewable Electricity Procurement



- 1 in 16 U.S. retail electricity customers
- 8% of U.S. retail electricity sales
- Data retrieved from utilities and CCAs that report data to NREL
- Data does not include electricity reported to meet RPS

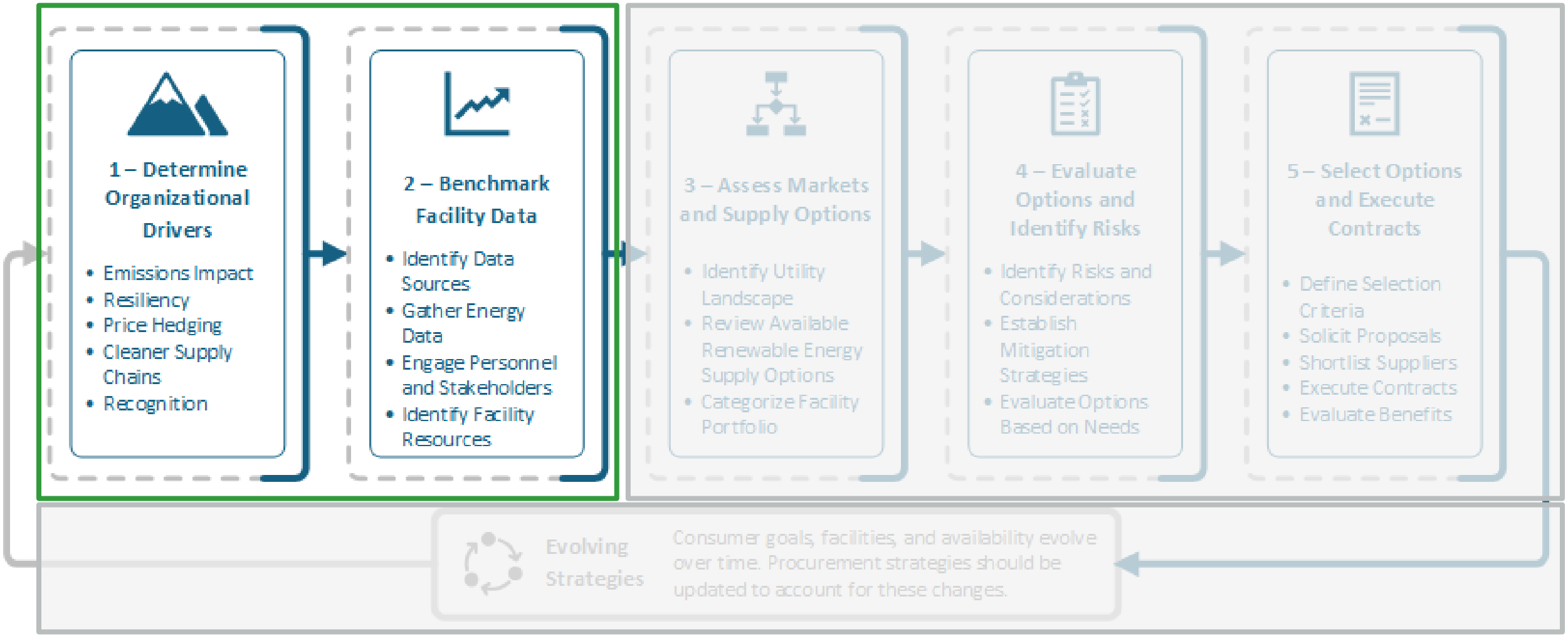
CCA: Community Choice Aggregations

Source: O'Shaughnessy, Eric, Sushmita Jena, and Jenny Sumner. Voluntary Green Power Procurement 2025.

