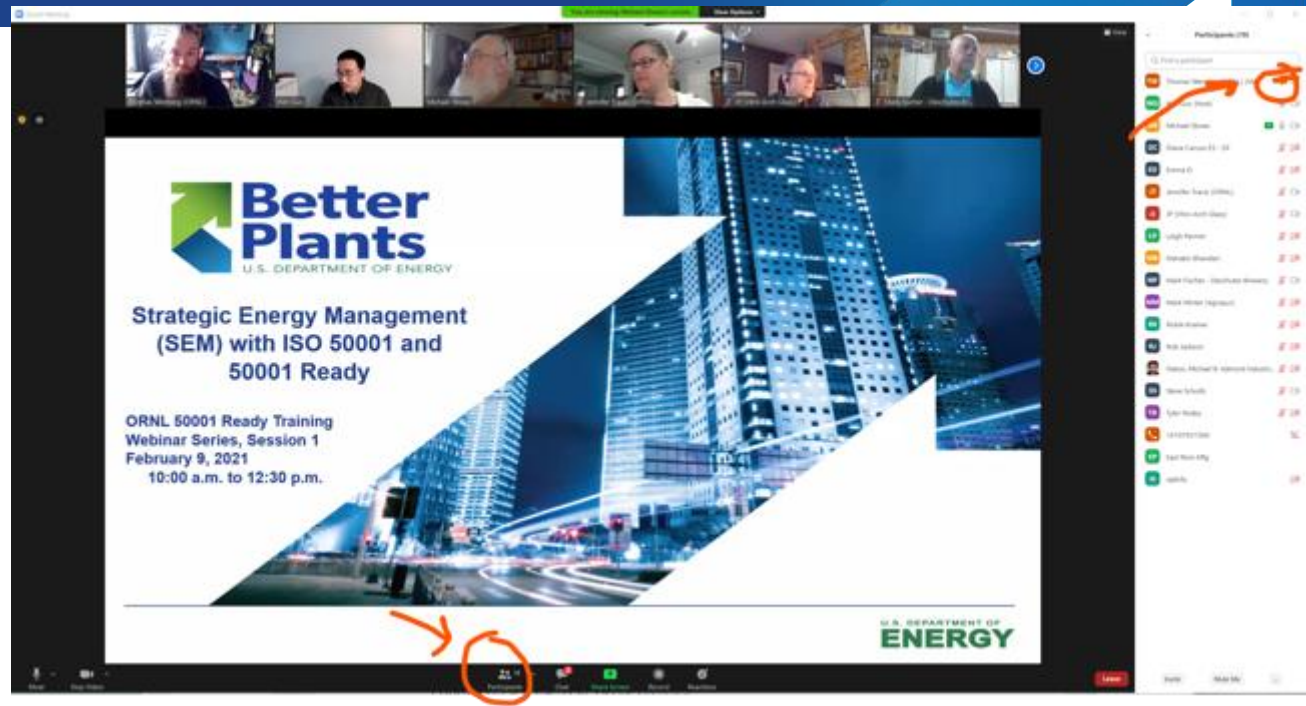
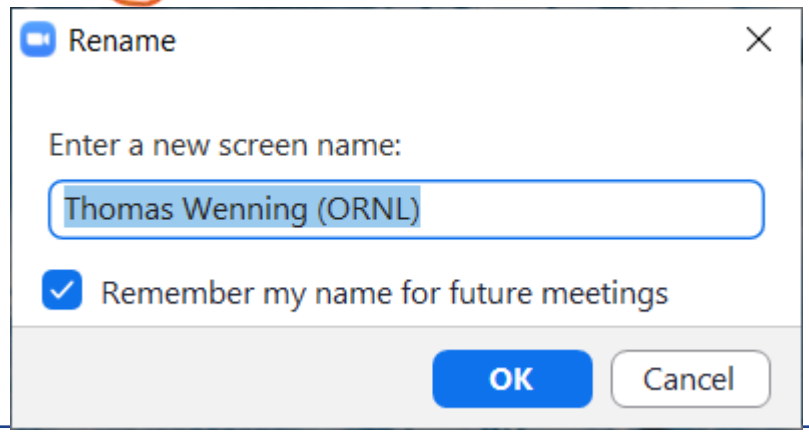
Rename Yourself to be your Real Name (Company Name)

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

Fundamentals Of Renewable Electricity And Emissions Inventory

Session #1
August 5, 2025
10:00am – 12:00pm EST

U.S. DEPARTMENT OF ENERGY

DOE's Better Plants Program

Helping manufacturers, water/wastewater utilities and other industrial organizations save money, improve their competitiveness and reduce impacts on the environment

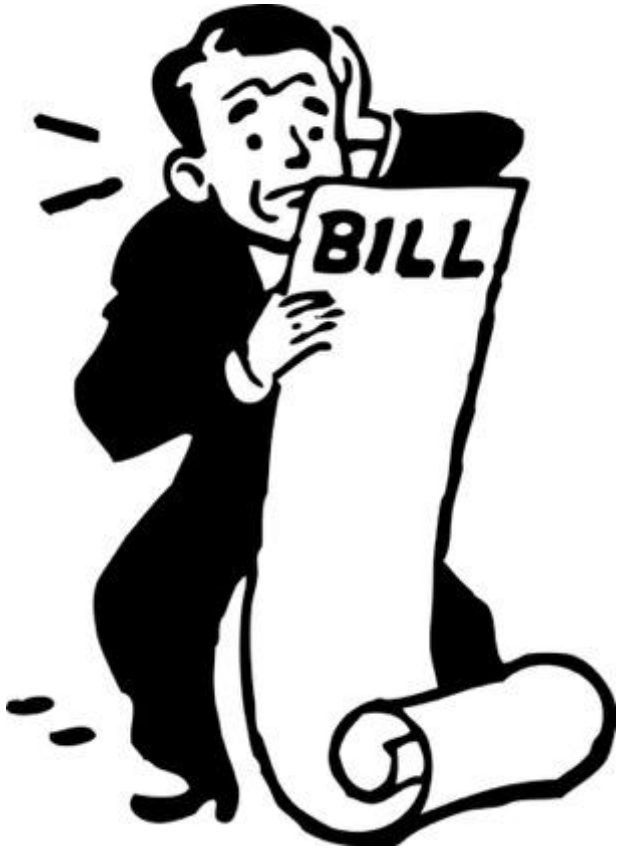
Increased Energy Productivity

Water Savings

Waste Reduction

Emissions Reduction
(Better Climate Challenge)

Manufacturing and Municipalities – Why do we care?



Manufacturers and utilities spend $200+ Billion/year on energy to operate their plants

DOE data demonstrates most plants have big opportunities to reduce energy use with relatively short payback periods

Resiliency, Competitiveness, Workforce

How Does Better Plants Work?

- Voluntary and Free to Participate
- Partners set long-term strategic goals
- DOE works with you to achieve your goals!

Better Plants Partners

Better Plants U.S. Department of Energy

U.S. Department of Energy

Better Plants Resources

NO-COST SOFTWARE & TOOLS

Access to no-cost software and tools to identify and implement energy saving opportunities and manage energy use.

- **80+ Calculators**
- **20+ No-Cost Tools for Loan**
- **Financing Navigator**
- **No-Cost Resources & Guides**

RECOGNITION

81 Better Project & Better Practice Winners

For innovative and industry-leading accomplishments in company-wide practice, principles, and energy management, as well as projects at individual facilities.

National Recognition in Media and Online

Solutions on Solution Center **350+**

78 Goal Achievers

TRAINING & EDUCATION

Over **150** In-Plant Trainings Conducted to Date

Multi-day trainings to identify, implement, and replicate energy savings projects.

85+ No-Cost Webinars & Growing

INNOVATION & LABS

Partner and learn from the DOE National Laboratories to spur innovation.

17 National Labs Across the Country

National Lab Technology Days

Field Validation Program

TECHNICAL ASSISTANCE

Partners have a Technical Account Manager for personalized assistance.

Expertise in 20+ Focus Areas

100+ Years of Combined Experience

Network and Share with Industry Leaders

Technical Assistance: In-Person and Virtual Trainings

Teach plant workers how to conduct assessments, use DOE tools, and implement projects

In-Plant Trainings (INPLTs)

- 175+ In-Plants - 3,200 participants since 2011
- Identified more than $75M+ in energy savings

Virtual Trainings

- Over 28 trainings completed
- All sessions were recorded and posted online
- Results: ~2,000 trained and ~$11M+ in savings

Bootcamp Trainings (Energy)

- 385+ participants since Aug 2022
- 112 unique companies

Training Topics:

- Pump Systems
- Fan Systems
- Compressed Air
- Processed Heat
- Process Cooling
- Steam Systems
- Motors
- CHP
- Industrial Refrigeration
- Water/Wastewater Treatment
- Municipal Water
- Energy Management
- Water Efficiency
- Treasure Hunts
- Mfg Waste Reduction

Virtual Trainings 2025

Topic	Dates
Combined Heat and Power	Dec 2024
Compressed Air	Jan to Feb 2025
Waste Reduction	Feb to Mar 2025
Process Heating	Apr to May 2025
Cyber Security	Apr to May 2025
Onsite Energy Generation and Storage	Jun to Jul 2025
Utility Bills Analysis	Jul to Sep 2025
Renewable Energy Contracting Options and RECs	Aug to Sep 2025
Drinking Water	Oct to Nov 2025
Motors	Dec 2025

https://bptraining.ornl.gov

U.S. DEPARTMENT OF ENERGY

Bootcamp Trainings

Bootcamp	Dates
Energy	Feb 24 to 28, 2025
Energy	Sep 29 to Oct 3, 2025

https://energybootcamp.ornl.gov

General Information

- Schedule: Every Tuesday (August 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

Thank You!

For More Information:

Wei Guo, guow@ornl.gov, 865-574-8632
Thomas Wenning, wenningtj@ornl.gov, 865-576-9257

Better Plants Website:
http://betterbuildingssolutioncenter.energy.gov/better-plants
https://bptraining.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

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Fundamentals Of Renewable Electricity

Indraneel Bhandari
Oak Ridge National Laboratory

U.S. DEPARTMENT OF ENERGY

Virtual Training Facilitator

Indraneel Bhandari

R&D Associate Staff Member
Oak Ridge National Laboratory

bhandarii1@ornl.gov
(865) 341-4259

Acknowledgements

- US Department of Energy, Industrial Technologies Office (ITO)
- Christopher Price, ORNL
- Paul Lemar, ORNL
- Tom Wenning, ORNL

Poll Time!

Week 1 Poll: Question 1

- What percentage of your facility's electricity consumption currently comes from renewable sources (e.g., Energy attributes, RECs, utility electricity products, onsite generation)?
  - 0%
  - 1–25%
  - 26–50%
  - 51–75%
  - 76–100%
  - Not sure

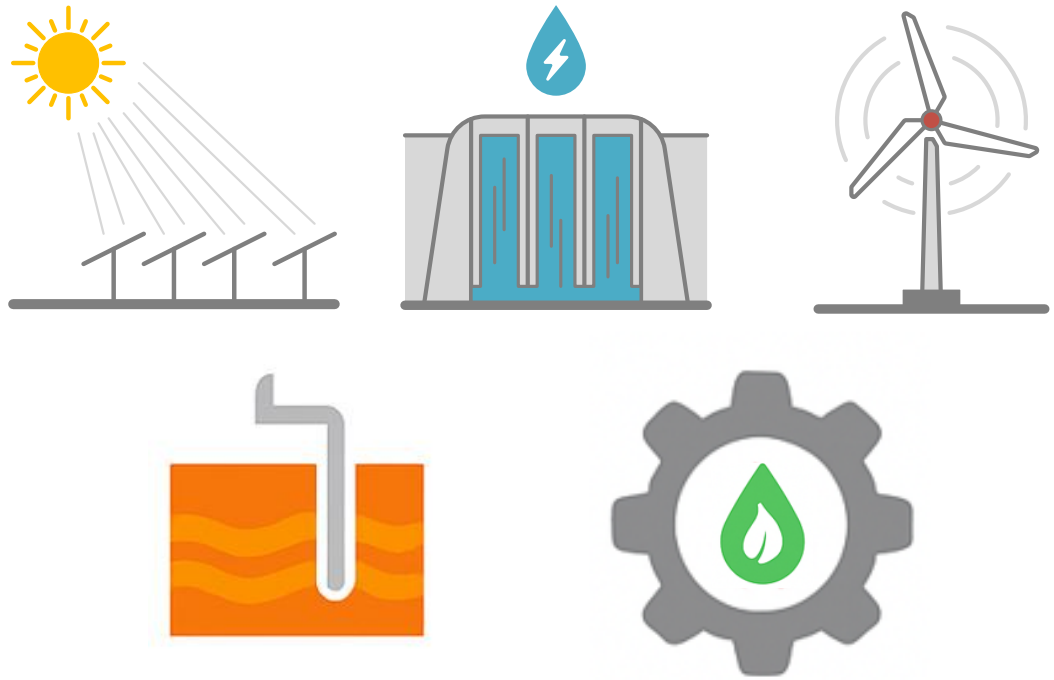
Week 1 Poll: Question 2

- Are you currently purchasing Renewable Energy Certificates (RECs), Renewable Natural Gas (RNG), or participating in a utility provided electricity program? (Select all)
  - Yes, RECs
  - Yes, RNG
  - Yes, Utility Renewable Electricity Program
  - No
  - Other (please specify in comments)

Renewable Electricity

Electricity generated from naturally replenishing sources:

- Solar
- Hydropower
- Wind
- Geothermal
- Biomass



"Renewable energy is energy from sources that are **naturally replenishing** but flow-limited; renewable resources are **virtually inexhaustible** in duration but limited in the amount of energy that is available per unit of time." [1]

[1]US Energy Information Administration (EIA), 2021, Renewable Energy Explained. https://www.eia.gov/energyexplained/renewable-sources/

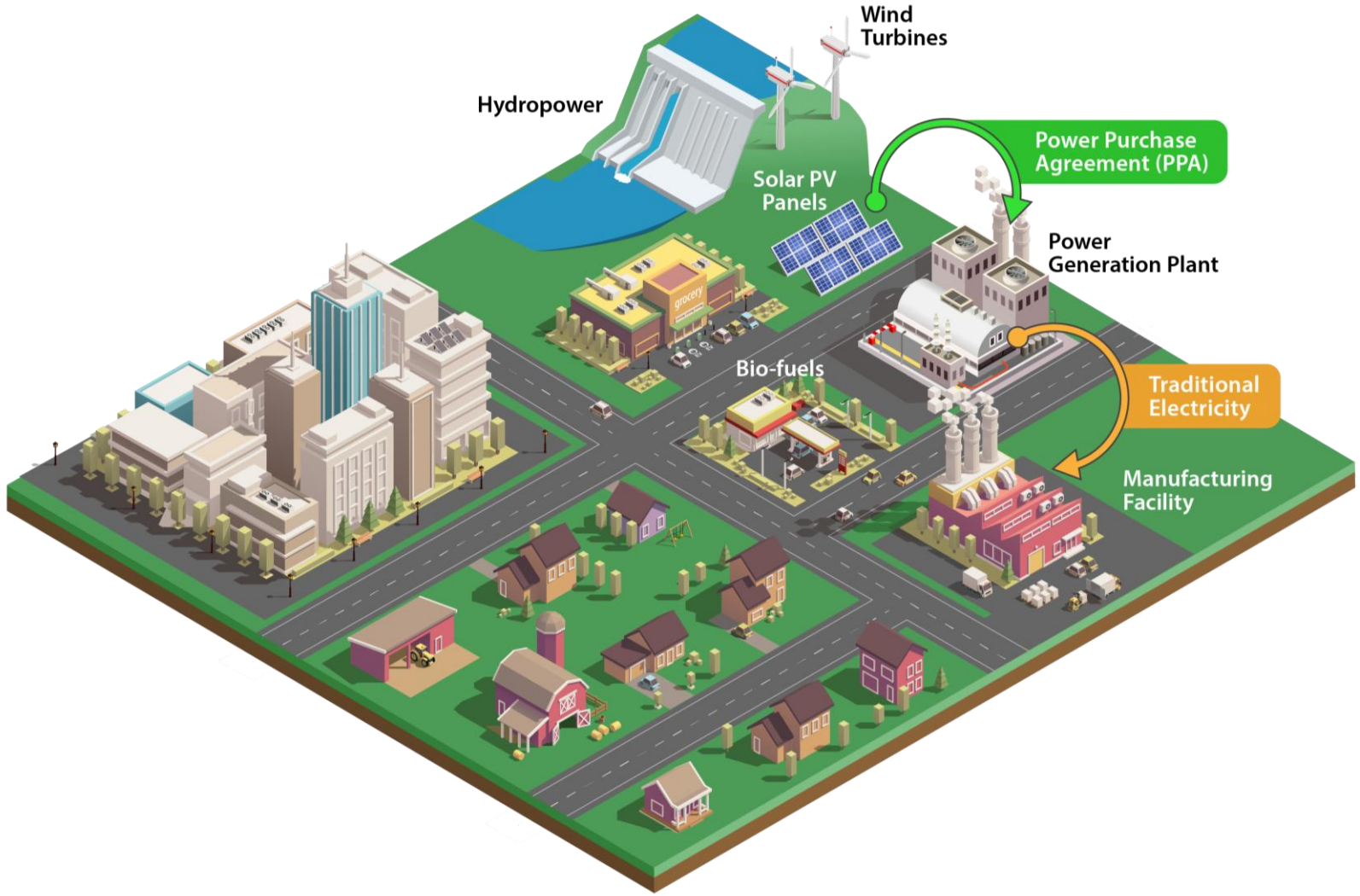
Renewable Energy Mechanisms

Project-Specific Supply Options

- Self-Supply
- Shared Renewables
- Utility Green Tariffs
- Physical or Virtual* (Financial) Power Purchase Agreements

