Better Plants
U.S. DEPARTMENT OF ENERGY

Resources for Industrial Efficiency and Decarbonization

Thomas Wenning, PE
Oak Ridge National Laboratory
CIBO Energy/Sustainability Meeting
March 9, 2022

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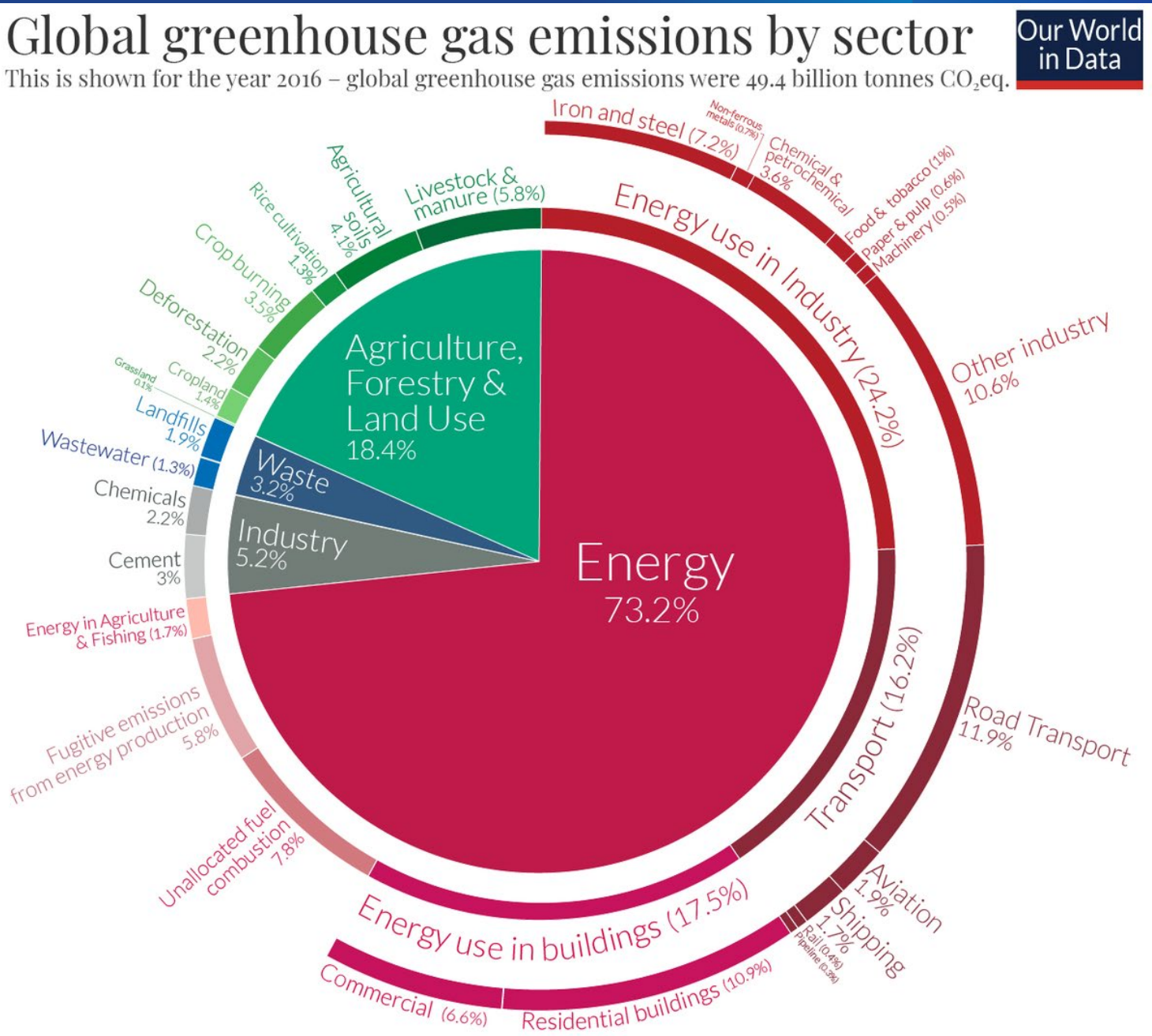
Hot Topics

- Decarbonization
  - Don't forget about EE!
- Corporate Goals
  - Net Zero / Carbon Neutral
  - Science Based Targets (~2.4k)
- Reporting
  - CDP (13k+), TCFD (2.6k), etc
- Roadmapping & Action Plans
  - How are you going to get there?