Procurement Roadmap

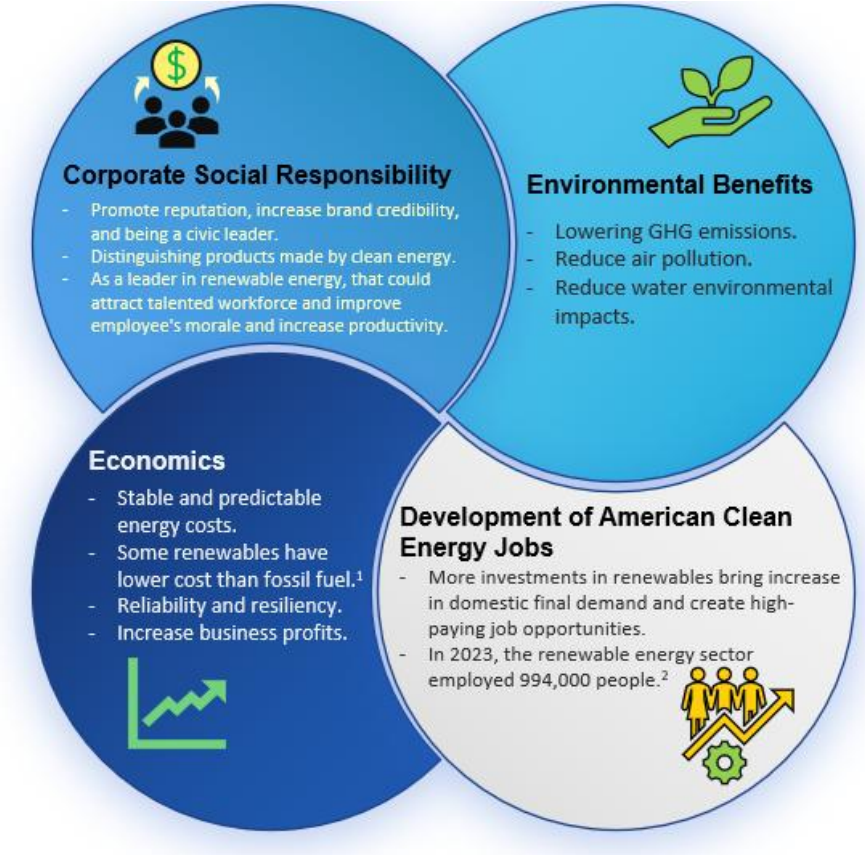
U.S. DEPARTMENT OF ENERGY

Renewable Electricity Procurement Roadmap



Determine Organizational Drivers

- Determine your drivers:
  - Emissions Impact
  - Stakeholder Relations
  - Recognition
  - Energy Independence
  - Hedging Price Risks
  - Cleaning Supply Chains
- What are your goals?
  - Outcomes
  - Metrics

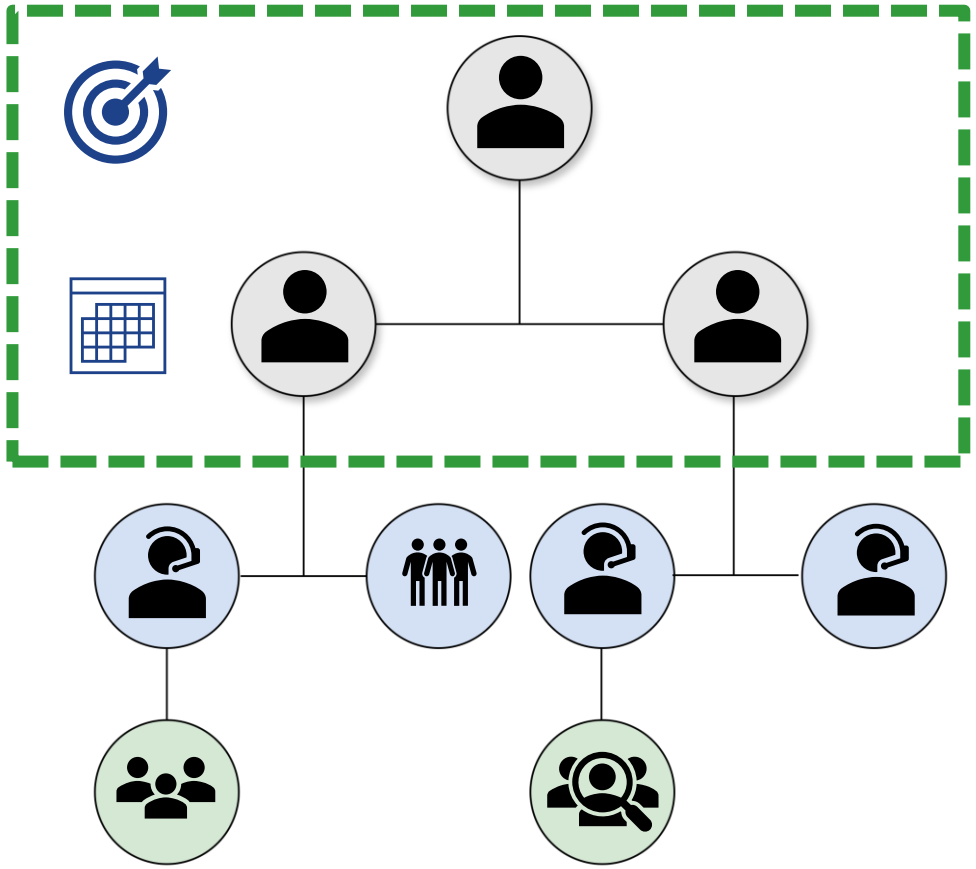


1: Solar power cost in some states reach below $0.10/kWh, average fossil fuel electricity cost is $0.13/kWh. Ref.: https://www.investopedia.com/articles/personal-finance/042315/how-profit-solar-energy.asp

2: According to IRENA's estimates: https://www.irena.org/Publications/2023/Sep/Renewable-energy-and-jobs-Annual-review-2023