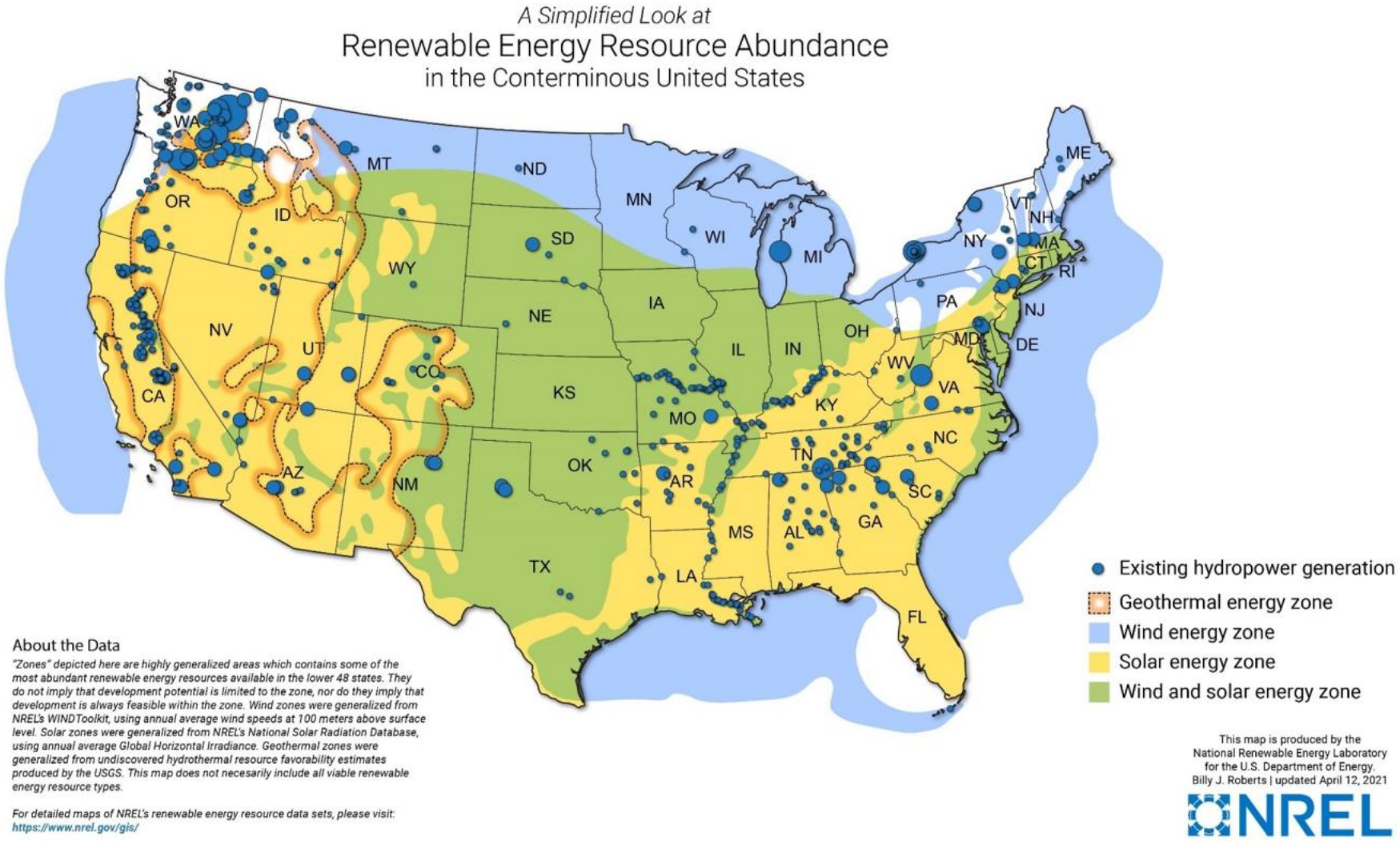
Retail Supply Options

- Unbundled RECs*
- Competitive Green Power
- Utility Green Power
- Community Choice Aggregations



* Does not include the commodity electricity

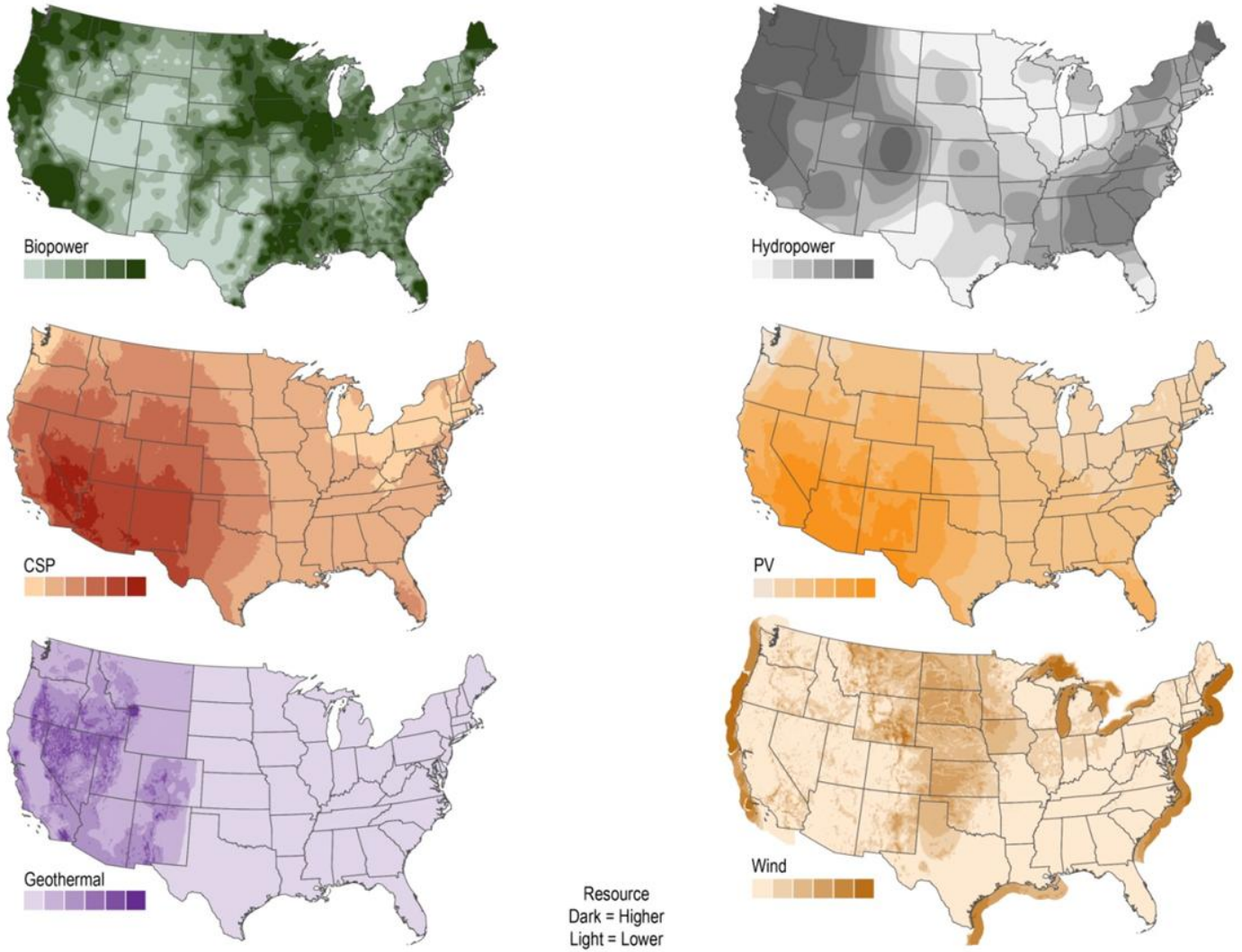
U.S. Renewable Energy Resource Abundance



Source: US Department of Energy, Office of Energy Efficiency & Renewable Energy, Renewable Energy Resource Assessment Information for the United States

U.S. Renewable Energy Resource Abundance

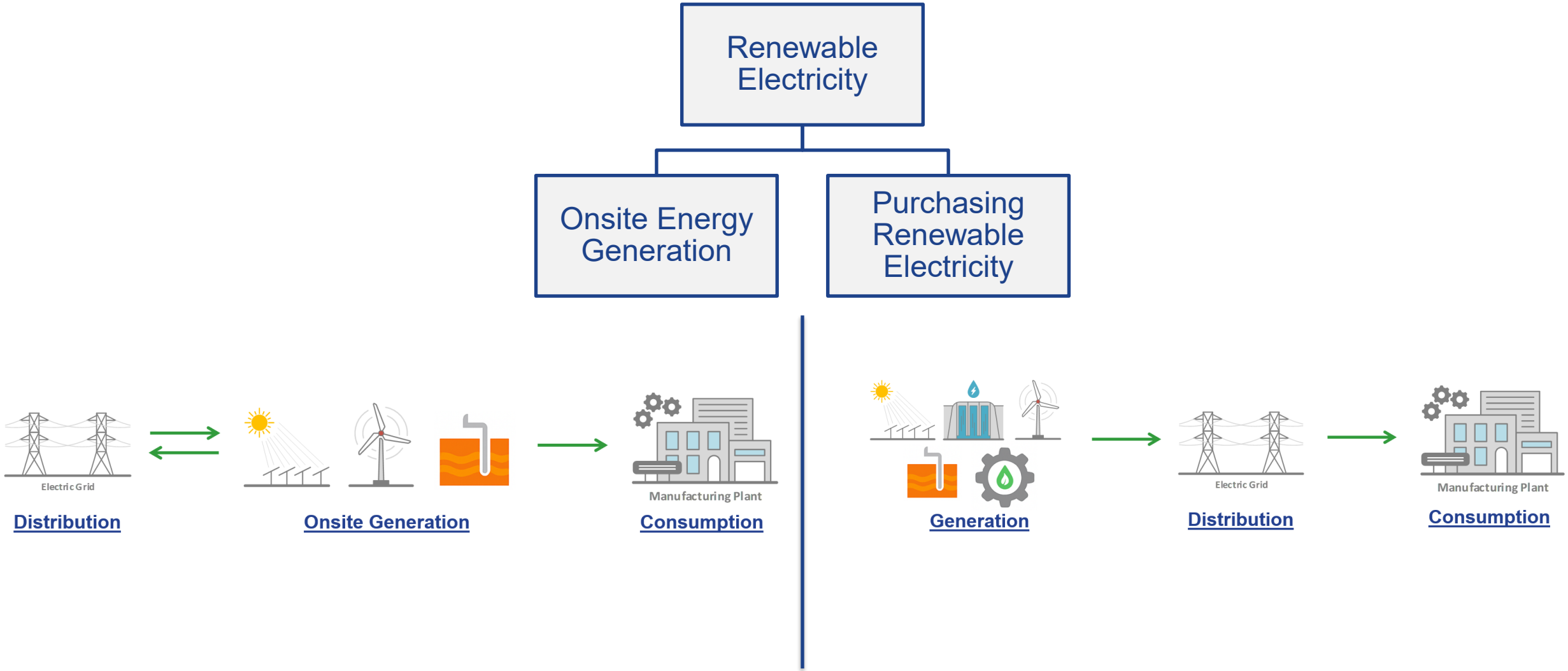
Geographic distribution of renewable resources in the contiguous United States



Source: US Department of Energy, Office of Energy Efficiency & Renewable Energy, Renewable Energy Resource Assessment Information for the United States

Options

Self-Generation or Purchasing Electricity



On-Site Technologies

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Onsite Energy Generation

- Behind-the-meter Onsite Generation
- Off-the-grid or Net-metered
- Consumer generates on-site
- Power is delivered to your facility directly

Distribution **Onsite Generation** **Consumption**

Solar Energy Technologies

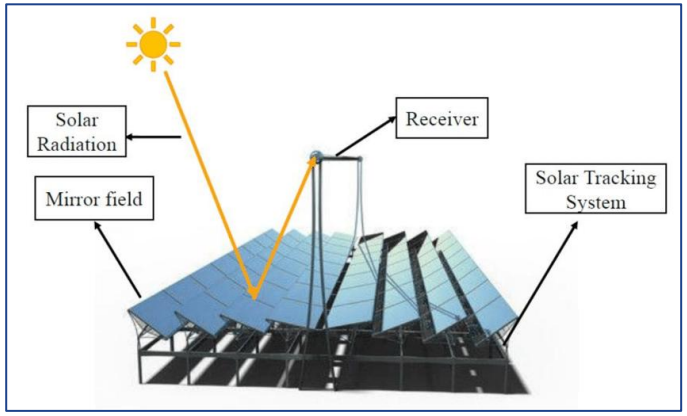
Electricity

- Photovoltaic (PV)
- Concentrated Solar Power (CSP)
  - Parabolic Trough
  - Linear Fresnels
  - Heliostats or Power Tower

Solar PV

CSP

Parabolic Solar Trough

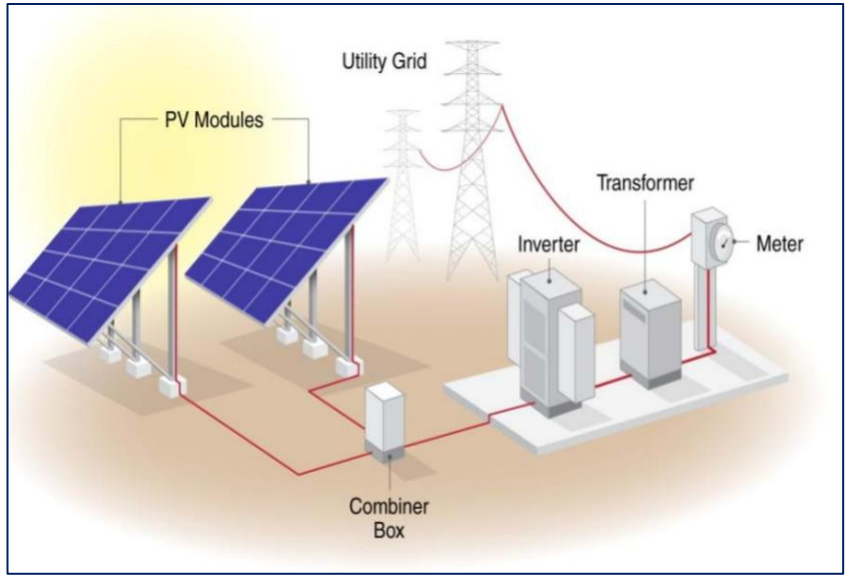


Linear Fresnels

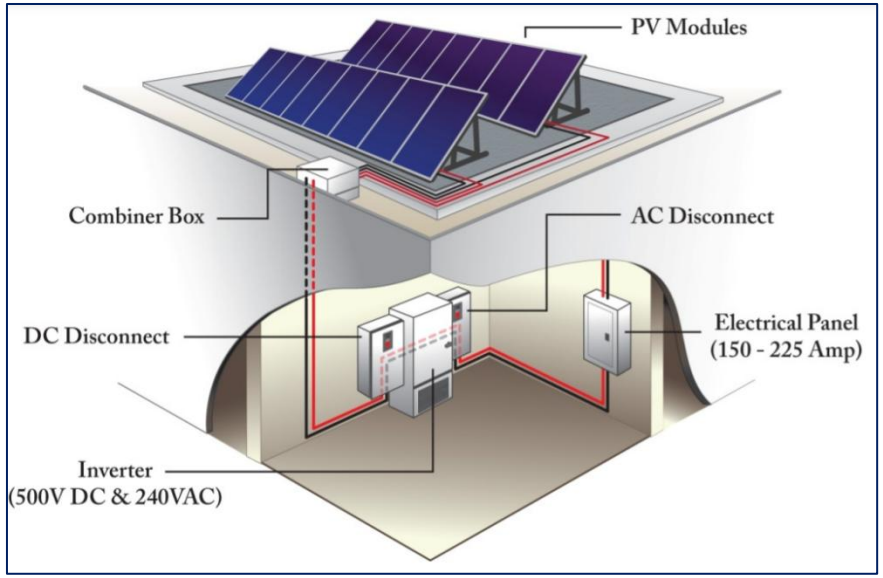
Image source: Scalco P., Copetti J. C., Macagnan M. H., Oliveira J. D.Linear Fresnel Solar Collector Concentrator – A review

Type of Solar PV Installations

1. Distributed Generation (Distributed Energy Resources, DER)
   a) Residential (3 - 10 kW)
   b) Commercial/Industrial (10 kW - 2 MW)
2. Utility-scale Generation (> 2 MW)