Better Plants
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DOE's Better Plants Program

Helping manufacturers and other industrial organizations save money and improve their competitiveness

Increased Energy Productivity

Water Savings

Waste Reduction

Decarbonization

How Does Better Plants Work?

Voluntary and Free to Participate

Partners set long-term strategic goals

DOE works with you to achieve your goal

Better Climate Challenge

Portfolio-wide reduction in GHG emissions of *at least* 50% in 10 years

- Reduction includes Scope 1 & 2 emissions
- RECs allowed; No offsets
- Baseline up to 5-years back from join date
- Encouraged to establish an absolute target, but intensity-based targets will be accepted
- Pursue an energy efficiency target that will contribute towards the 50% emissions reduction. This target is intended to encourage prioritizing energy efficiency when pursuing a decarbonization plan.
- Partners in energy-intensive sectors are asked to set a minimum goal of 25%

WIIFM: Better Plants in a Nutshell

Technical Assistance

- **Technical Account Manager:** navigate program and access resources
- **In-Plant Trainings**: expert instructors come to your plant
- **Resources:** Diagnostic & Software Tools, Industrial Assessment Centers, CHP TAPs, Water Savings Tools, Connection to National Labs
- **Supply Chain Engagement:** resources to advance supplier energy efficiency

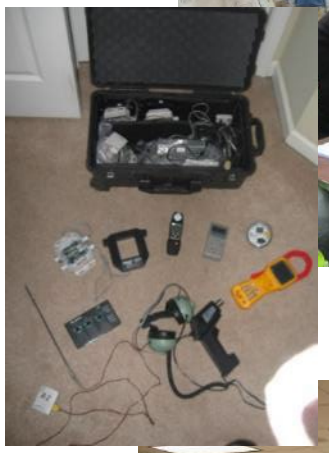
National Recognition

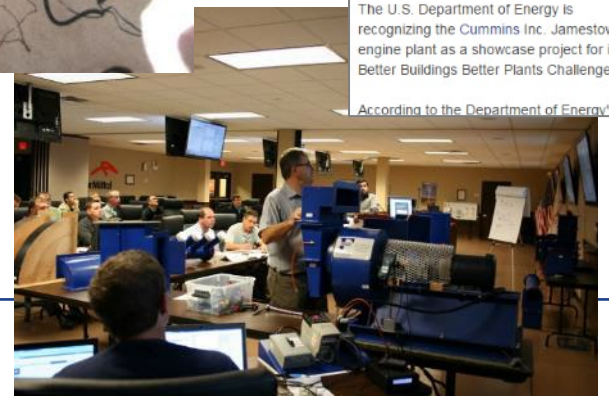
- **Awards** for Goal Achievers
- **Better Project/Better Practice Awards**

Peer-to-Peer Networking Opportunities

- BBBP Summit (May), Peer Exchange Calls, Working Groups

Access to DOE and National Lab R&D





Decarbonization

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Scope of Emissions

Scope 1 (Direct Emissions)