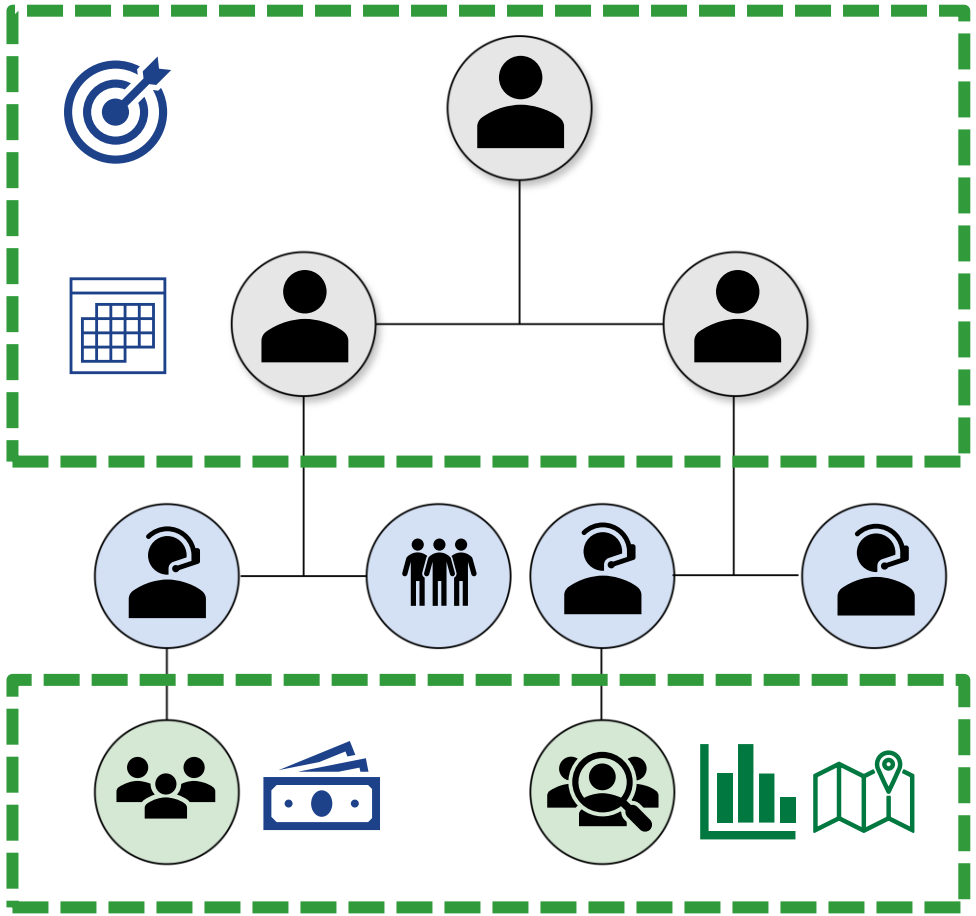
Identify Key Stakeholders

- Who are the key decision-makers?
  - Procurement Team
  - Executive Leadership
  - Energy Team
  - Internal Accounting
  - Legal
- What is your timeline?
  - Commercial Operation Date or COD
  - Based on your renewable energy targets
    - Technology preference
    - Due date



Benchmark Facility Data

- Where do you need to procure?
  - Number of facilities
  - Location of facilities
  - Emissions Inventory
- How much energy do you need?
  - Purchase Volume
  - Short term vs Long term goals
    - Hedging future energy costs
    - Highest value RECs
- Utility Landscape
- Financial Bandwidth