Ground Mounted



Rooftop Mounted

Source: NREL, 2016. Facility-Scale Solar Photovoltaic Guidebook

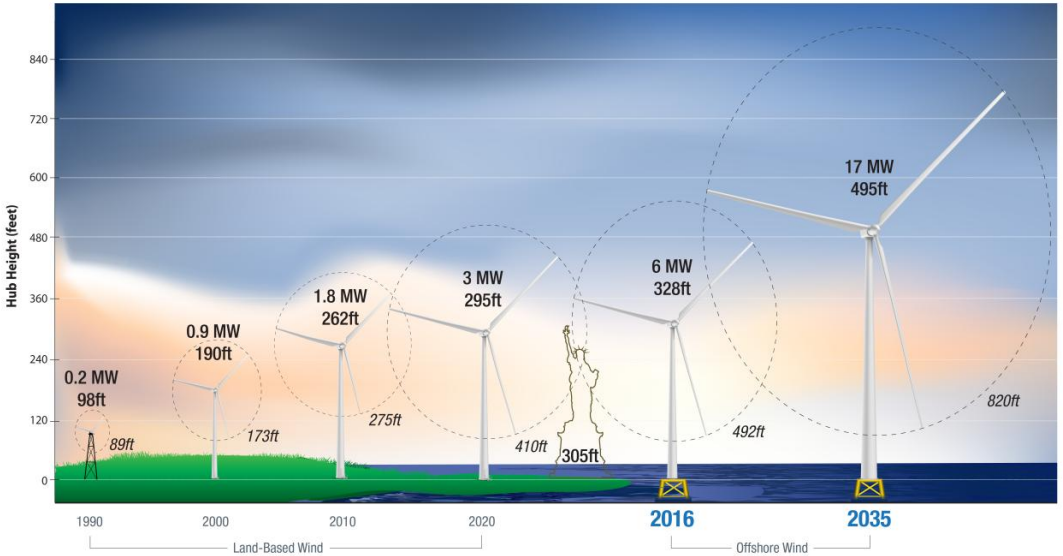
Wind Energy Technologies

System Variations

- Axis orientation
- Tower height
- Blade counts
- Orientations

Horizontal Axis Wind Turbine

Vertical Axis Wind Turbine

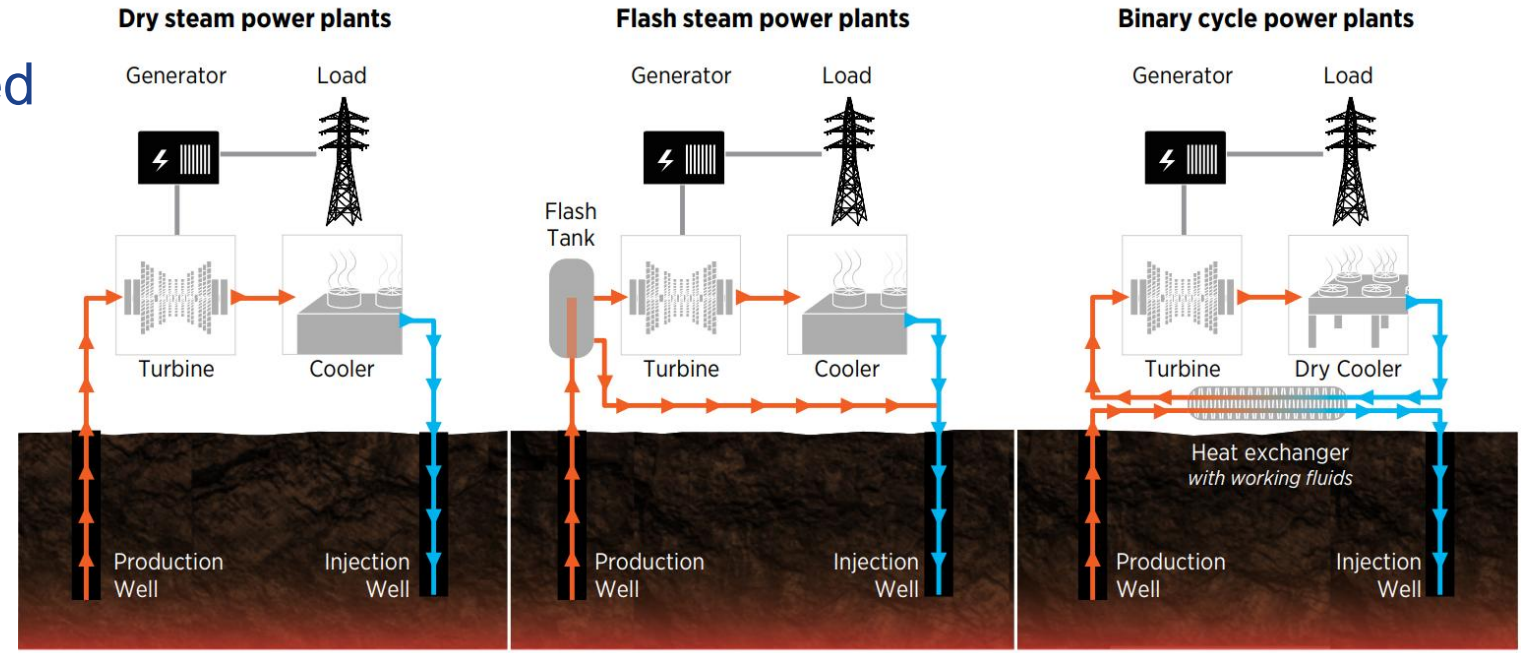


- Size of the Blades ~ **Wind-Swept Area = More Energy**
- Generator Capacity = **Rating (kW or MW)**

Image Source: DOE

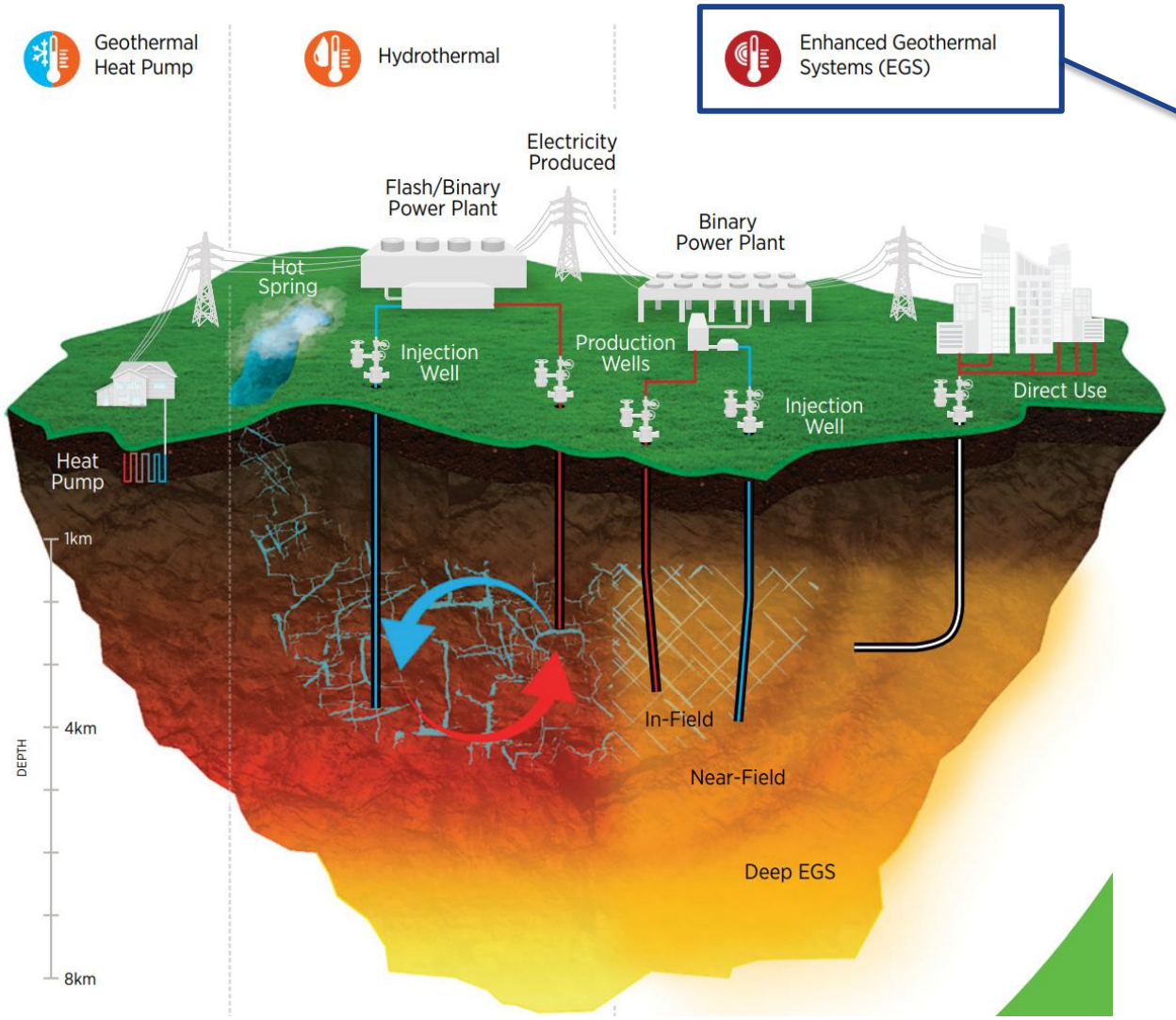
Geothermal Electricity

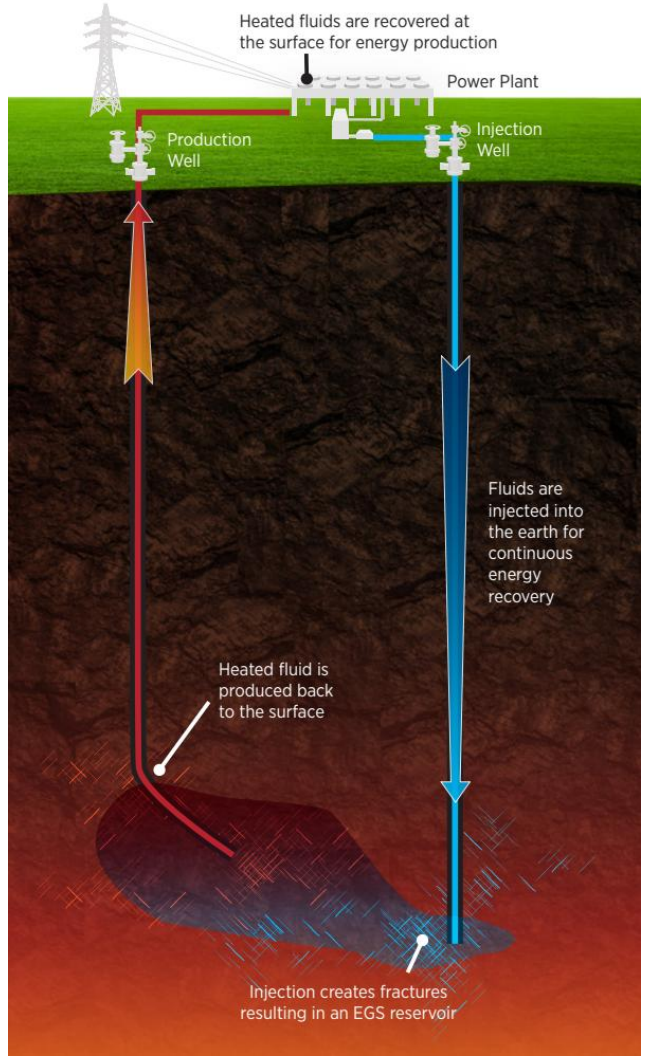
- Dry Steam
  - Use hydrothermal fluids (underground sources of steam; >220 °F)
  - Very locational (unique locations)
- Flash Steam
  - Water > 400°F (200°C) flashed to steam
- Binary Cycle
  - Use of secondary fluid at temperatures ranging between 225-360°F (107-182°C)



Source: U.S. Department of Energy, Geovision 2019

Geothermal Electricity



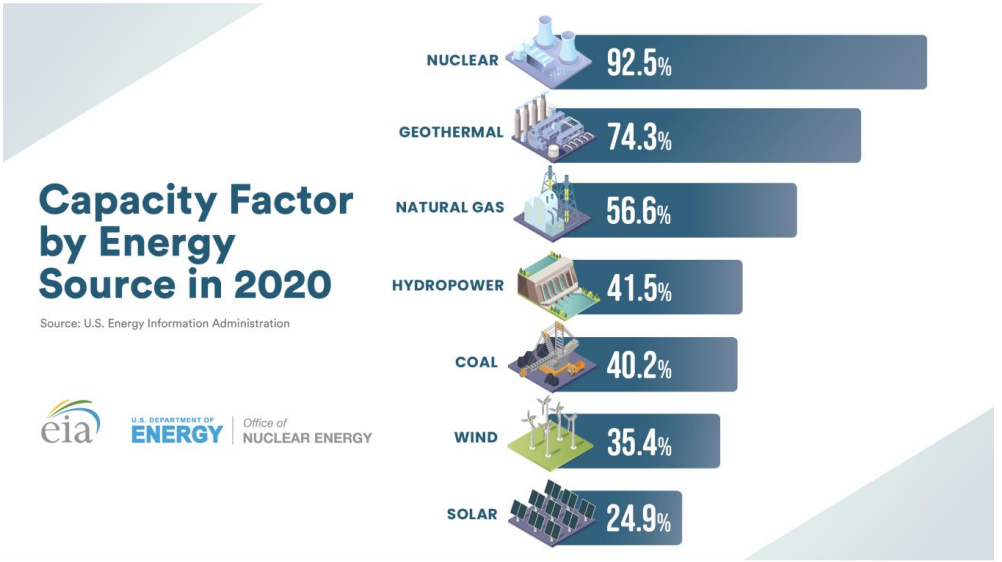


Source: U.S. Department of Energy, Geovision 2019

Capacity Factor (CF)

- Capacity Factor (CF) is a ratio of energy (kWh or MWh)

$$CF = \frac{actual\ electricity\ production}{modeled\ production}$$



Capacity Factor influences electricity production ⟹ **RECs Generated**

Purchasing Electricity

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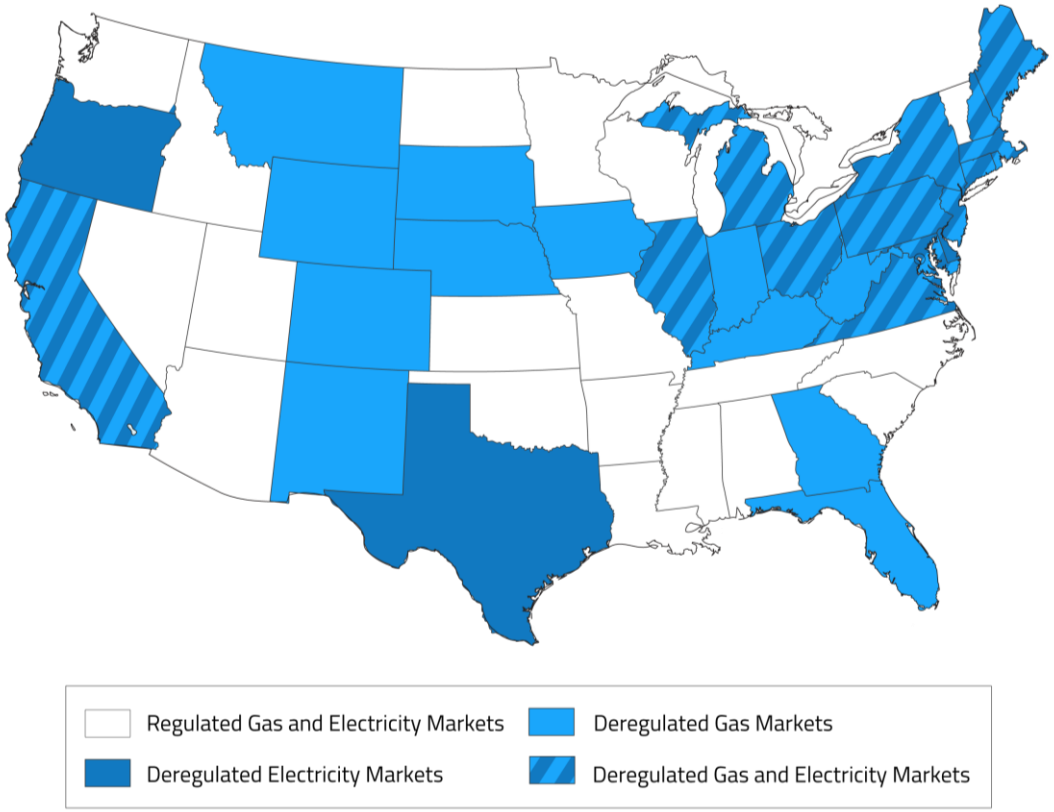
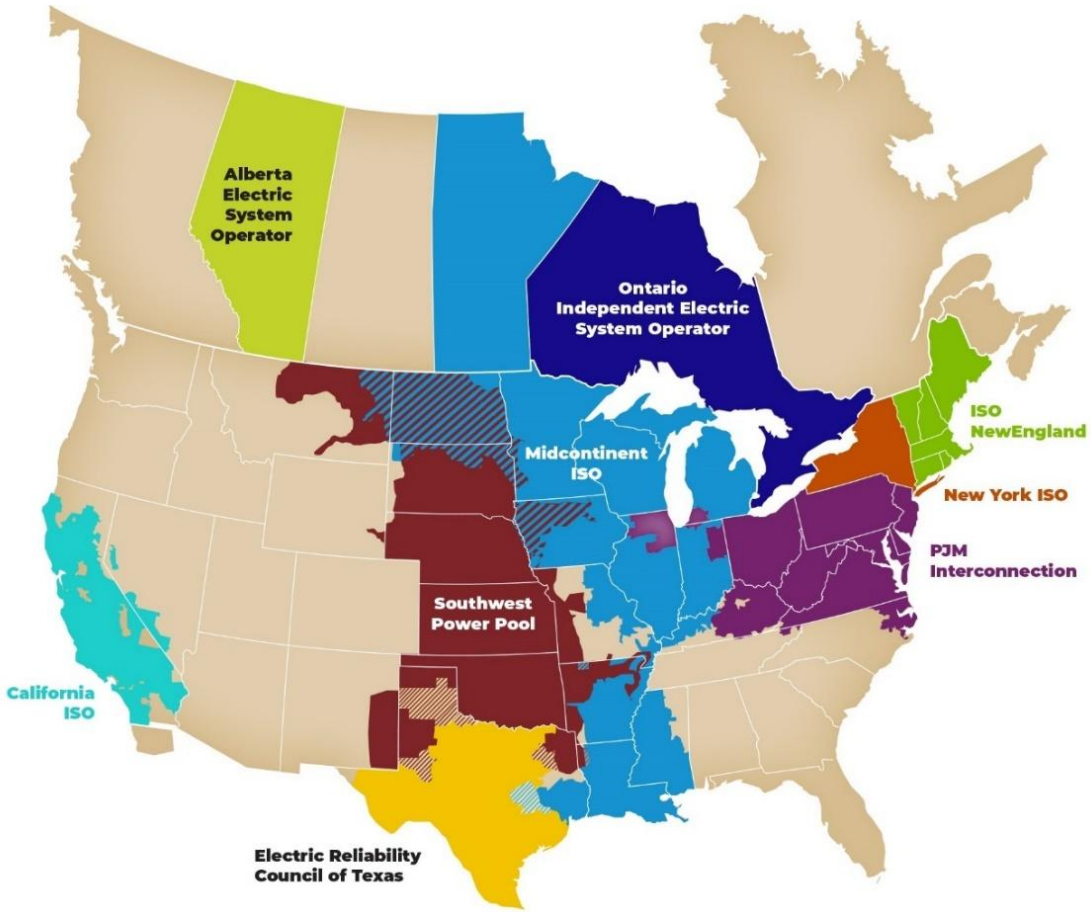
Electricity Markets



Status of electricity markets by state

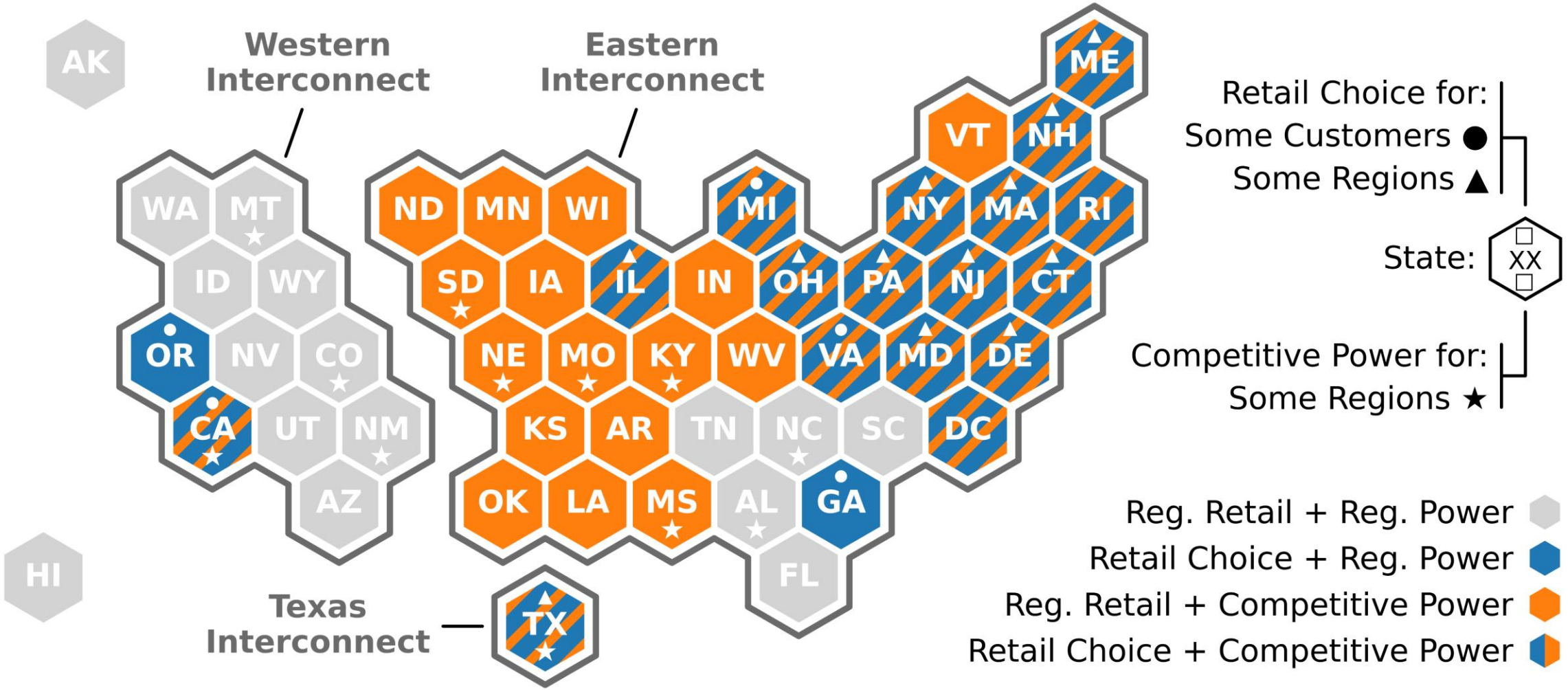
Note: States may be partially regulated/deregulated, regulated only in some utility markets, or deregulated for industrial consumers. Additional information is available at the American Coalition of Competitive Energy Suppliers



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

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

Location Matters



Electricity Markets – Renewable Portfolio Standards

A renewable portfolio standard (RPS) is a regulation that requires the increased production of energy from renewable energy sources, such as wind, solar, biomass, and geothermal.