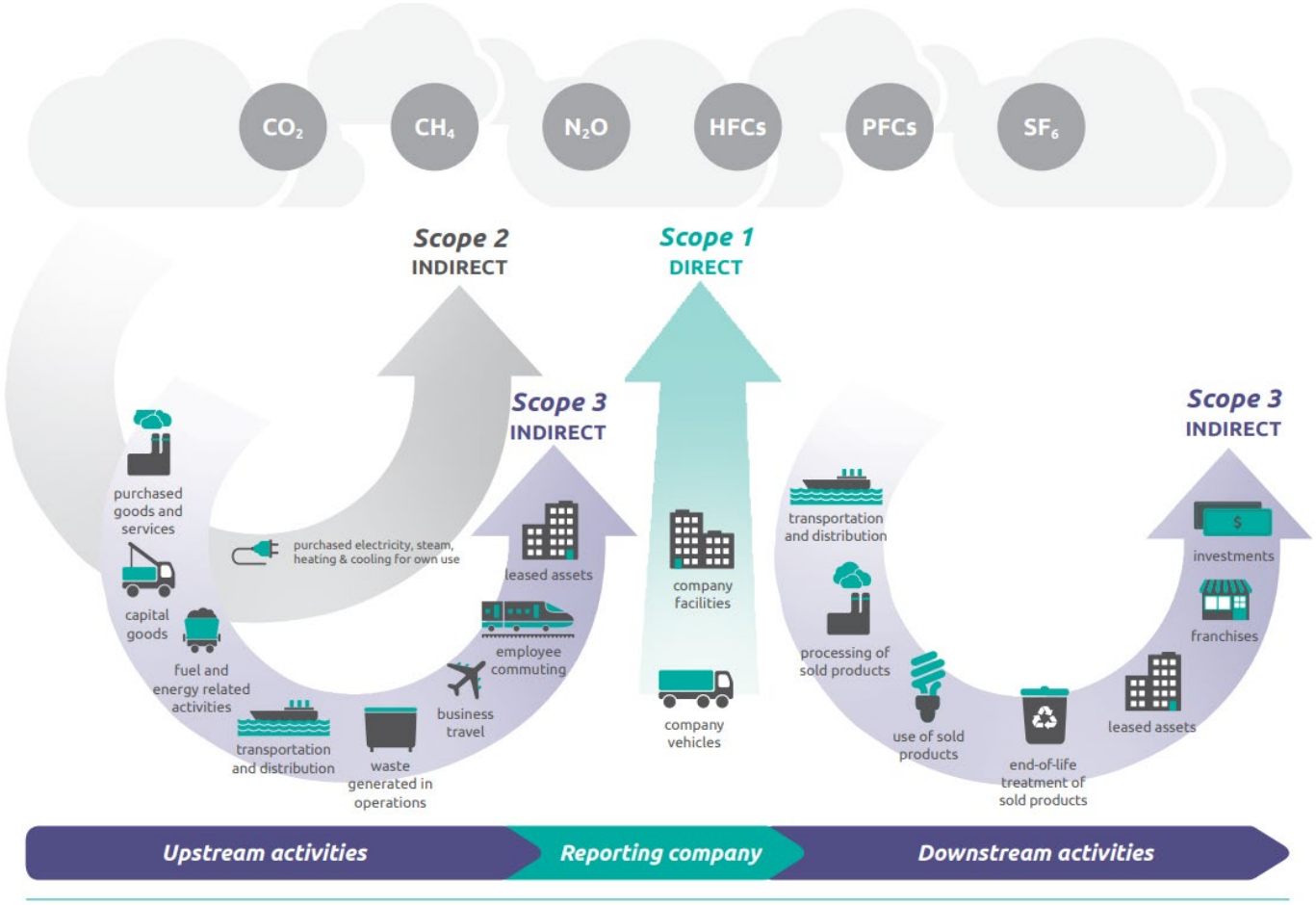
- Stationary Emissions
- Mobile Emissions
- Fugitive Emissions

Scope 2 (Indirect Emissions)