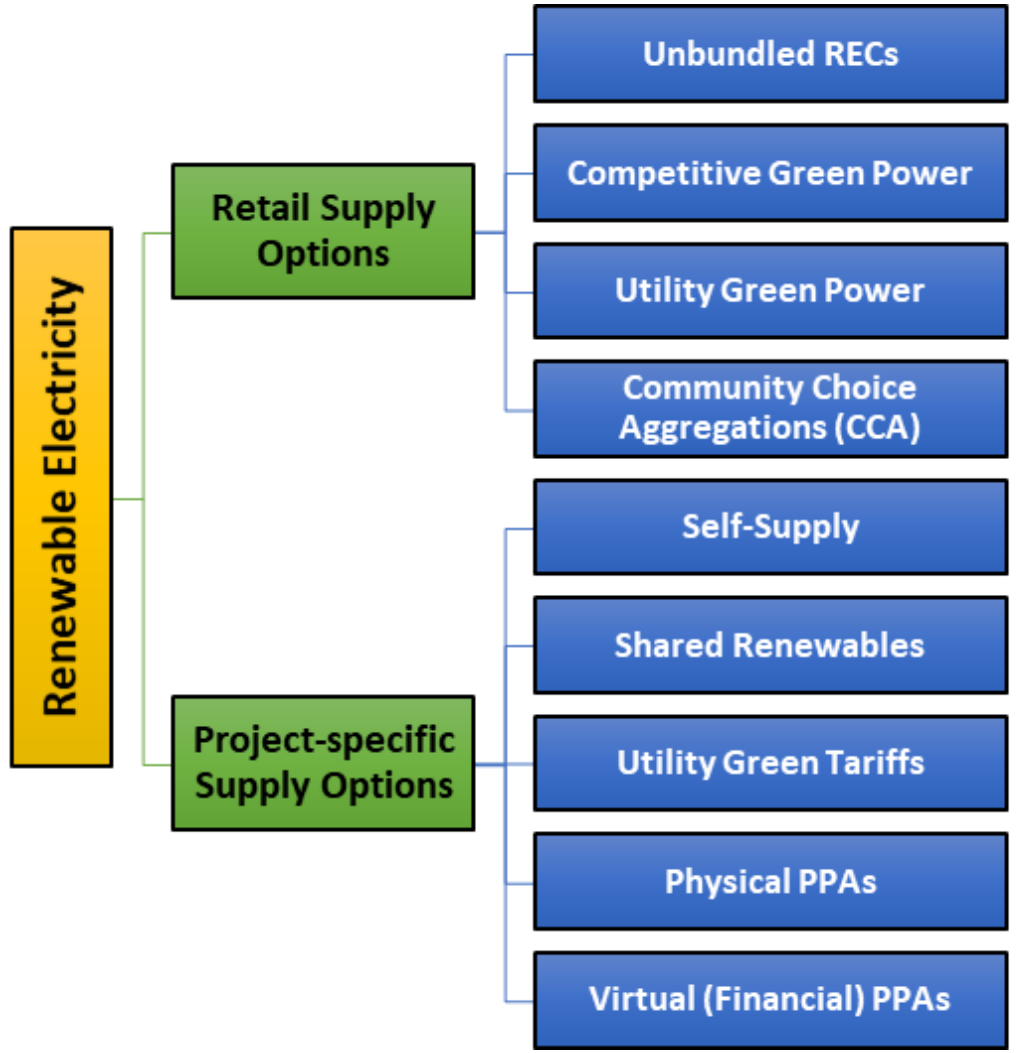


Recap: Renewable Electricity Supply Options

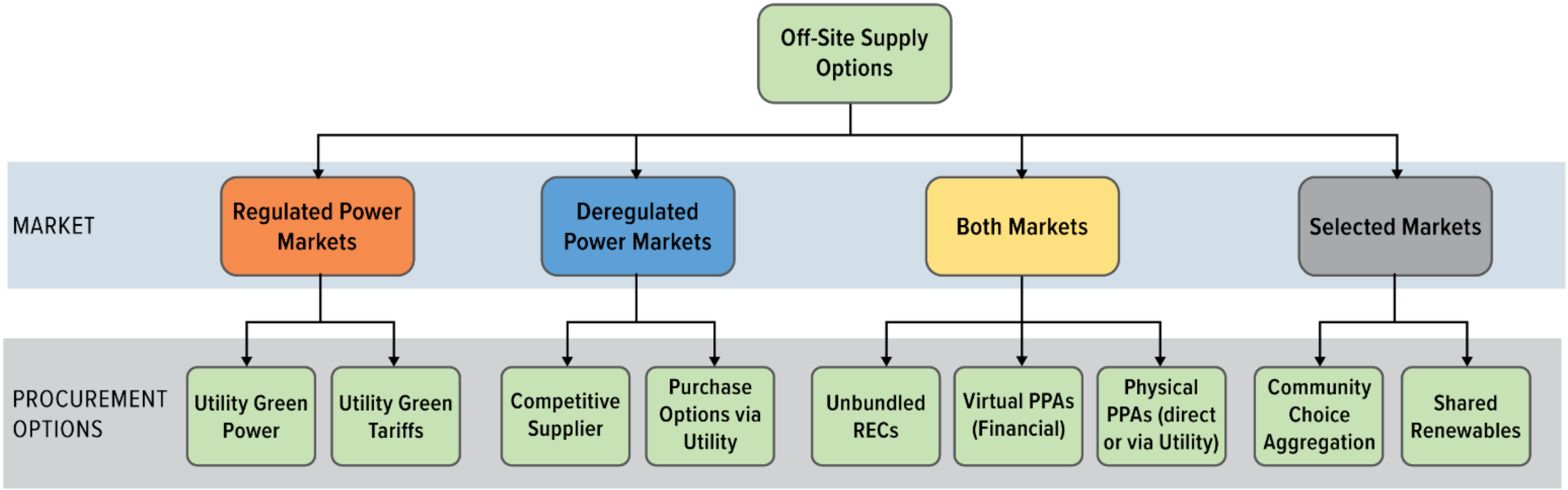
On-site Generation

Unbundled RECs

Off-Site Energy Market Offerings

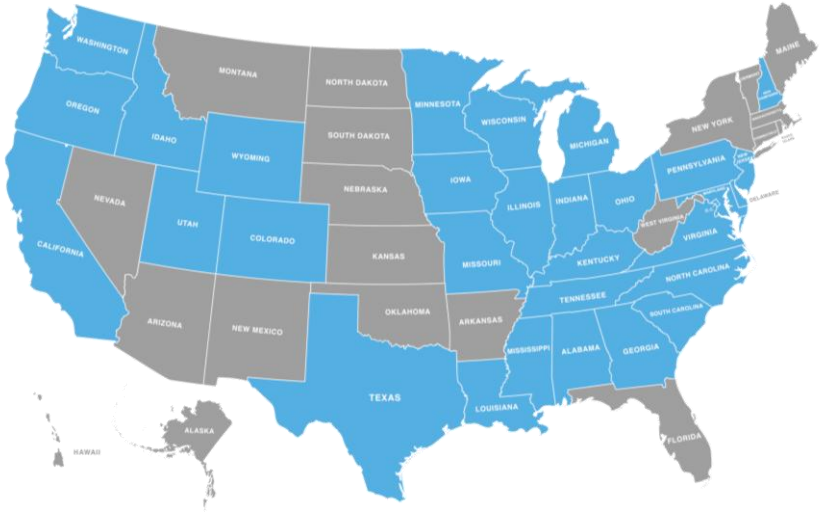


Off-site Renewable Electricity Options



REC Certification

- Green-e® Certification
  - Ensures credibility and validity of qualifying sources and environmental attributes of generation
  - Ensure exclusivity of RECs