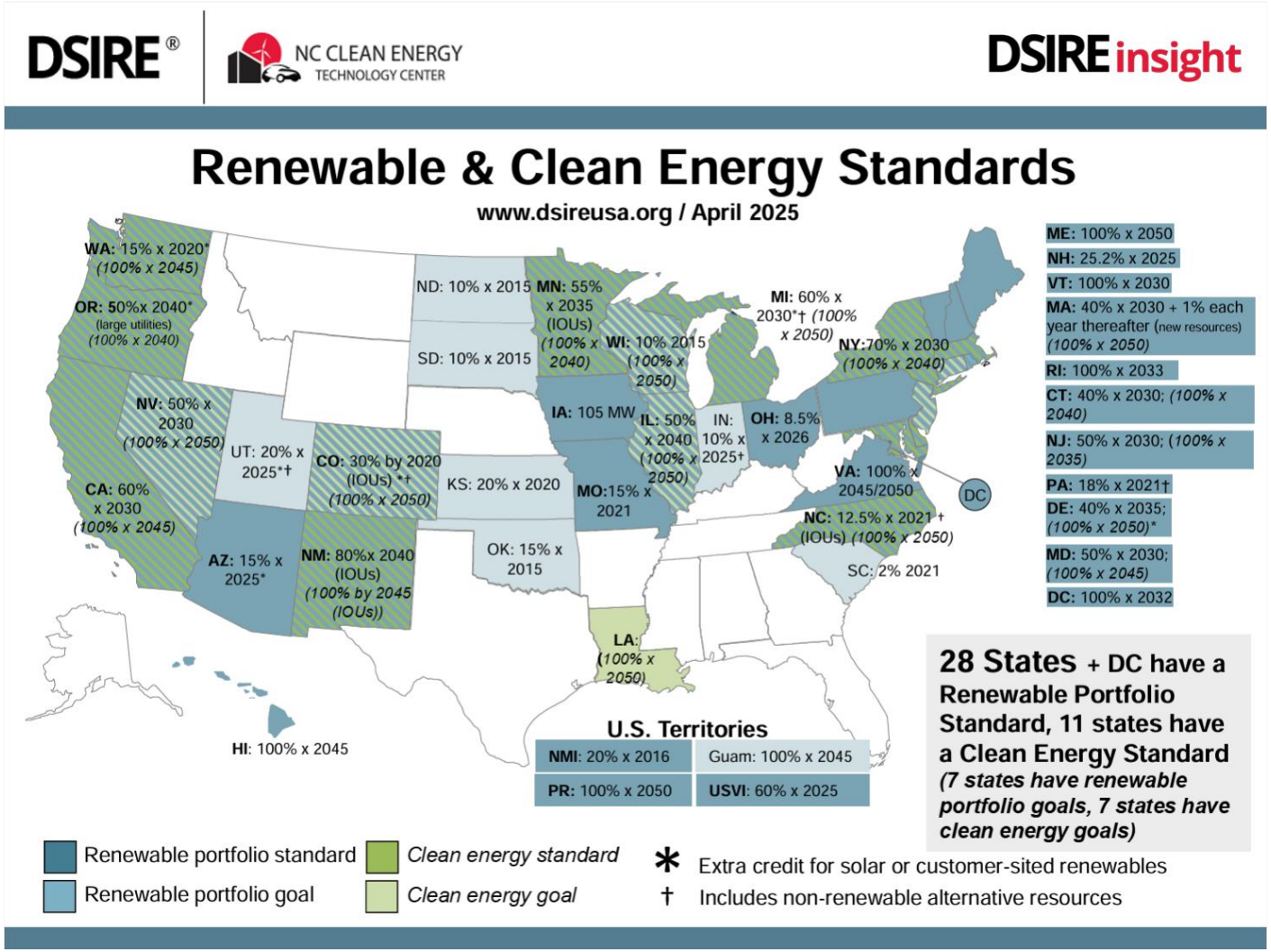
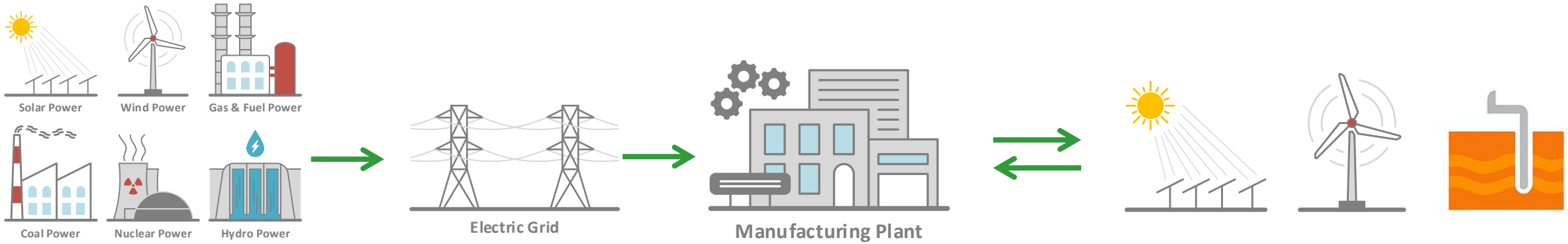


Image Source: https://www.dsireusa.org/

Electricity Generation in U.S.

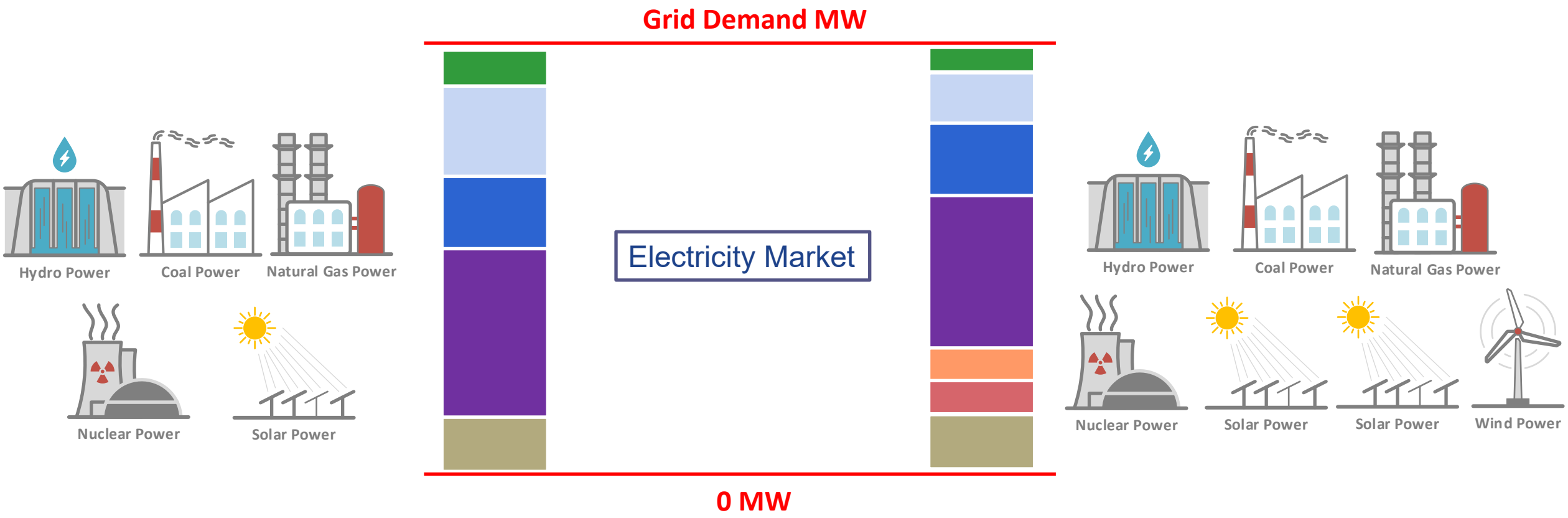
- All electrons are the same
- How do we know the source?



Generation **Electrical Grid** **Consumption** **Onsite Generation**

Electricity Generation in U.S.

The idea that your renewable energy purchase leads to *new* energy being added to the grid.



Concept of Additionality

- The term “additionality” describes the concept of adding new renewable energy generation to the grid
- Can be created when an organization procures a bundled renewable energy contract such as a PPA.
- Based on that purchase, organizations may claim that increment in renewables generation as an “addition” since it has a direct impact on implementing more renewable energy projects
- To properly claim additionality, an organization must be committed prior to the construction of the project, to ensure its financial contribution to the project

Poll Time!

Week 1 Poll: Question 3

- How familiar are you with the difference between market-based and location-based Scope 2 accounting?
  - Very familiar
  - Somewhat familiar
  - Heard of it, but unclear
  - This is new to me

Week 1 Poll: Question 4

- What are the primary drivers for your organization's renewable energy purchasing decisions? (Rank all options: 1 being most important)
  - Cost savings
  - Energy reliability/resilience
  - Price hedging
  - Corporate sustainability commitments
  - Regulatory compliance
  - Stakeholder/Investor/ Customer requirements

Energy Attribute Certificates (EACs)

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Energy Attribute Certificates (EACs)

1 EAC = 1 MWh

EACs label the attributes of each MWh that is produced

- Location
- Traceability
- Environmental Claims
- Time of Generation

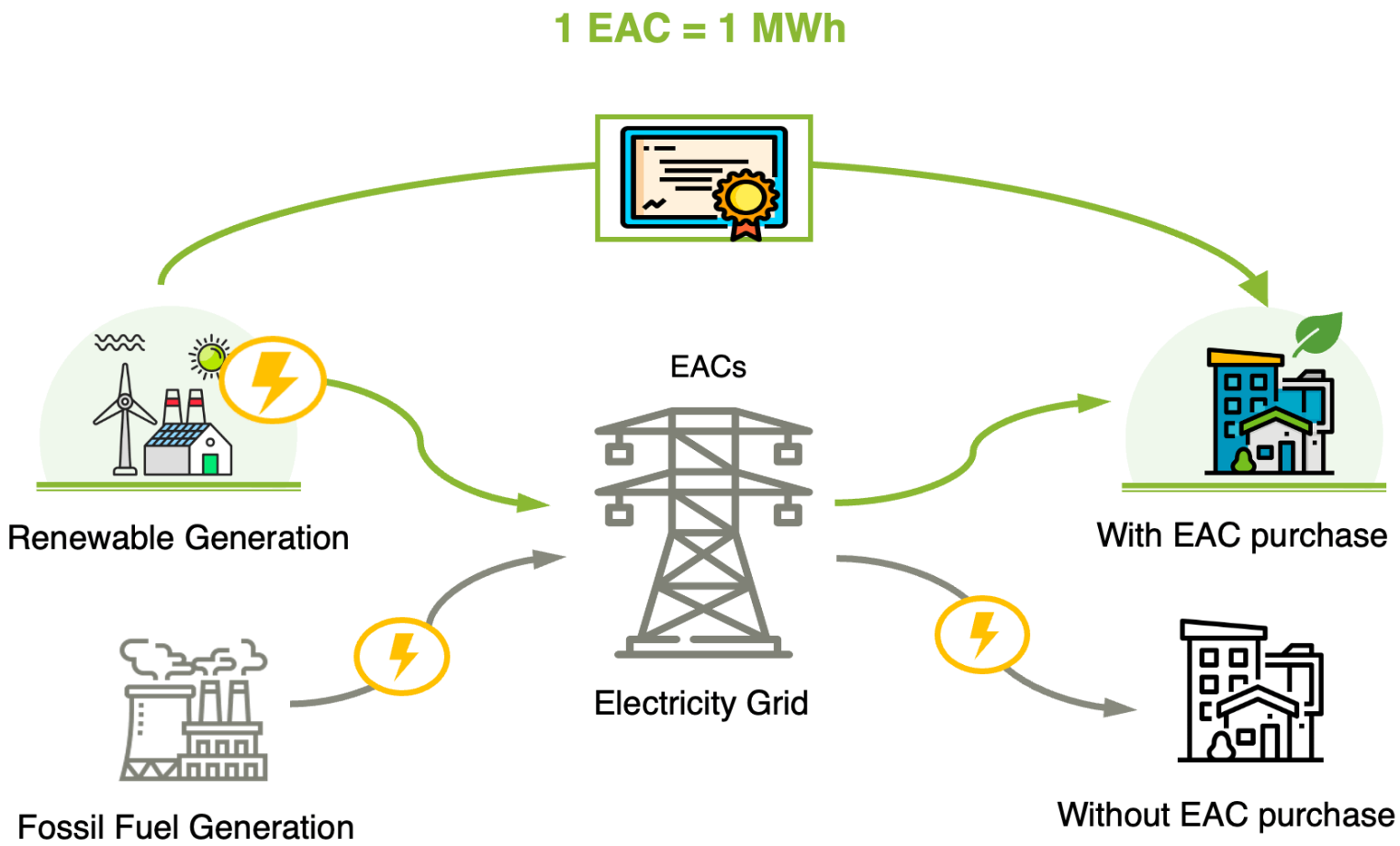
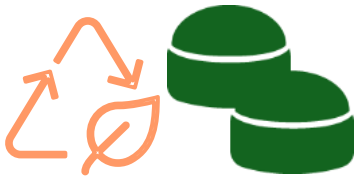


Image source: mtstonegate.com

Energy Attribute Certificates (EACs)

- EACs are market instruments to track source of energy
- Unique and Tradable
- Non-physical commodity
- Represents claims to associated environmental attributes

Renewable Energy Certificates (RECs)	Renewable Fuel Certificates (RFCs)	Renewable Thermal Certificates (RTCs)



Renewable Thermal Credits (RTCs)

A Renewable Thermal Certificate (“RTC”) is a unique representation of the Environmental Attributes associated with the production and use of one dekatherm (“Dth”) of renewable thermal energy.

- Renewable thermal power for heat from solar, biomass, geothermal, and other renewable thermal technologies.
- Assign RECs on “electric equivalency basis”.

3,412,000 BTUs = 1 MWh = 1 REC

Source: https://www.mrets.org/wp-content/uploads/2021/06/M-RETS-Thermal-Tracking-System-6-2021.pdf, https://www.cesa.org/wp-content/uploads/Renewable-Thermal-RPS.pdf

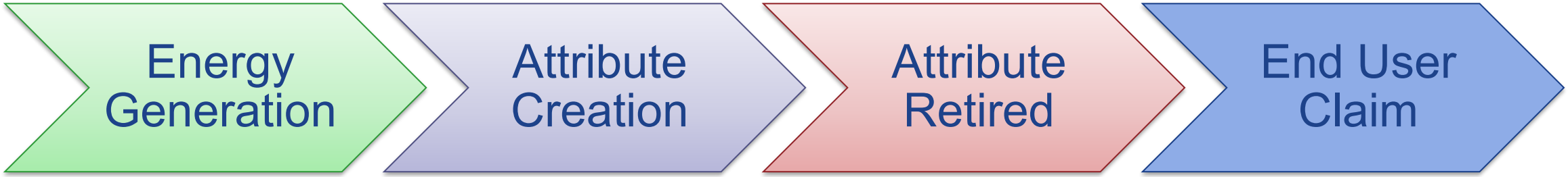
Renewable Fuel Certificates (RFCs)

- Also referred to as RINs or Renewable Identification Numbers
- A contractual instrument that represents and conveys all attributes of a unit of renewable fuel from production until delivery to a renewable fuel consumer.
- Contains environmental attributes such as feedstock, production process, renewable fuel type, location of production etc.
- RFCs are created when renewable fuel is injected into a pipeline for consumption
  - Certificates can be used in all regions of U.S. And some parts of Canada.