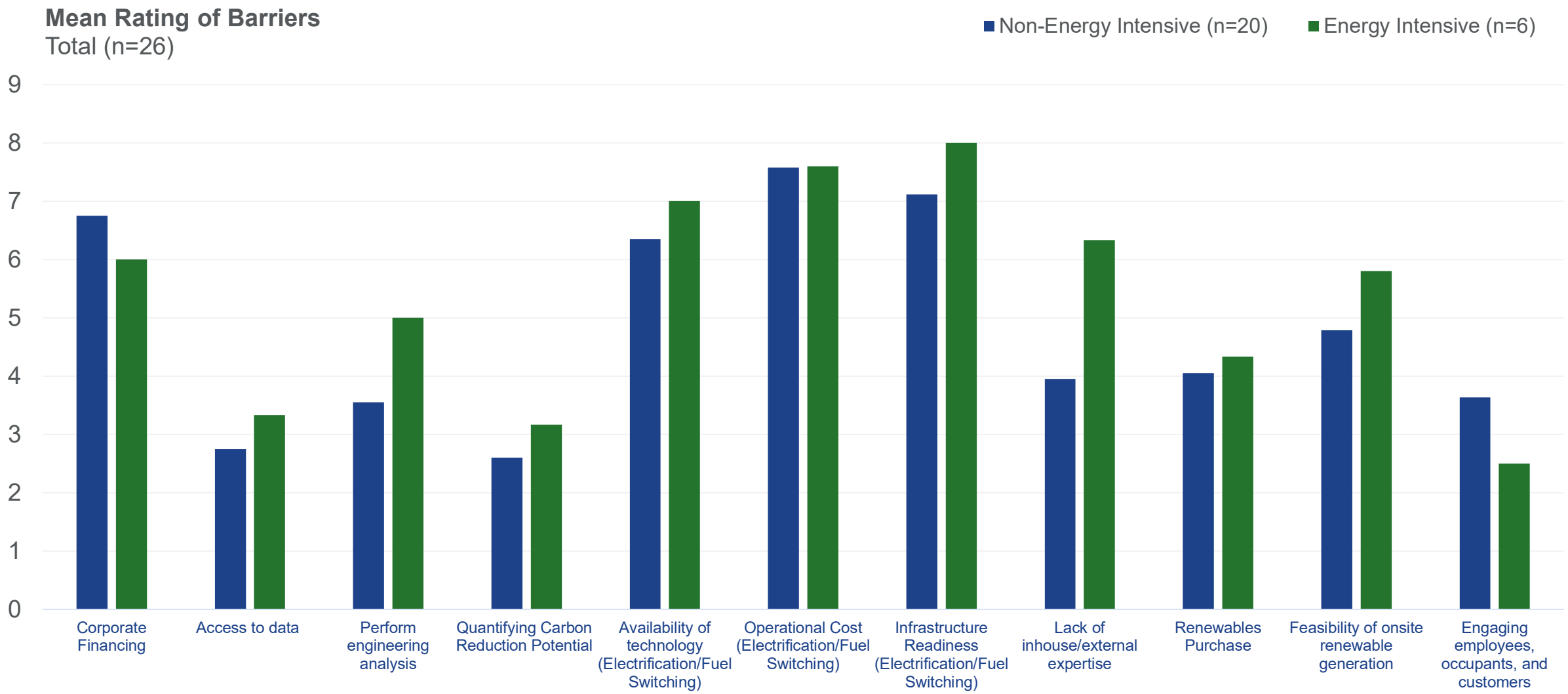
- Purchased Electricity
  - Location Based Approach using eGrid emissions
  - Market based approach using provider's emissions factor
- Other Purchased Commodity

Scope 3

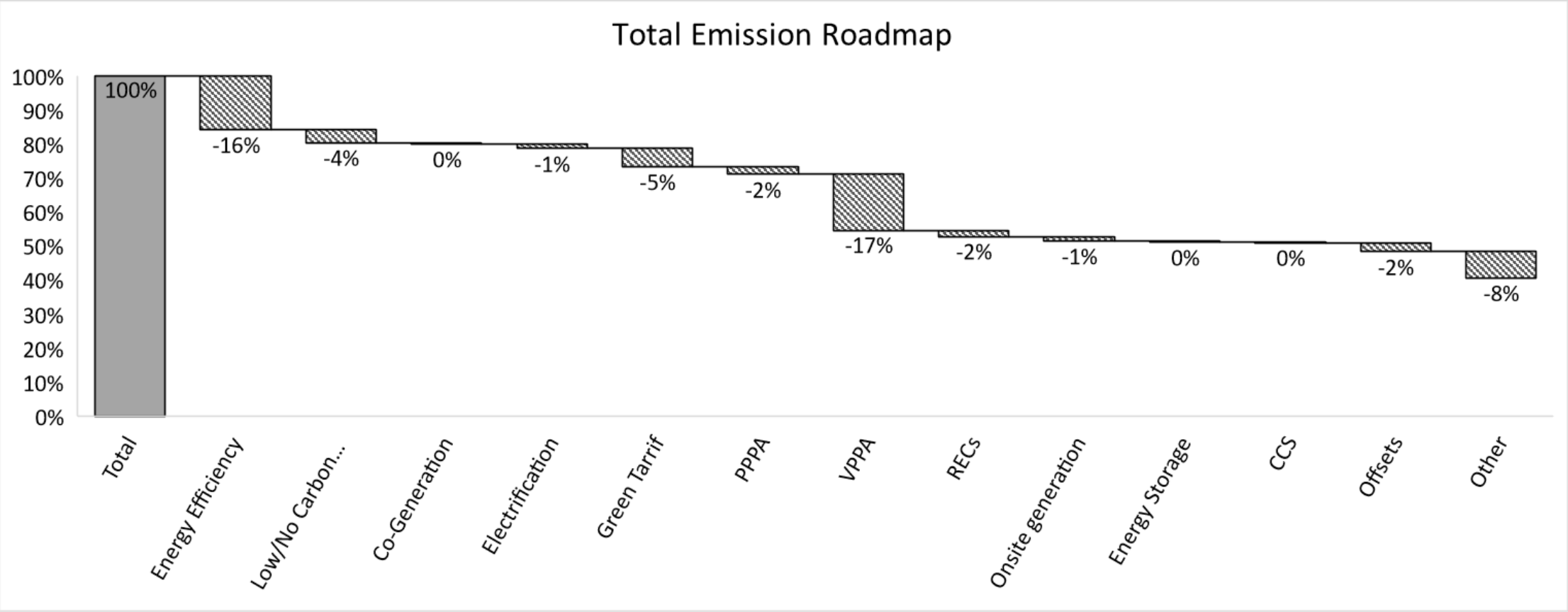
- Supply Chain
- Transportation and Distribution
- During Life and After Life Product Emissio
- Company Commute