  - Developed by Center for Resource Solutions (CRS) in 1997
  - Leading renewable energy certification program in North America
  - Applicable for voluntary and compliance purposes
  - >125 million MWh in 2023 through 159 companies

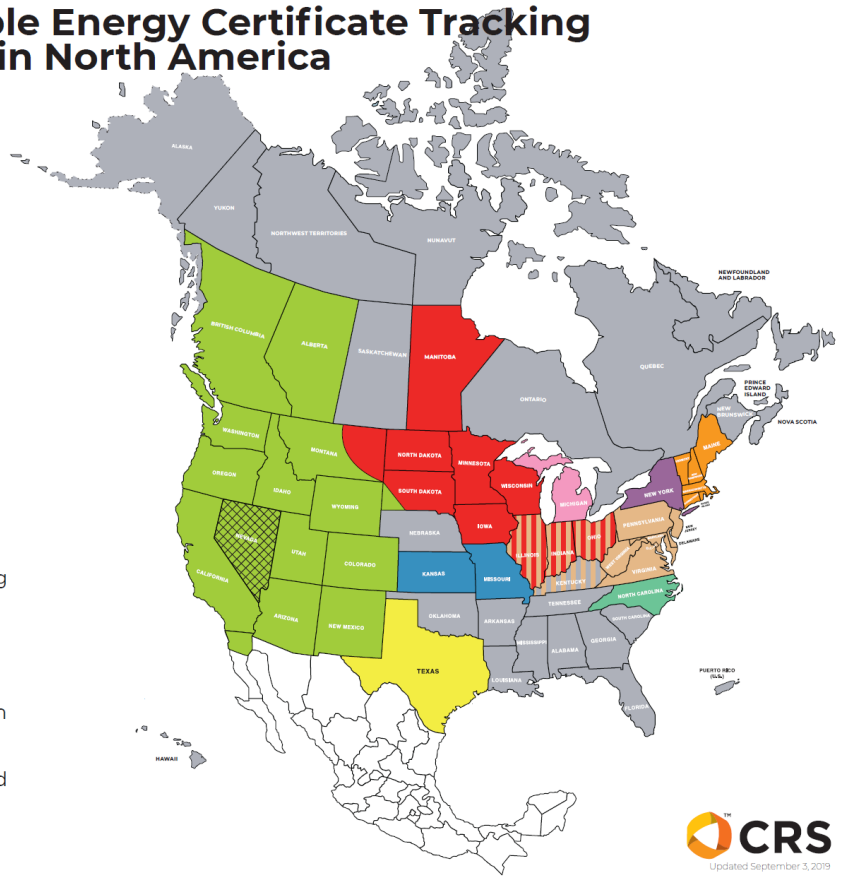


States with Green-e® Energy Certified Renewable Electricity Options

Source: 2024 Green-e Verification Report (2023 Data) Released https://resource-solutions.org/g2024/