Source: https://www.green-e.org/docs/rf/Green-e%20Renewable%20Fuels%20Standard.pdf

Energy Attribute Certificates (EACs)

- EACs Lifecycle:

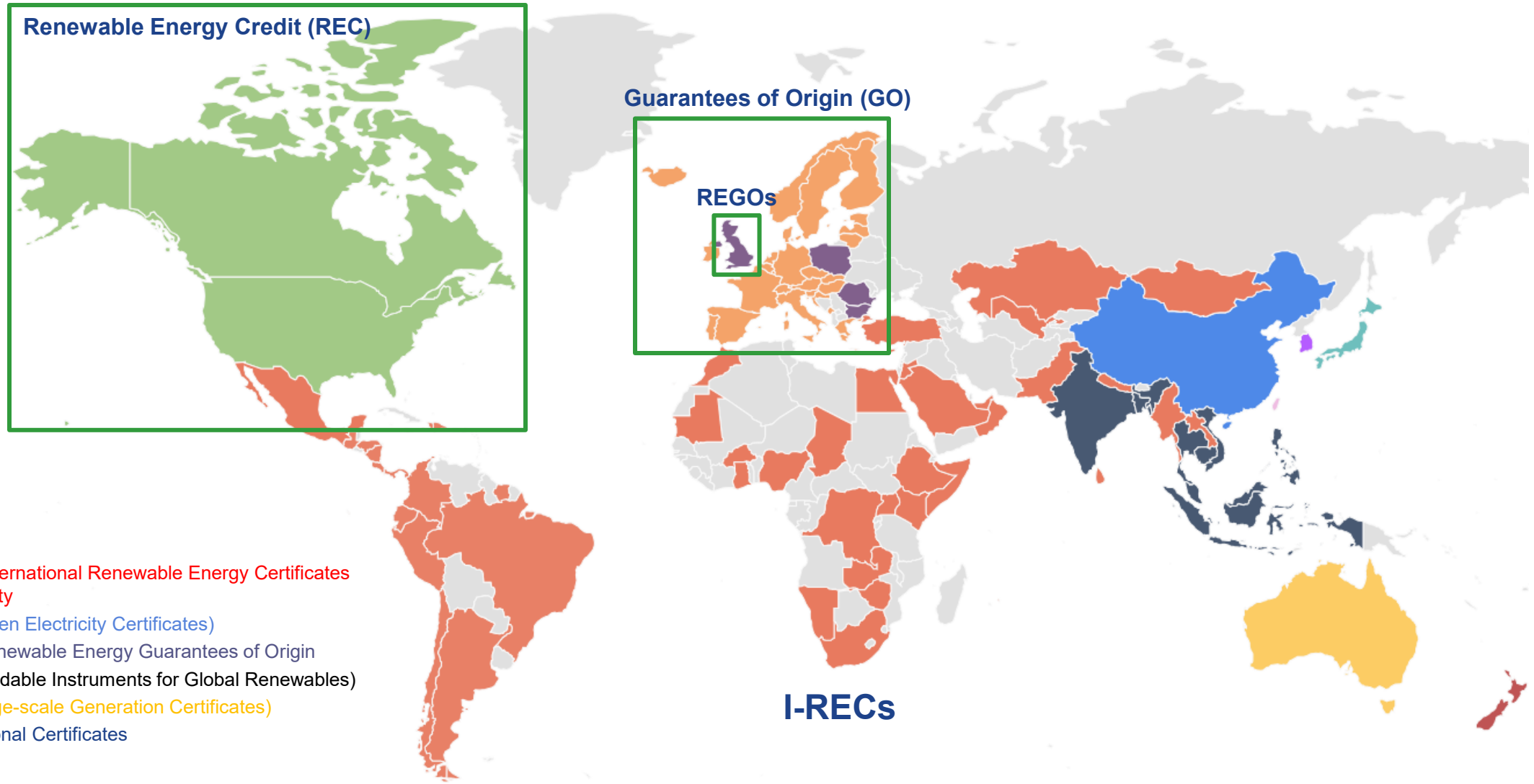


The certificate is created each time a MWh is produced by a facility registered in the tracking system

The unique certificate is retired in the tracking system by company wishing to make claims; avoids double counting

Owner claims associated benefits

Global EACs



- I-RECs (International Renewable Energy Certificates for Electricity
- GECs (Green Electricity Certificates)
- REGO (Renewable Energy Guarantees of Origin
- TIGRs (Tradable Instruments for Global Renewables)
- LGCs (Large-scale Generation Certificates)
- Other National Certificates

Source: 3Degrees

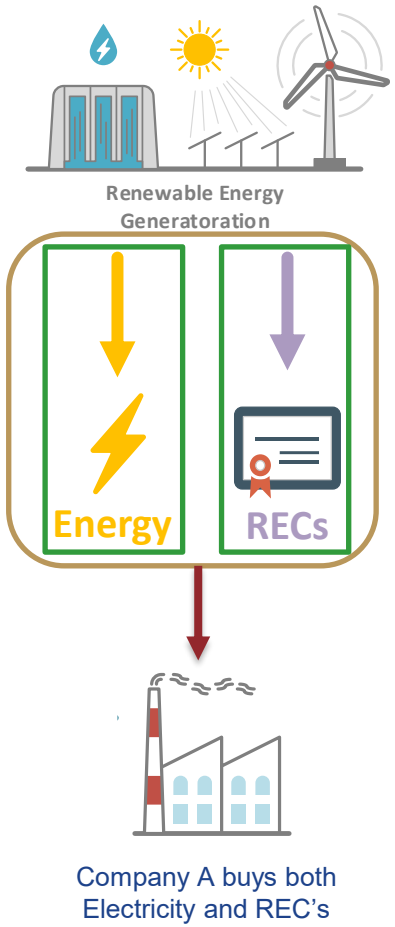
Renewable Energy Certificates (RECs)

U.S. DEPARTMENT OF ENERGY

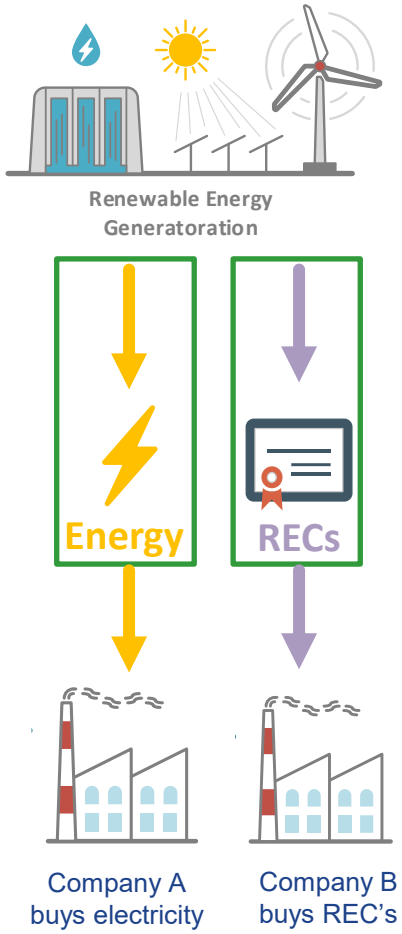
Renewable Energy Certificates/Credits (RECs)

- Corporates can get RECs through
  - Self/Onsite generation
  - P-PPA's and V-PPA's
  - Utility programs (Green Tariffs etc.)
  - Buying unbundled RECs
- Two types of RECs
  - Bundled
  - Un-bundled
- What does a REC contain?
  - Generation location
  - Generation date
  - Renewable source
  - Unique identifier for Tracking etc.
- Typically, Green-e® Certified

Bundled REC



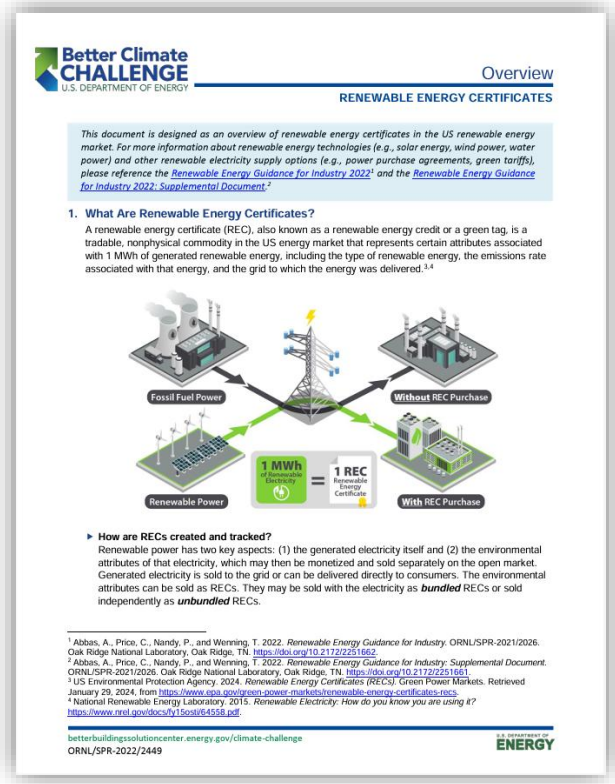
Unbundled REC



% Renewable for a facility = RECs retired/Electricity purchased

Benefits of RECs

- Reduced carbon footprint by lowering corporates scope 2 emissions
- Promote renewable generation both locally and nationally
- Flexibility to purchase from any location
- Promoting corporate commitment to renewable energy
- Good option when onsite renewable installation is not possible
- Additionality is more commonly accepted for certain REC procurements, as more information is known about the nature of the REC generation



Better Climate CHALLENGE
U.S. DEPARTMENT OF ENERGY

Overview

RENEWABLE ENERGY CERTIFICATES

This document is designed as an overview of renewable energy certificates in the US renewable energy market. For more information about renewable energy technologies (e.g., solar energy, wind power, water power) and other renewable electricity supply options (e.g., power purchase agreements, green tariffs), please reference the Renewable Energy Guidance for Industry 2022[1] and the Renewable Energy Guidance for Industry 2022: Supplemental Document.[2]

1. What Are Renewable Energy Certificates?

A renewable energy certificate (REC), also known as a renewable energy credit or a green tag, is a tradable, nonphysical commodity in the US energy market that represents certain attributes associated with 1 MWh of generated renewable energy, including the type of renewable energy, the emissions rate associated with that energy, and the grid to which the energy was delivered.[3,4]

▸ **How are RECs created and tracked?**

Renewable power has two key aspects: (1) the generated electricity itself and (2) the environmental attributes of that electricity, which may then be monetized and sold separately on the open market. Generated electricity is sold to the grid or can be delivered directly to consumers. The environmental attributes can be sold as RECs. They may be sold with the electricity as ***bundled*** RECs or sold independently as ***unbundled*** RECs.

[1] Abbas, A., Price, C., Nandy, P., and Wenning, T. 2022. *Renewable Energy Guidance for Industry.* ORNL/SPR-2021/2026. Oak Ridge National Laboratory, Oak Ridge, TN. https://doi.org/10.2172/2251662.
[2] Abbas, A., Price, C., Nandy, P., and Wenning, T. 2022. *Renewable Energy Guidance for Industry: Supplemental Document.* ORNL/SPR-2021/2026. Oak Ridge National Laboratory, Oak Ridge, TN. https://doi.org/10.2172/2251661.
[3] US Environmental Protection Agency. 2024. *Renewable Energy Certificates (RECs).* Green Power Markets. Retrieved January 29, 2024, from https://www.epa.gov/green-power-markets/renewable-energy-certificates-recs.
[4] National Renewable Energy Laboratory. 2015. *Renewable Electricity: How do you know you are using it?* https://www.nrel.gov/docs/fy15osti/64558.pdf.

betterbuildingssolutioncenter.energy.gov/climate-challenge
ORNL/SPR-2022/2449
U.S. DEPARTMENT OF ENERGY

REC Tiers

- REC tiers are determined by the source of generation or sometimes by the age of renewable energy generation company
- REC tiers affects the price at which REC is available to a customer
- Tier 1 RECs can be expensive compared to Tier 2 and 3 depending on how each state allocates their tiers
- Example of Tiers
  - Solar
  - Wind
  - Geothermal
  - Fuel Cell

  } Tier 1 { Generation asset commenced after Jan' 2015

  - Hydro *
  - Biogas/Biomass

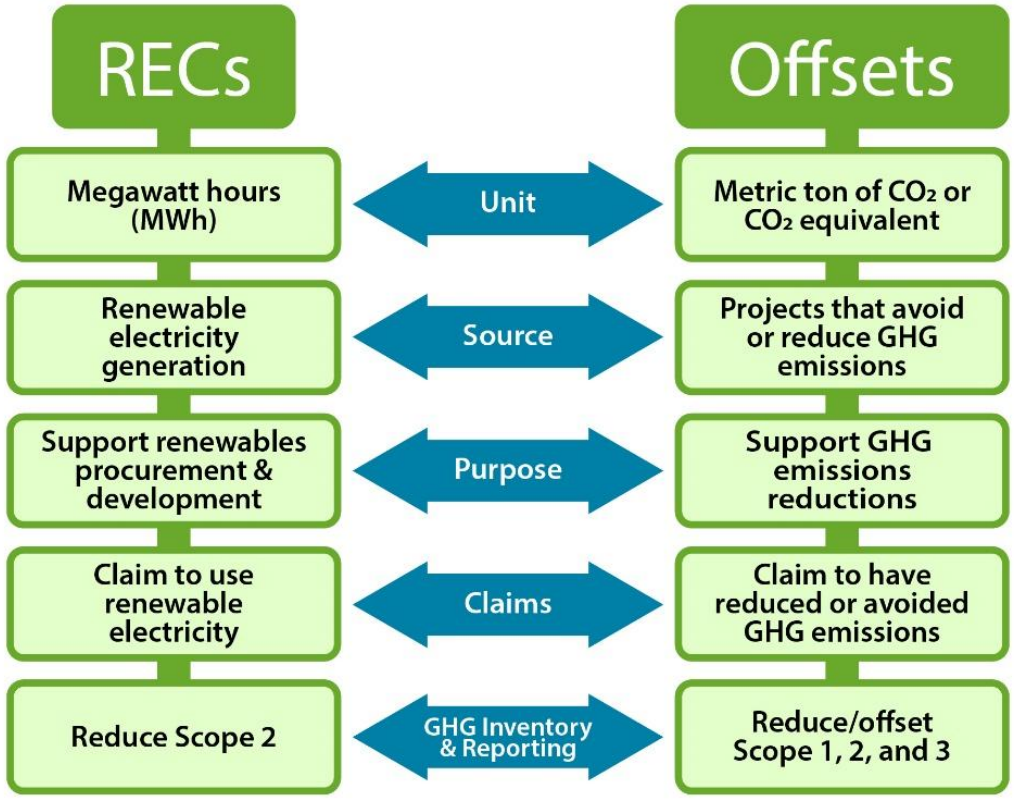
  } Tier 2 & 3 { Generation asset in service before Jan' 2015

*Hydroelectric assets are considered Tier 1 in some markets

RECs versus Carbon Offsets

- A REC: represents **1 MWh of energy**
- An Offset: represents **1 metric ton of avoided emissions**
- The Better Climate Challenge program **allow RECs** but **do not recognize** the use of offsets.
- Unlike a REC, an offset **only reduces a carbon footprint** and has no effect on the renewable character of the energy streams being used by a facility.
- An offset can **reduce all emissions scopes**, whereas a REC can only reduce an organization's Scope 2 market-based emissions.
- Both **RECs and Offsets are not included** in energy baselines for Better Plants program.

Better Climate™ CHALLENGE
U.S. DEPARTMENT OF ENERGY



Wrapping Up!

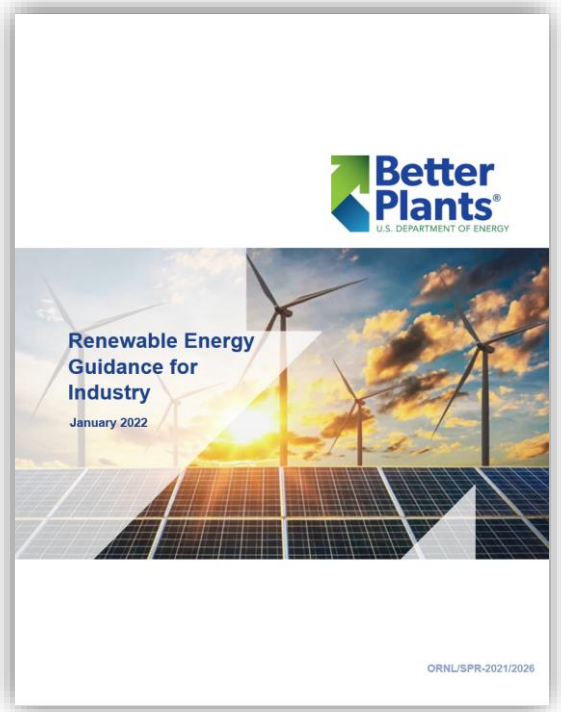
Other Programs and Platforms for Renewable Energy

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

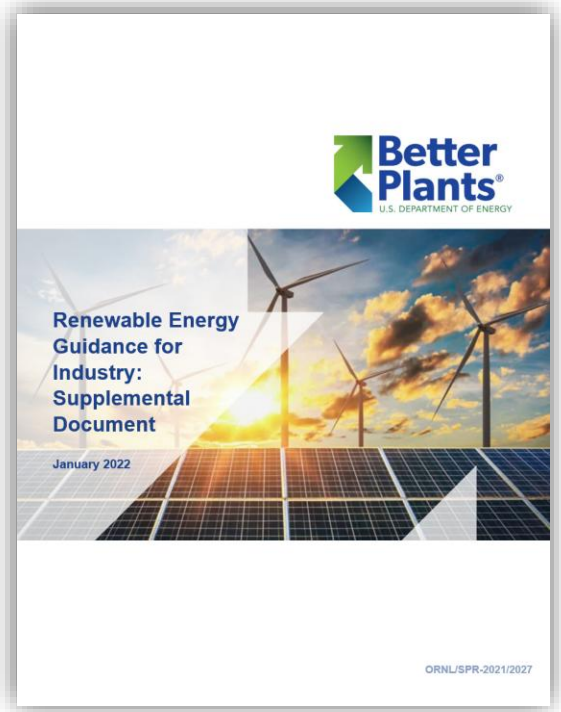
Renewable Energy for Industry Guidance Documents

- Access the full main document here.

- Access the supplemental document here.