Tracking and Retiring RECs

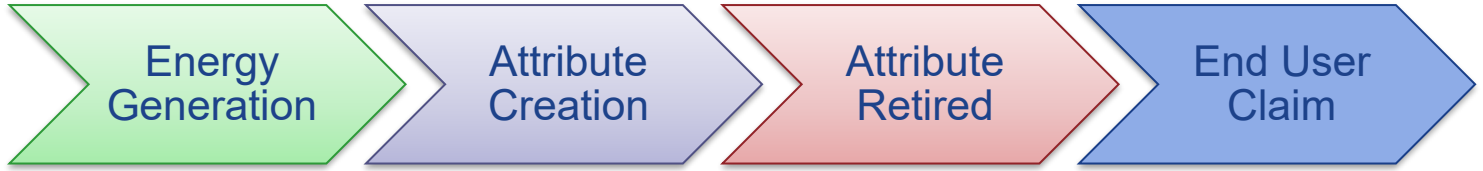
- REC generation and ownership are established by tracking systems in different regions, and retirement of RECs by members of tracking systems
- Voluntary RECs must be Green-e® Certified to be eligible for retirement
- Retirement of compliance RECs by utilities are also tracked by reporting to regulatory bodies
- Only renewable generation exported to grid can generate RECs, if site chooses to use all its onsite renewable generation and not export it to a tracking system, then no RECs are created



Source: Center for Resource Solutions, September 2019
https://resource-solutions.org/wp-content/uploads/2018/02/Tracking-System-Map.pdf

Who can retire RECs?

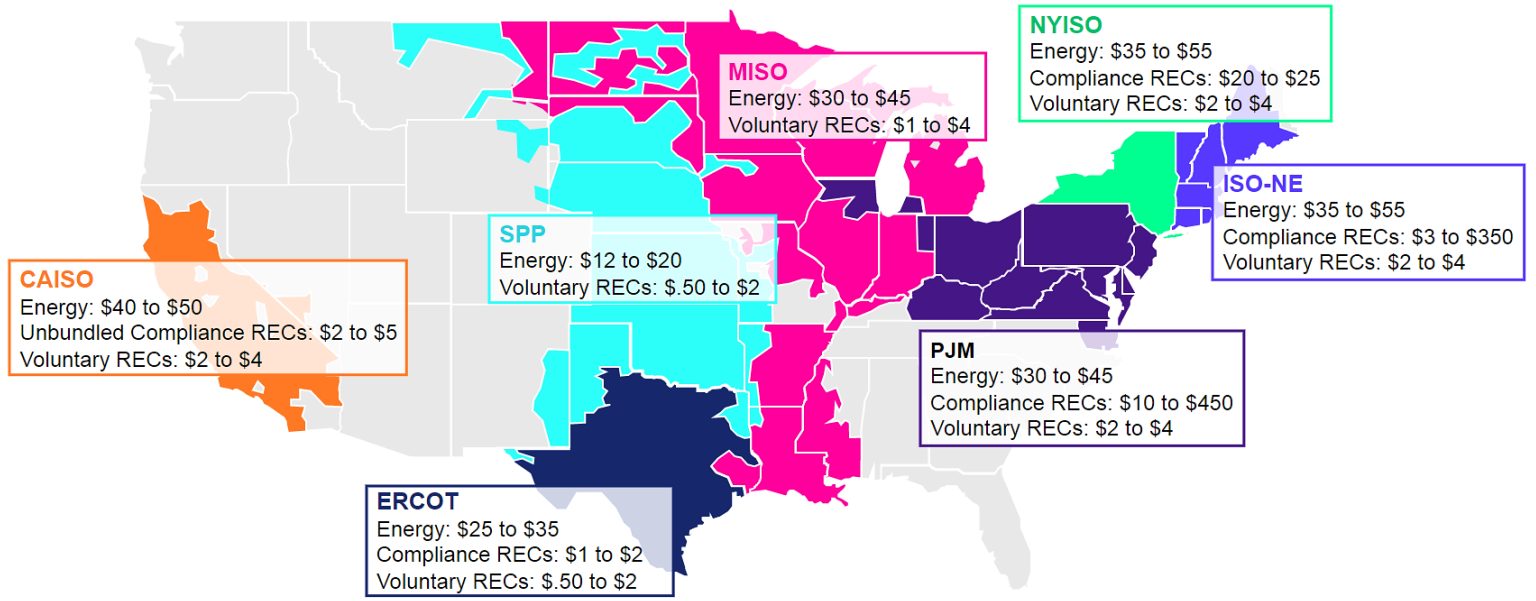
- Legal owner of the REC can retire or claim the RECs
  - End-Users or consumers – purchasing organization
  - Utilities
    - On behalf of customers in green power or compliance programs
  - Energy supplier or broker for specific buyers under contract
- Once retired, RECs cannot be claimed by others or sold to others to prevent double counting.