Main Document



Supplemental Document

Tools and Resources

- System Advisor Model (SAM)
  - Detailed technology performance
  - Detailed economic modeling
- REopt®: Renewable Energy Integration and Optimization
  - Optimized system size and dispatch
  - High-level economics
- PVWatts Calculator
  - PV energy generation (no economics)

Other Resources:

- Renewable Energy Certificates
- Federal Trade Commission Guides for the Use of Environmental Marketing Claims
- CRS REC Claims and Ownership
- Geovision report
- Onsite Energy Program
- Better Plants Solutions Center
- State-Level Incentives
- U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks
- Energy Storage Cost and Performance Database
- DOE Factsheets on Distributed Wind Power
- DOE Factsheets Solar Photovoltaic Panels For Industrial Applications

5 Minute Break

Today's Speakers

Paulomi Nandy

R&D Associate,
Oak Ridge National Laboratory

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GHG Accounting Basics

Paulomi Nandy
Oak Ridge National Laboratory

U.S. DEPARTMENT OF ENERGY

Agenda

- Scope of Emissions
- Setting Corporate Boundary
- Calculate Scope 1 Emissions
  - Fuel Consumption Method
  - Estimation Method
- Calculate Scope 2 Emissions (Electricity)
  - Location Based
  - Market based
- Calculate Scope 2 Emissions (Other Utility)
- Reporting Best Practices
- Accounting for Changes in Organization

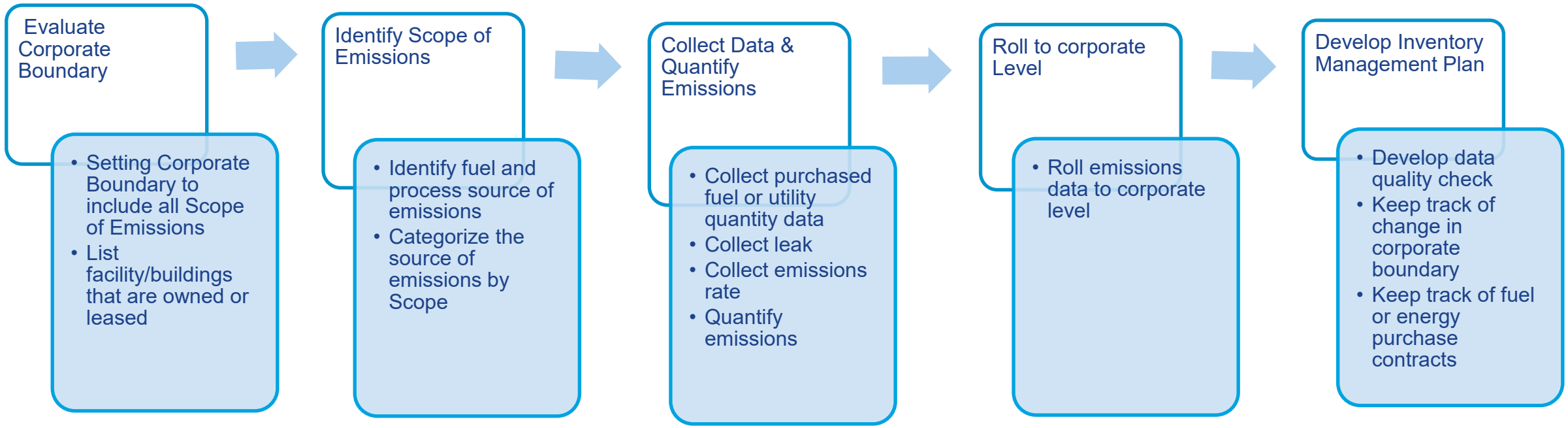
What is a GHG inventory

GHG Inventory is a list of all the emissions sources and associated emissions within an organization boundary.

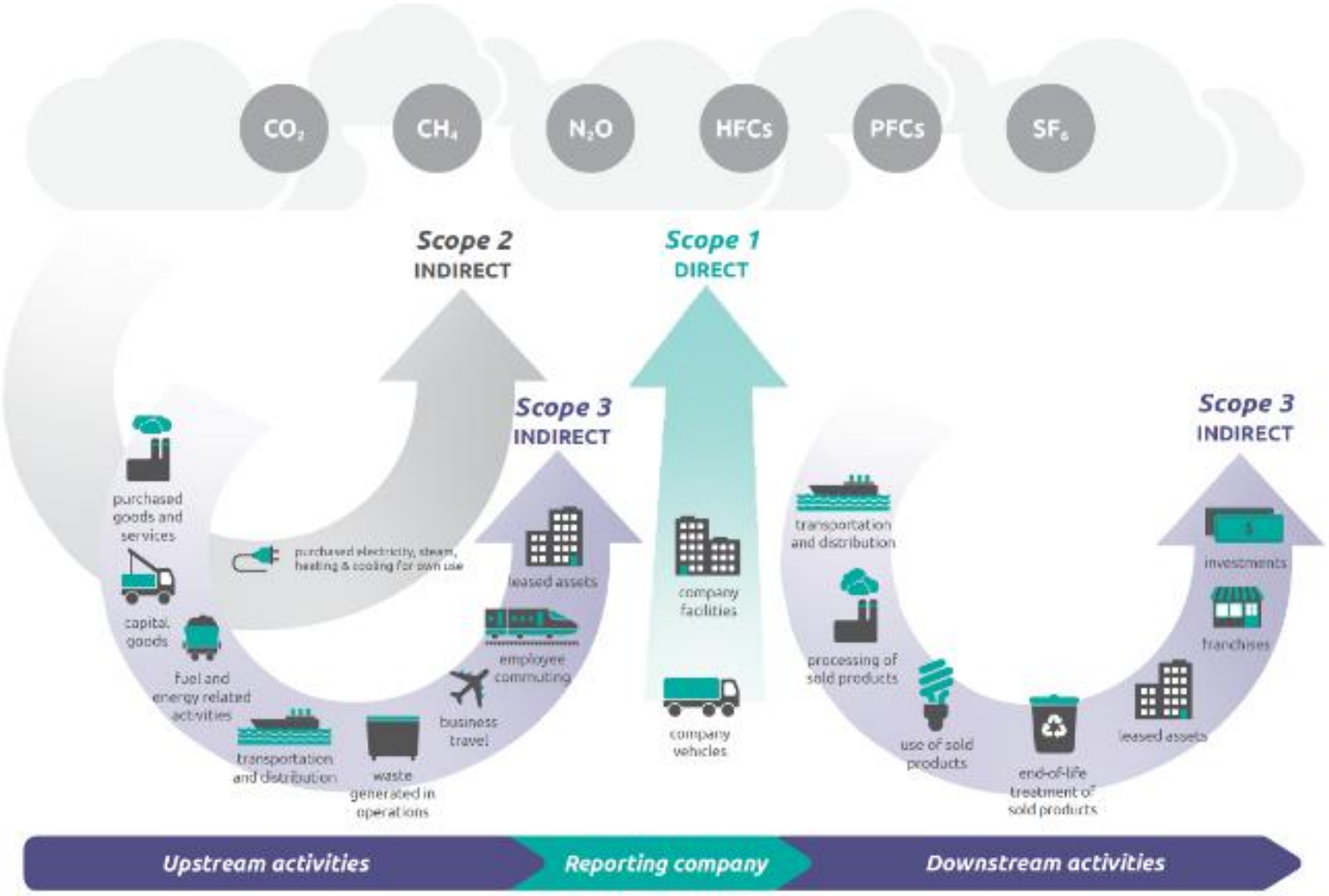
Reasons for GHG inventory:

- Identifying emissions reduction opportunity
- Managing risk related to high GHG emissions
- Setting and tracking towards a goal

Steps to develop a GHG Inventory



Scope of Emissions



Global Warming Potential

Global Warming Potential (GWP) helps compare the global warming impact of different gases.

Measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO2)

CH4 GWP- 25 (AR4) / 28 (AR5)

N2O GWP- 298 (AR4) / 265 (AR5)

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

Setting Corporate Boundary

Equity Share Approach

Reflects activities that are wholly or partially owned based on equity share

Financial Control

Reflects activities that organization can direct financial policies and gain economic benefits from activities.

Operational Control

Reflects activities that organization can implement operational policies.

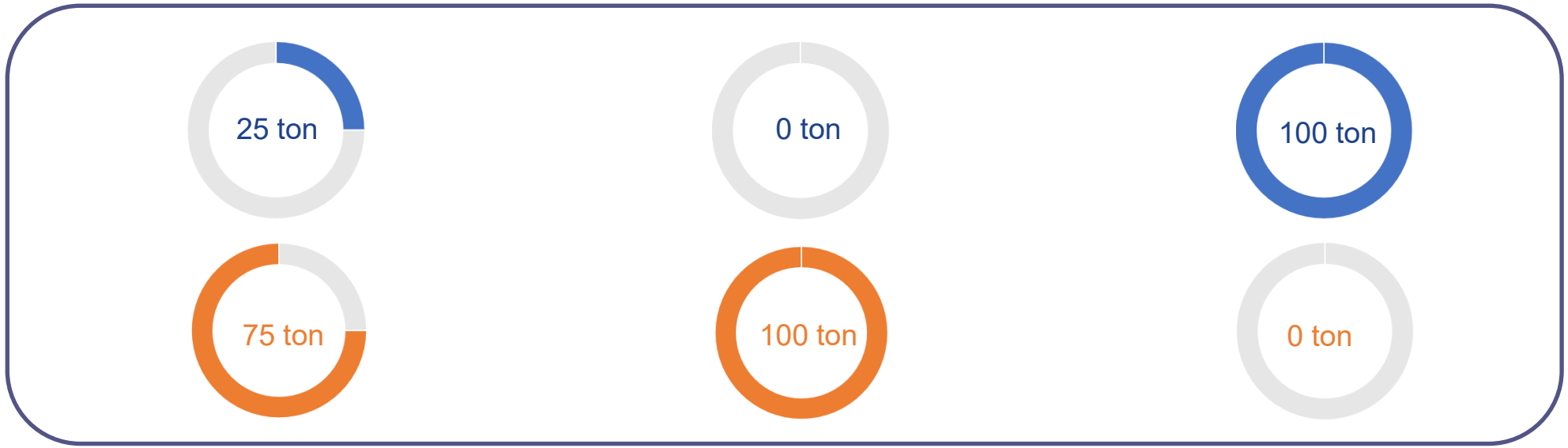
Total Emissions
100 ton CO_{2e}/yr.

Company A

Operator: 25% stake

Company B

Financer: 75% stake



Leased Buildings (Lessee's Perspective)

Table 1. Emissions from Leased Assets: Leasing Agreements and Boundaries (Lessee's Perspective)

	Type of Leasing Arrangement	
	Finance/Capital Lease	**Operating Lease**
Equity Share or Financial Control Approach Used	Lessee does have ownership and financial control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.	Lessee does not have ownership or financial control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are scope 3.
Operational Control Approach Used	Lessee does have operational control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.	Lessee does have operational control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.[a]
Note: [a] Some companies may be able to demonstrate that they do not have operational control over a leased asset held under an operating lease. In this case, the company may report emissions from the leased asset as scope 3 but must state clearly in its GHG inventory report the reason(s) that operational control is not perceived.		

https://ghgprotocol.org/sites/default/files/2022-12/Categorizing%20GHG%20Emissions%20from%20Leased%20Assets.pdf

Leased Buildings (Lessor's Perspective)

Table 2. Emissions from Leased Assets: Leasing Agreements and Boundaries (Lessor's Perspective)

	Type of Leasing Arrangement	
	Finance/Capital Lease	**Operating Lease**
Equity Share or Financial Control Approach Used	Lessor does not have ownership or financial control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are scope 3.	Lessor does have ownership and financial control, therefore emissions associated with fuel combustion are scope 1 and with use of purchased electricity are scope 2.
Operational Control Approach Used	Lessor does not have operational control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are scope 3.	Lessor does not have operational control, therefore emissions associated with fuel combustion are scope 3 and with use of purchased electricity are scope 3.[a]

Note: [a] Some companies may be able to demonstrate that they do have operational control over an asset leased to another company under an operating lease, especially when operational control is not perceived by the lessee. In this case, the lessor may report emissions from fuel combustion as scope 1 and emissions from the use of purchased electricity as scope 2. The lessor must clearly state in the GHG inventory report the reason(s) that operational control is perceived.

https://ghgprotocol.org/sites/default/files/2022-12/Categorizing%20GHG%20Emissions%20from%20Leased%20Assets.pdf

Method of Calculation

Calculation Based

- Calculate CO2 emissions for each unit of fuel consumption
- Calculate CH4 and N2O CO2 emissions for each unit of fuel consumption
- Converting emissions to CO2e

Measurement Based

- Emissions measured directly through system that monitors the concentration of the GHGs and output flow rate using Continuous Emissions Monitoring System (CEMS)

Estimation Method

- Estimate emissions

Stationary Emissions

Stationary Emissions include emissions from boiler, turbine, process heating and generator.

Emission from **biofuel** also needs to be reported as biogenic emissions (CO_2)

CH4 and N2O should be included in stationary emissions

Common Fuel	Natural Gas, Propane, Fuel oil, Coal
Data	utility usage data, sub-metered data

Emissions Fuel Use Data

Quantifying emissions based on fuel consumption
Calculate CO_2 , CH_4 and N_2O using equation below

$$Emissions = Quantity\ of\ fuel \times Emissions\ factor$$

Reported Emissions for Fossil Fuel

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

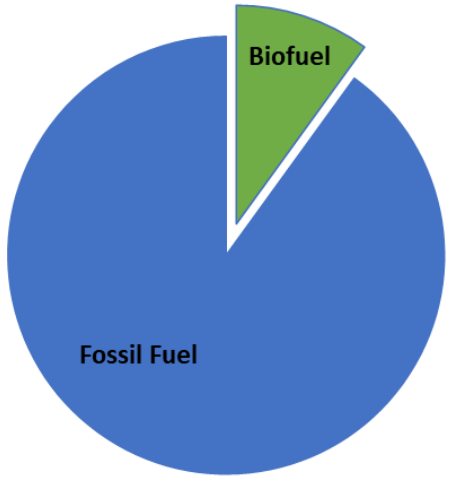
Reported Emissions for Biofuel

$$Biofuel\ CO_2e(ton) = \frac{(Quantity\ of\ biofuel \times (25 \times CH_4\ emissions) + (298 \times N_2O\ emissions))}{1000}$$

$$Biogenic\ CO_2(ton) = \frac{(Quantity\ of\ biofuel) \times Emission\ factor}{1000}$$

Emissions from blended fuel

Blended fuel is composition of fossil fuel with biofuel or other fuel sources.



Quantify quantity of biofuel= $Fuel\ consumption\ (unit) \times \%\ biofuel$

Quantify quantity of fossil fuel = $Fuel\ consumption\ (unit) \times \%\ fossil\ fuel$

$$Fossil\ fuel\ CO_2e(ton) = \frac{(Quantity\ of\ fossil\ fuel)\times(CO_2\ emissions+(25\times CH_4\ emissions)+)+(298\times N_2O\ emissions))}{1000}$$

$$Biofuel\ CO_2e(ton) = \frac{(Quantity\ of\ biofuel\times(25\times CH_4\ emissions)+(298\times N_2O\ emissions))}{1000}$$

$$Total\ emissions\ (CO_2e\ ton) = Fossil\ fuel\ CO_2e(ton) + Biofuel\ CO_2e(ton)$$

$$Biogenic\ CO_2(ton) = \frac{(Quantity\ of\ biofuel)\times Emission\ factor}{1000}$$

Mobile Emissions

Emissions resulting from operation of owned or leased mobile sources that are within the organization boundary

Emissions from **biofuel** also needs to be reported as biogenic emission (CO_2)

Common Fuel	Gasoline, Diesel,
Data	Fuel used, vehicle type, miles travelled
Emission Factor	kg CO_2/unit, g CH_4 per distance travelled, g N_2O per distance travelled

Emissions for Mobile Emissions (On-Road Vehicles)

Emissions from On-Road Vehicles such as trucks, bus, ships, etc.

$$CO_2 \text{ Emissions} = Quantity\ of\ fuel \times Emission\ factor$$

$$CH_4, N_2O \text{ Emissions} = Miles\ travelled \times Emission\ factor$$

Reported Emissions for Fossil Fuel

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

CH_4 and N_2O emissions depend more on the emission control technologies employed in the vehicle and the distance traveled.

Emissions for Mobile Emissions (Off-Road Vehicles)

Emissions from Off-Road Vehicles such as tractors, forklifts, lawn care equipment etc.

Reported Emissions for Fossil Fuel

$$Emissions = Quantity\ of\ fuel \times Emissions\ factor$$

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

Other Methods of Estimation of Mobile Emissions

Blended fuel: E10 (10% ethanol/90% gasoline), E15 (10.5% to 15% ethanol blended with gasoline), B5 (5% biodiesel/95% diesel), and B2 (2% biodiesel/98% diesel)

Fuel data unavailable for On-Road Vehicle:

$$Fuel\ Use\ (gallons) = \frac{Distance}{miles\ per\ gallons}$$

Fugitive Emissions

Emissions due to refrigerant or gas leaks during installation, operation or disposal.

Common Refrigerants	HFCs, R-410A, R-404A
Data	Types of refrigeration units, Type of refrigerant, state of the equipment (new installation, operating equipment, disposed equipment), quantity of refrigerant leaks
Emission data	GWP of the refrigerant

Quantifying fugitive emissions from leaks

Mass Balance Method

Method relies total amount of refrigerants/gases purchased

$$Emissions = (I_B - IE) + (CB - CE)$$

Screening Method

Method relies on emission factors which are equipment specific.

Reported Emissions for Installed or Operated Equipment

$$Emissions = Volume\ of\ refrigerant\ leak\ \times (\frac{\%\ loss}{100})$$

Reported Emissions Disposed Equipment

$$Emissions = Volume\ of\ refrigerant\ leak\ \times \frac{\%\ capacity\ remaining\ at\ disposal}{100} \times (1 - \frac{\%\ refrigerant\ recovered}{100})$$

Scope 2: Purchased Electricity, Steam etc.