Pricing Considerations

The price of RECs varies depending on:

- Market's supply and demand
- Market policies (i.e., RPS)
- Product Types
- Purchase Volume
- Term of Commitment
- Generation Type
- Operating Status and Geography
- New or Repowered



Example RECs Prices as of September 2020
Source: Enel X

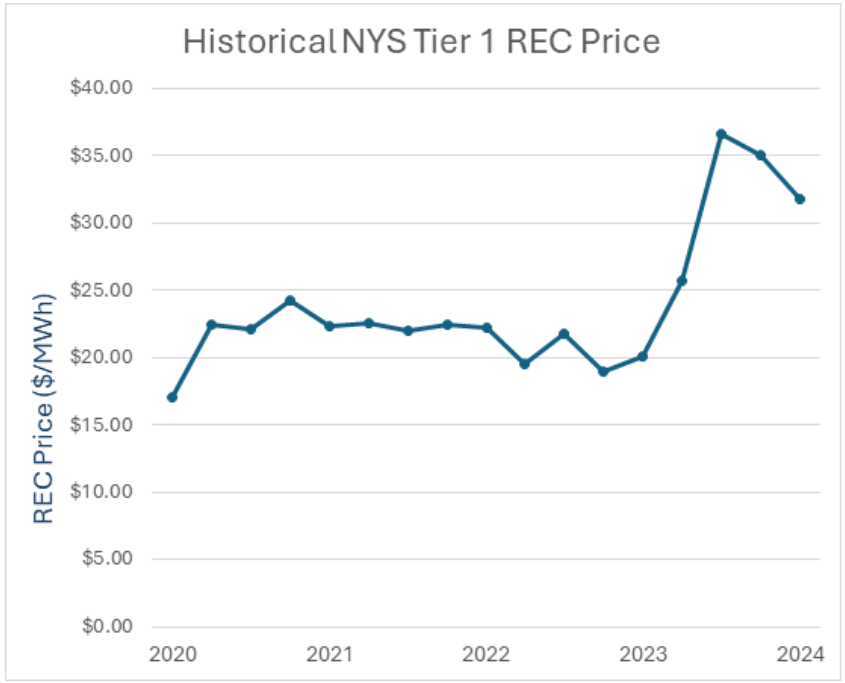
If there is a significant discrepancy between REC prices in the voluntary and compliance markets, an organization may consider **REC Arbitrage (REC Swap).**

Examples of RECs Prices

The price of RECs varies depending on:

1- Market's supply and demand

2- Market policies (i.e., RPS)



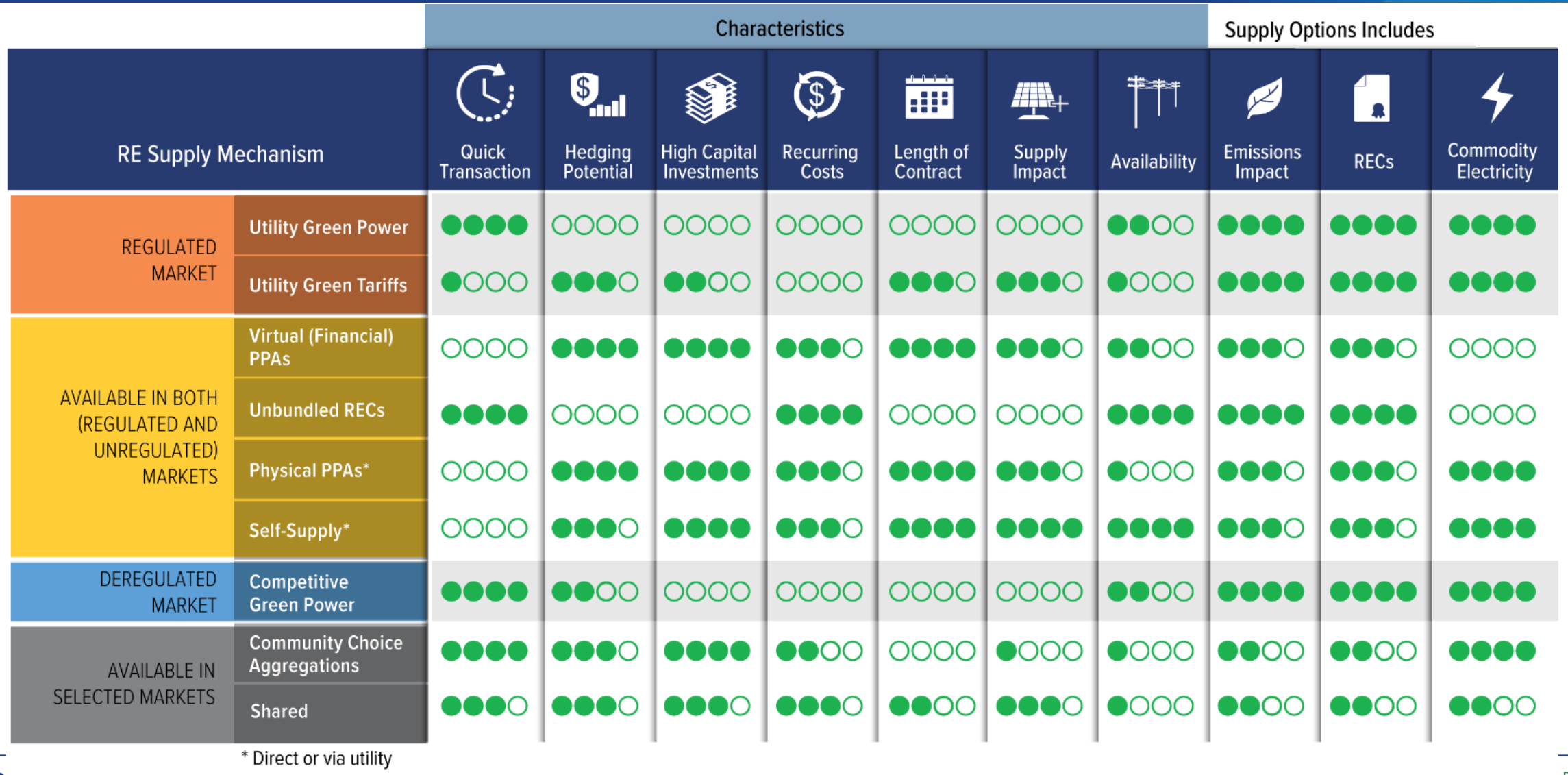
Source: Energyby5. https://www.energyby5.com/understanding-recs-in-ny-2024

PJM Tri-Qualified Tier 1 REC, 2011-Present ($/MWh)

PJM Tier 1 REC experienced steady price rise from $1.50 to $37.50 in 10 years

Source: Power Advisory LLC. REC Prices Reach Record Highs. https://www.poweradvisoryllc.com/reports/rec-ord-high-price#:~:text=In%20June%2C%20PJM%20Tri%2DQualified,REC%20that%20few%20saw%20coming

REC Characteristics



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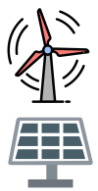
Partner Case Studies

AstraZeneca

100%, 272 GWh/year



LOCKHEED MARTIN

20%, 301 GWh/year

Johnson Controls

100%, 281 GWh/year

SUSTAIN ABILITY DC

100%, 434 GWh/year

General Mills

100%, 1,007 GWh/year

ARLINGTON VIRGINIA

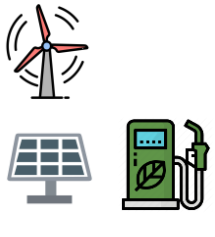
100%, 84 GWh/year

Northwestern University

39%, 100 GWh/year

gm

52%, 1,795 GWh/year



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Source: U.S. EPA's Green Power Partnership (www.epa.gov/greenpower) and https://betterbuildingssolutioncenter.energy.gov/

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Other Programs and Platforms for Renewable Energy

EPA's Green Power Partnership (GPP) [https://www.epa.gov/greenpower]	EPA GREEN POWER PARTNERSHIP	Center for Resource Solutions (CRS) [https://resource-solutions.org]	CRS
Clean Energy Buyers Association (CEBA) [https://cebuyers.org]	CEBA Clean Energy Buyers Association	Green-e Energy and Green-e Marketplace [https://green-e.org/programs/energy]	Green-e
Database of State Incentives for Renewables & Efficiency (DSIRE) [https://www.dsireusa.org]	DSIRE® | NC CLEAN ENERGY TECHNOLOGY CENTER	GHG Protocol Scope 2 Guidance [https://ghgprotocol.org/scope_2_guidance]	GREENHOUSE GAS PROTOCOL
RE100 [https://www.there100.org]	RE100 | CLIMATE GROUP | CDP	The Renewable Thermal Collaborative (RTC) [https://www.renewablethermal.org]	RENEWABLE THERMAL COLLABORATIVE
Solar Energy Industries Association (SEIA) [https://www.seia.org]	SEIA Solar Energy Industries Association®	American Council on Renewable Energy (ACORE) [https://acore.org]	ACORE AMERICAN COUNCIL ON RENEWABLE ENERGY

Other Resources:

- Onsite Energy Program
- Better Plants Solutions Center
- Federal Battery Storage Tax Credit
- State-Level Incentives
- General Energy Storage Facts
- U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks
- Energy Storage Cost and Performance Database
- DOE Factsheets on Energy Storage
- Grid-scale Energy Storage Technologies Primer – NREL
- 2024 Electricity ATB Technologies and Data Overview

Questions?

Thank you!