Emissions from purchased electricity, steam over the boundary

Electricity can be considered emissions free only if you retain the Renewable Energy Credits(RECs)

Emissions Estimation: Location Based, Market Based

Common Contract	Electricity from grid, onsite, green tariff, RECs, PPPA
Data	Electricity/steam usage from utility bill, sub-meter, Certificates, Contracts
Emission Factor	kg CO_2/unit, g CH_4/unit, g N_2O/unit

Location Based vs. Market Based Emissions

Location Based Approach

This method allows you to quantify average emissions from electricity consumption in organization's geographic regions of operation

Using eGRID factor

Market Based Approach

This method allows you to quantify emissions from electricity generated or consumed that the organization has purposefully purchased

Using emission factors conveyed through contractual instruments

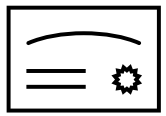
Scope 2: Location Based vs. Market Based Emissions

Electricity from Grid= 20,000 MWh
Onsite Direct Connected Solar = 100 MWH
RECs = 20,000
Location Based Emissions = 0.372846274 e-GRID (RFC Michigan)
Market Based Emissions = Residual mix (RFC Michigan)

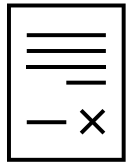
Electricity Consumed (MWh)	Location Based (mtCO2e)	Market Based (mtCO2e)
From Grid	20,000 X 0.3728= 7,456	(20,000-20,000) X Residual Mix factor
Onsite Solar	100 MWH X 0	100 MWH X 0
Total	7,456	0

Market Based Emissions Hierarchy

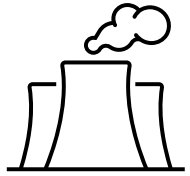
Market based emissions follows a hierarchy of emissions factor



Energy Attribute Certificates



Energy Contracts



Supplier Specific Factors

Residual Mix Factors

Regional Emissions Factor

National Average

Decreasing Precision

Renewable Energy Certificate Quality

- ✓ Organizations can claim renewable electricity only when RECs have been retired on their behalf
- ✓ REC owners of the RECs should have exclusive ownership and claims on the certificates
- ✓ Source renewable energy from within the boundary of the market in which they are consuming electricity
- ✓ RECs certificate should have
  - ✓ Trust worthy generation sources
  - ✓ Verified by third party (Green-e)
  - ✓ Renewable energy benefits claims
  - ✓ Generation should occur relatively close to the year a credit is retired

Electricity Consumption Data

If actual electricity consumption is not known:

Estimated based on Area

$$Electricity\ Use = \frac{Area\ occupied \times Building\ Electricity}{Building\ Area \times Occupancy\ Rate}$$

75% of the building occupied: Occupancy rate= 0.75

Based on expenditure

$$Electricity\ Use = \frac{Facility\ Expenditure(\$) \times 100}{Average\ cent/kWH}$$

Scope 3

Scope 3 Upstream

- Purchased goods and services
- Capital Goods
- Fuel and energy related activities
- Upstream transportation and distribution
- Waste generated in operation
- Business travel
- Employee commuting
- Upstream leased assets

Scope 3 Downstream

- Downstream transportation and distribution
- Processing of sold products
- Use of sold products
- End-of-life treatment of sold products
- Downstream leased assets
- Franchises
- Investments

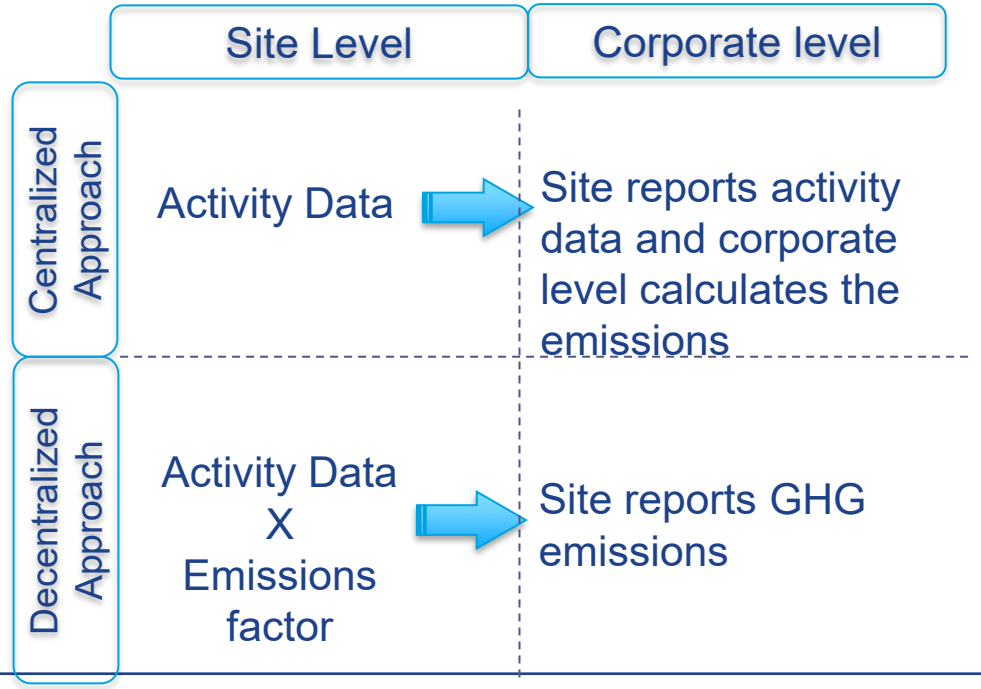
Centralized Approach vs Decentralized Approach

Centralized Approach

Individual facilities report activity/fuel use data (such as quantity of fuel used) to the corporate level, where GHG emissions are calculated.

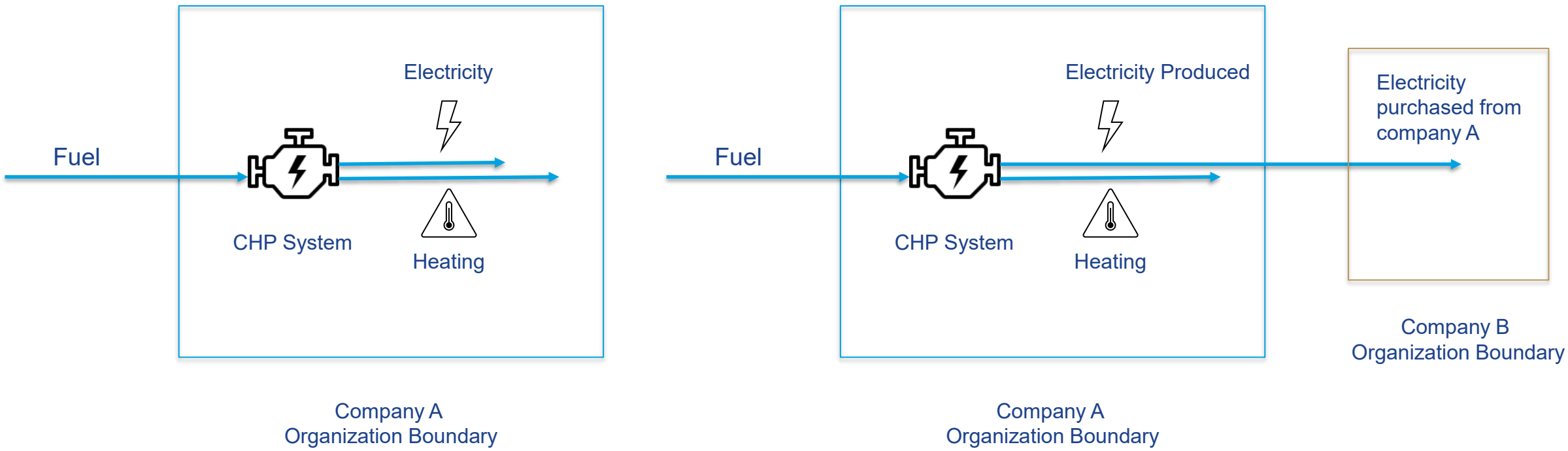
Decentralized Approach

Individual facilities collect activity/fuel use data, directly calculate their GHG emissions using approved methods, and report this data to the corporate level.



Emissions for a CHP system

The fuel used for onsite CHP operation would fall under Scope 1 stationary emissions.



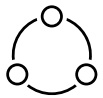
Emission Factor and Vintage

- ✓ Use the most updated emission factors available during that reporting year
- ✓ You do not have to update the emissions reported for previous year if updated emission factors were not available during reporting
- ✓ EPA every year published updated e-GRID emission factors

2020	2021	2022
Emissions factor 2020	Emissions factor 2020	Emissions factor 2022
Correct ✓	Does not require update ?	Correct ✓

Reporting Best Practices

Include all emissions sources in your inventory



Report all scope of emissions

Track and report Scope 2 location and market-based emissions

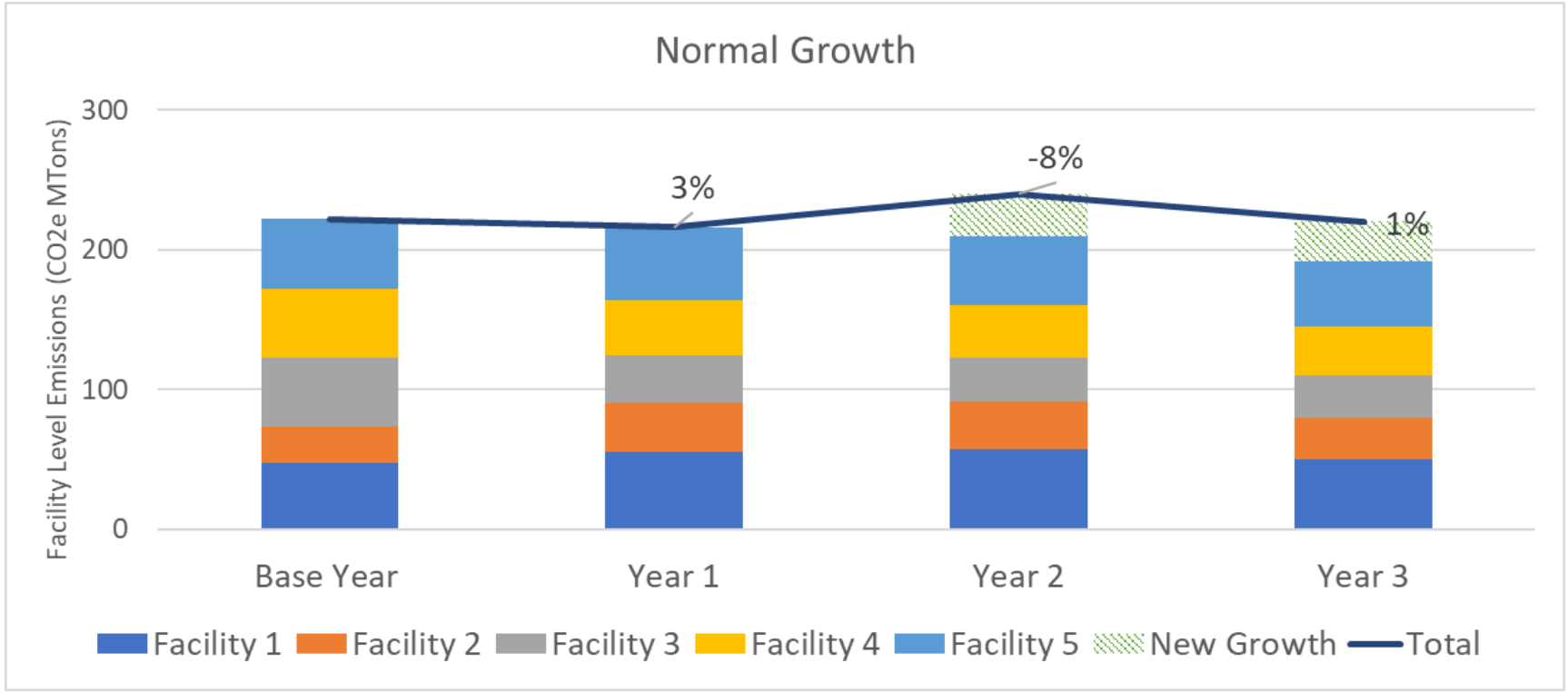
Use correct and most current emissions factor

If you don’t have actual data start with estimation

Avoid double counting for emissions

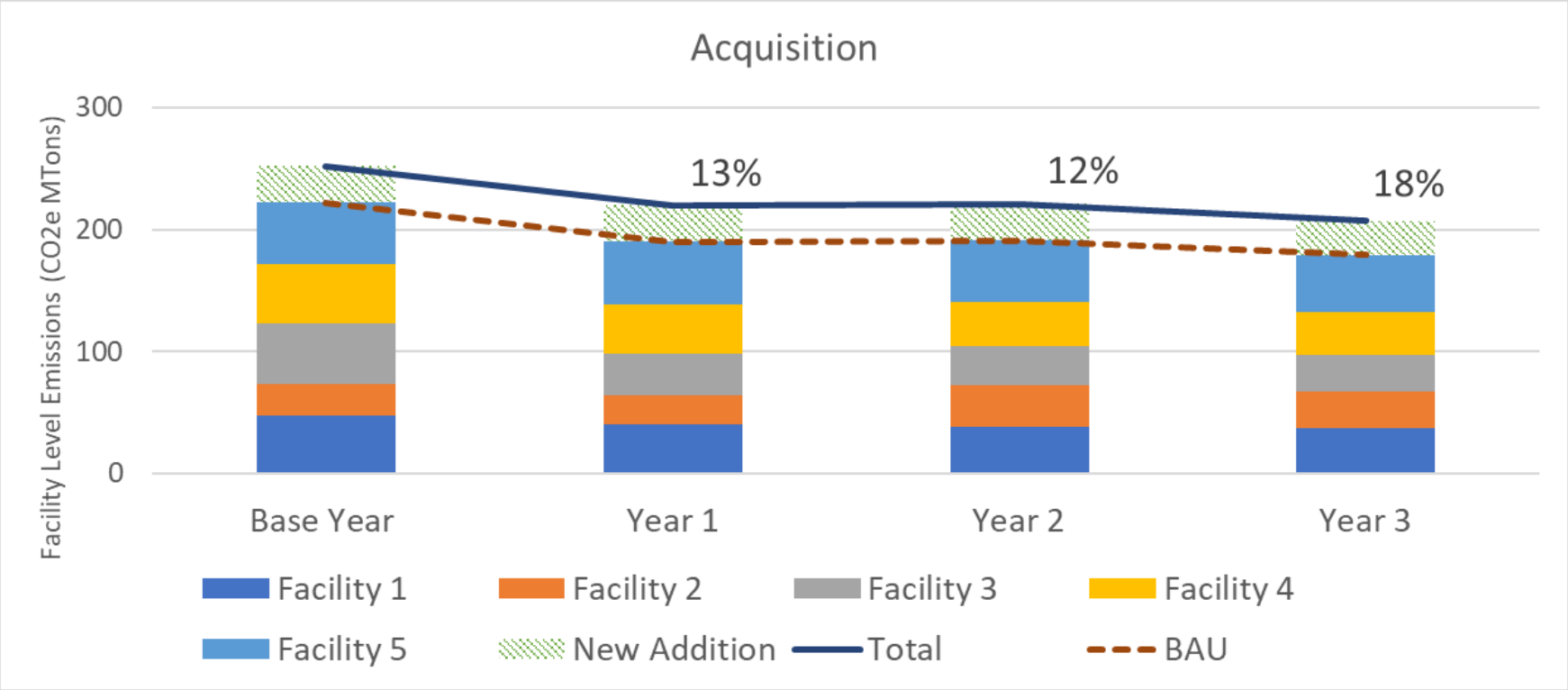
Changes in portfolio

Normal Growth: No changes in GHG inventory when there is business growth



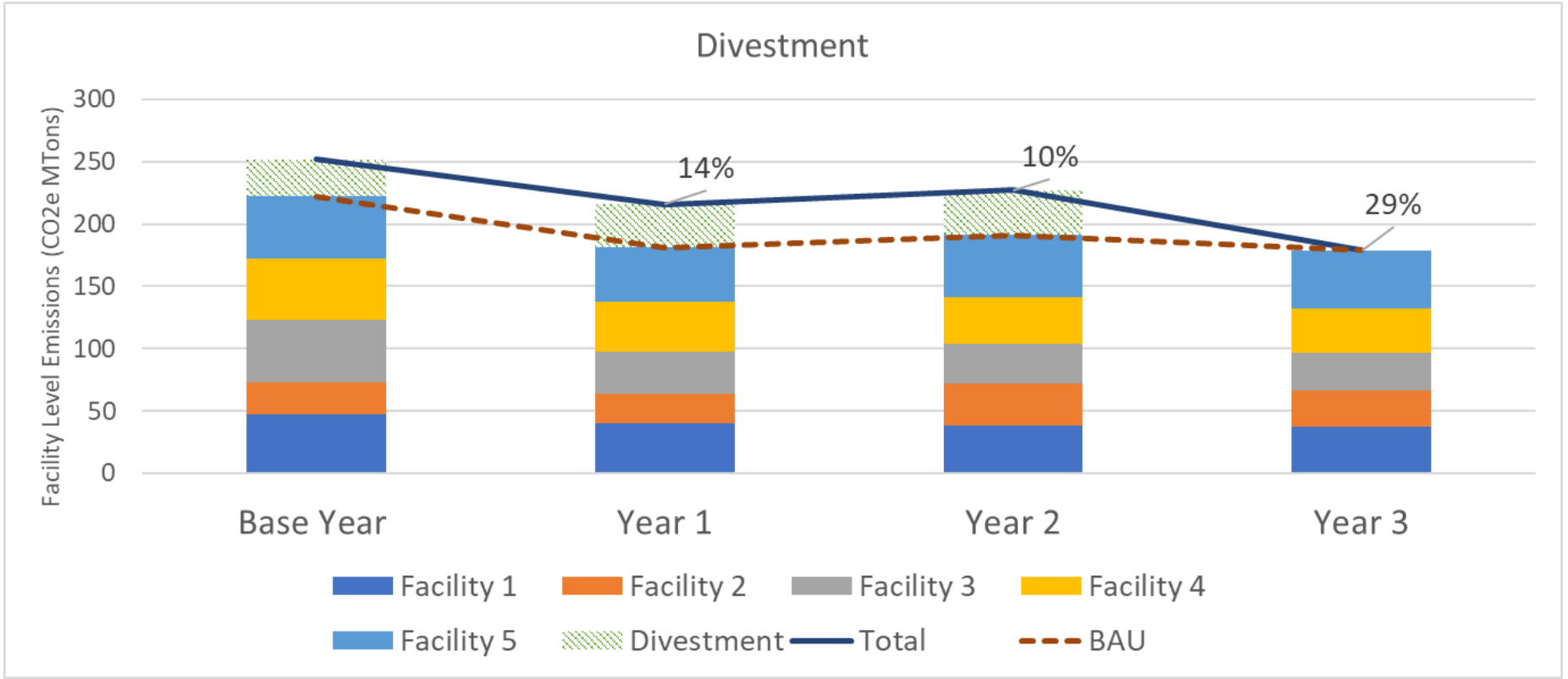
Changes in portfolio

Growth through acquisition: Need changes in GHG inventory

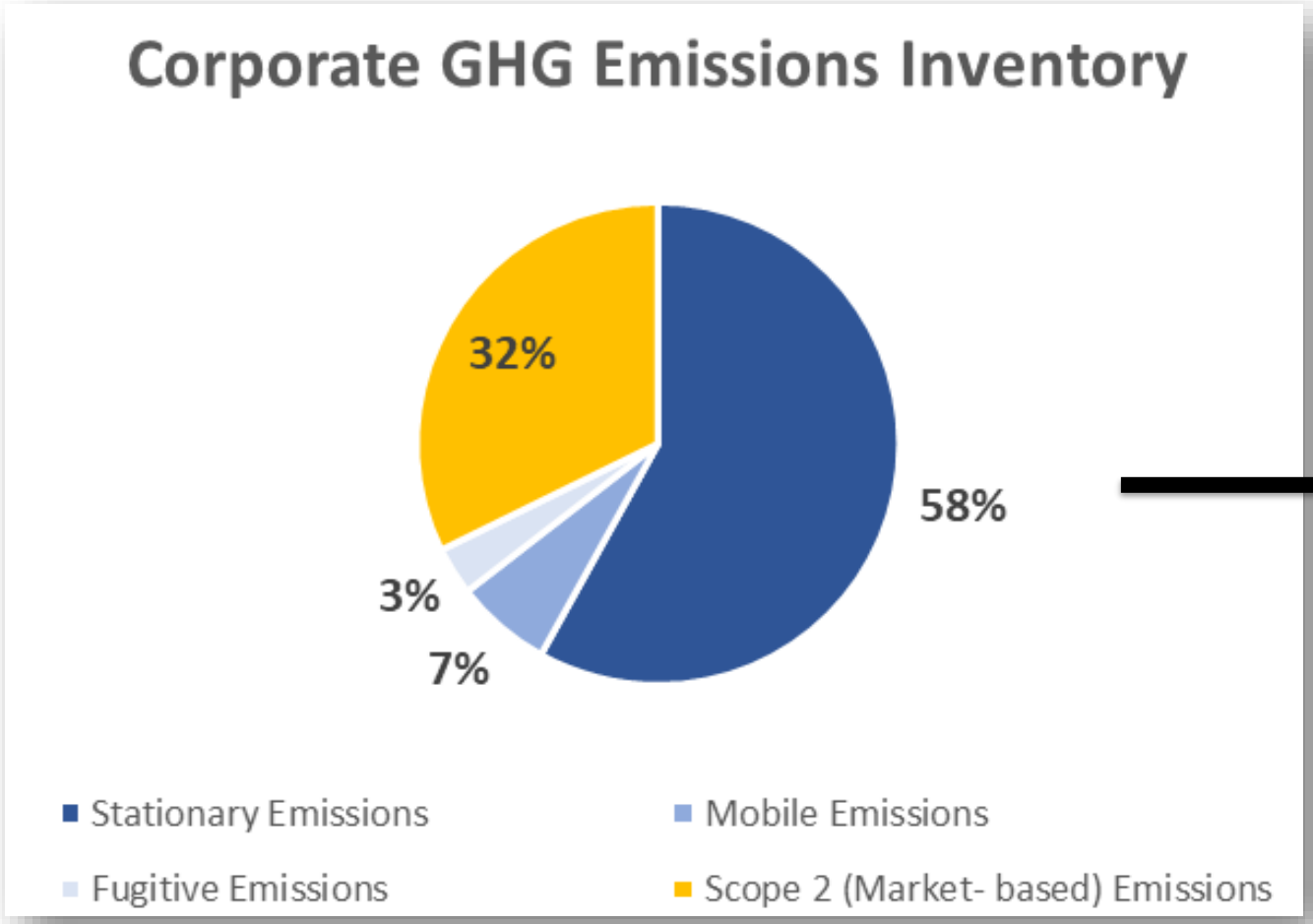


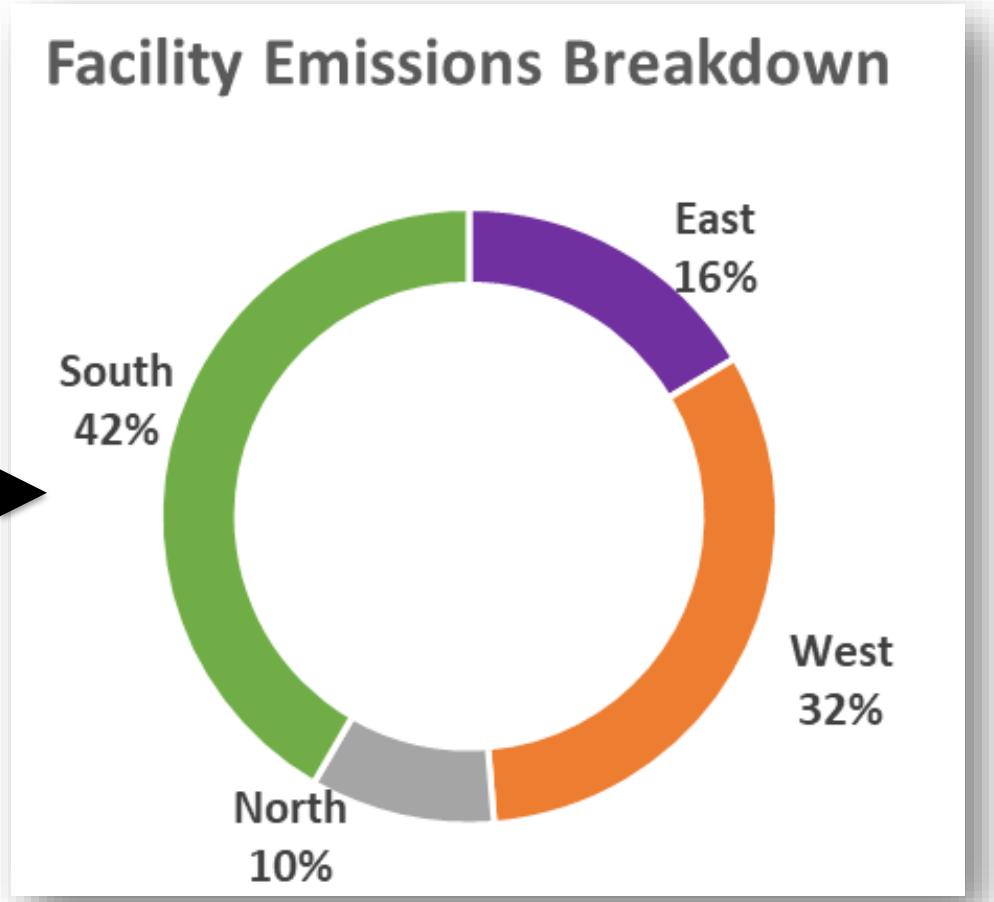
Changes in portfolio

Growth through Divestment: Need changes in GHG inventory

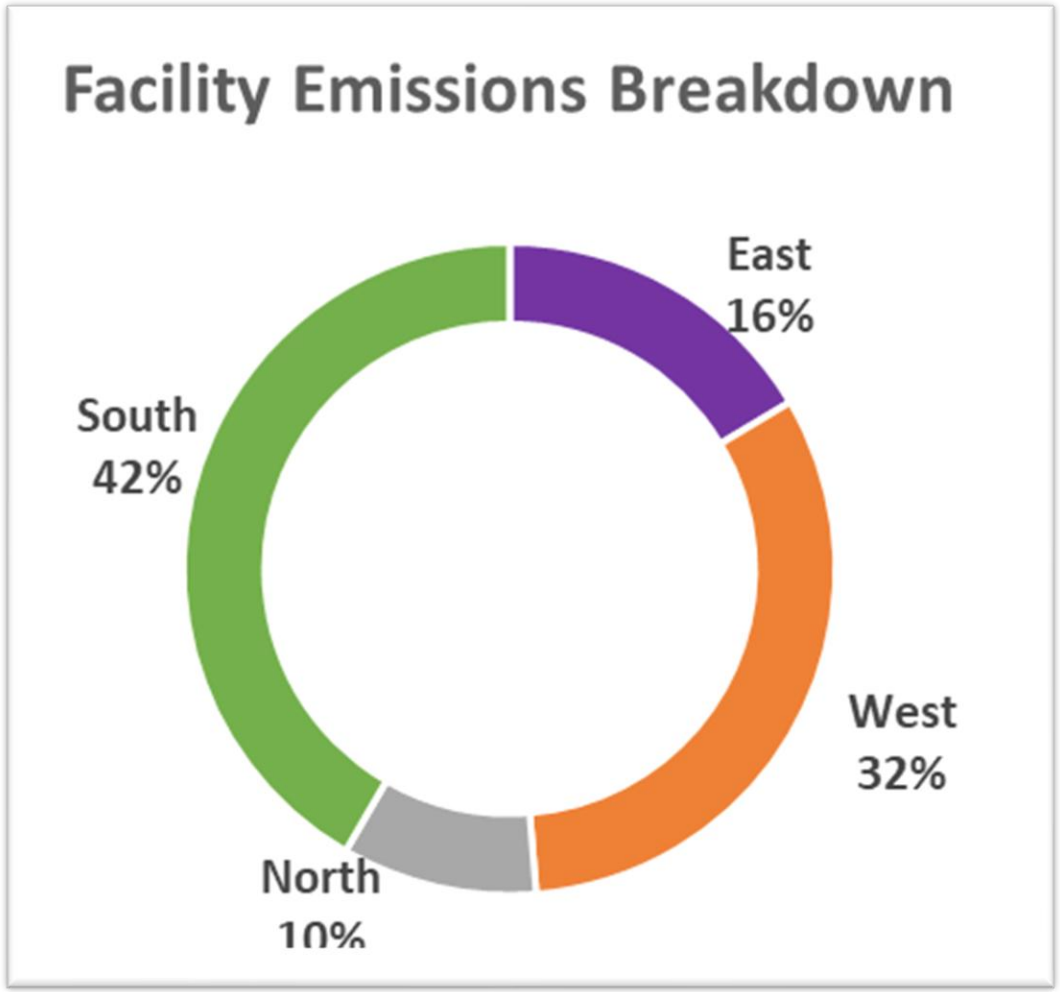


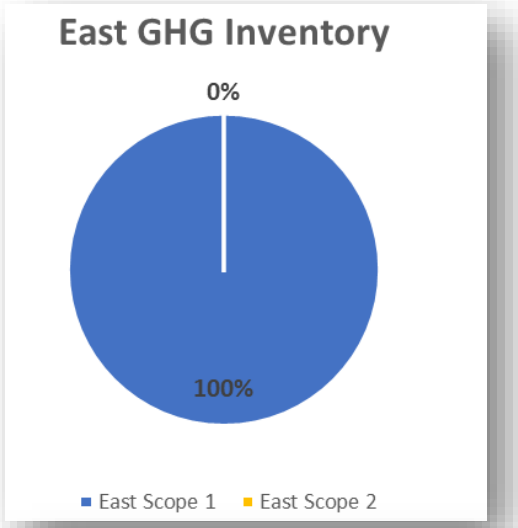
Corporate to Facility Level GHG Emissions Breakdown

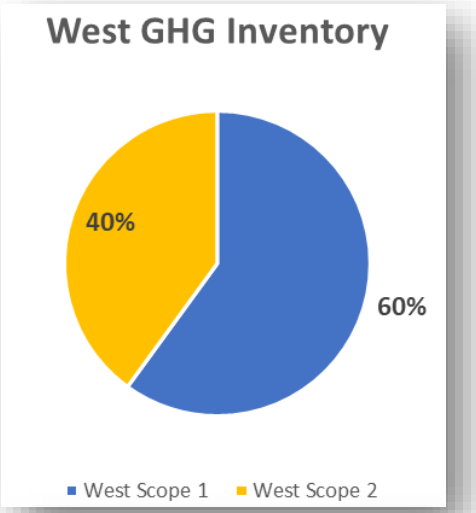


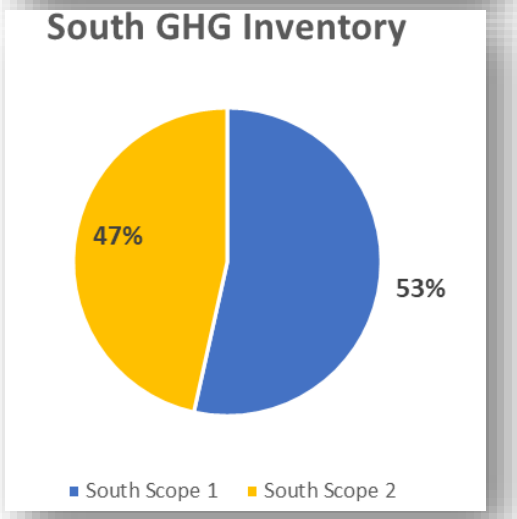


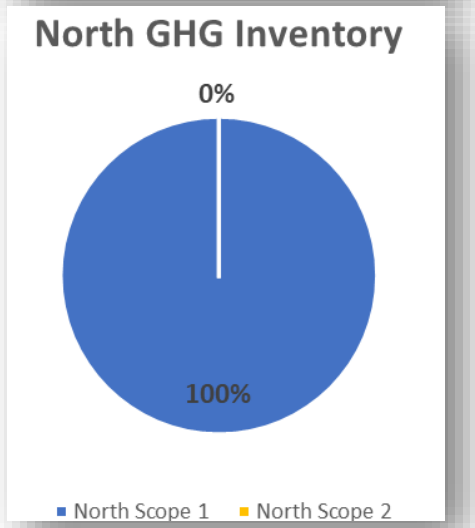
Facility Level GHG Emissions by Scope



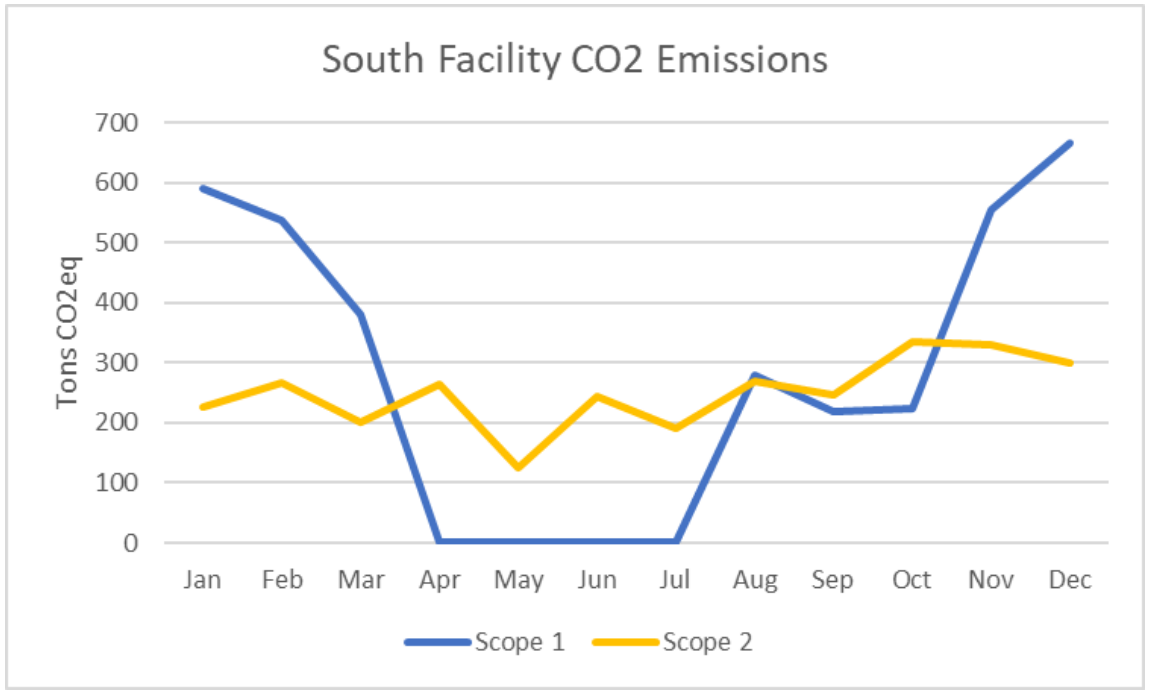


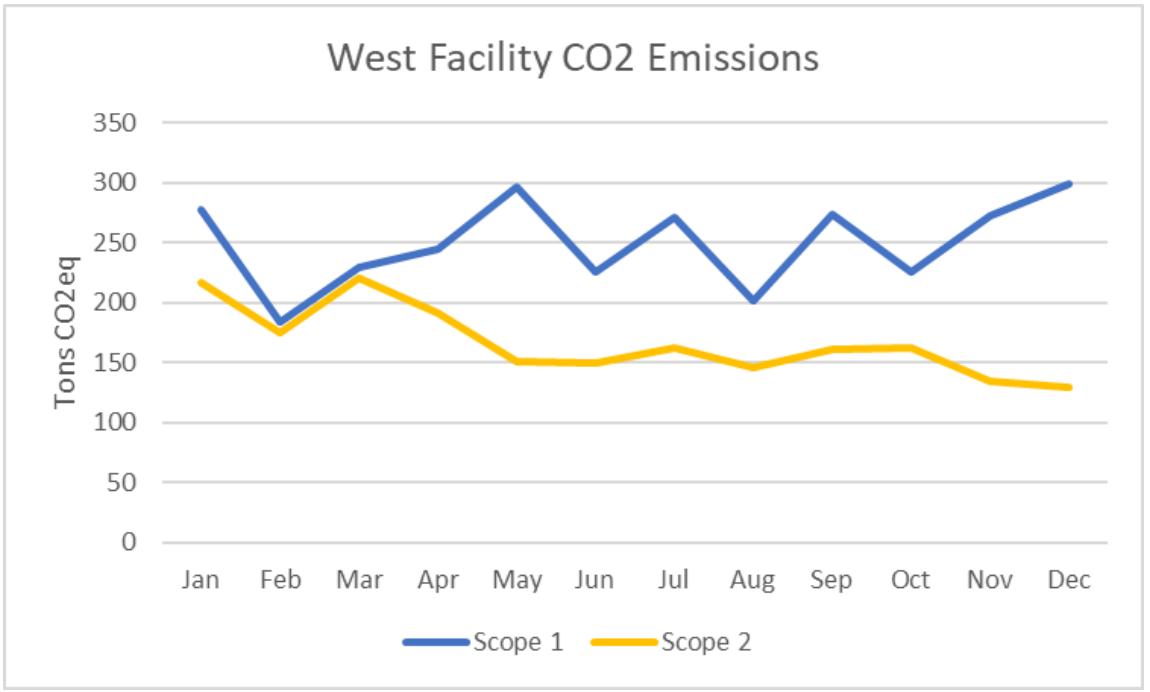






Annual Facility Level Emissions





Seasonal Scope 1 emissions
Fuel use maybe for hot water/steam system, HVAC

Not so seasonal Scope 1 emissions
More process related use

Questions?

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Questions?

Thank you!