Barriers to Decarbonization – Lesson from the Low Carbon Pilot

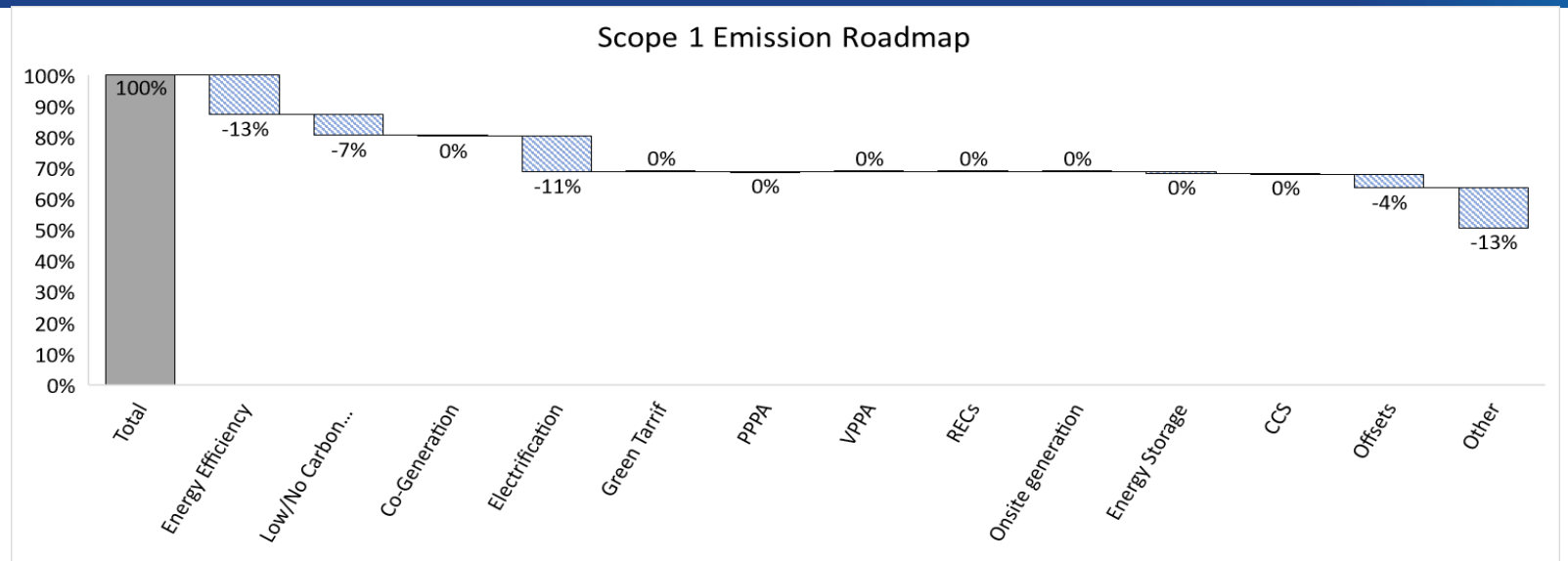


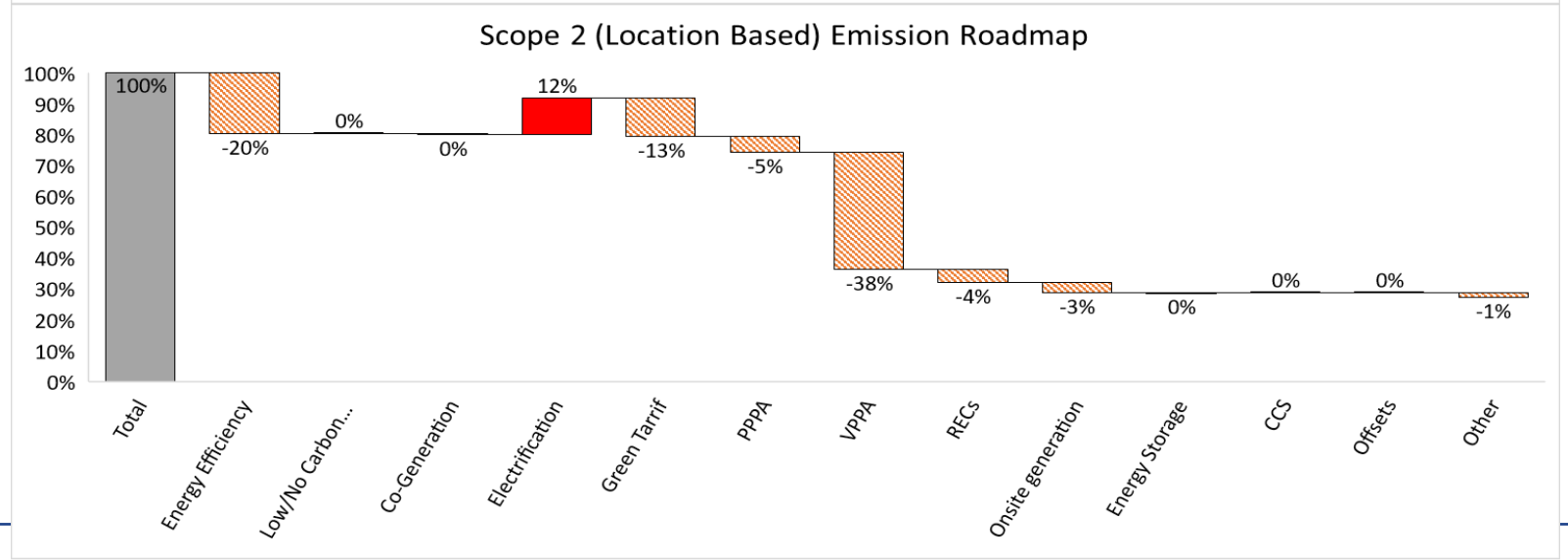
Total Emissions Reduction Roadmap



This roadmap shows the pathways Partners are planning on undertaking for their 2030 or 2050 goal for their total GHG reduction

Emissions Reduction Roadmap by Scope





This roadmap shows the pathways Partners are planning on undertaking for their 2030 or 2050 goal for their GHG reduction

Manufacturing's Pathway to Carbon Neutrality

Implementation Steps:

1) Aggressively Pursue Energy Intensity Reductions
   a) Energy efficiency is a foundational activity that is continual and ongoing
2) Renewable Energy Procurement
   a) Procure 100% electricity from renewables – largely accomplished through corporate vPPAs
   b) Procure Renewable Natural Gas – small opportunity and highly regionally dependent
3) Implement Widespread Electrification
   a) Replace fossil fuel processes and equipment with electric driven equipment
4) Transformation Process Upgrades
   a) Largely unknown and untested for most industries
   b) Example: Advanced Direct Reduced Iron using Hydrogen in steel making
5) Implement Onsite Carbon Capture Technologies
6) Purchase Carbon Offsets to offset remaining fossil fuel consumption
   a) Includes reforestation, supporting clean cooking, etc

Side note – Once a company has achieved Carbon Neutrality, they will ultimately **return to setting additional energy efficiency** goals to continue lowering energy consumption

Hot Topics to Keep your Eyes On

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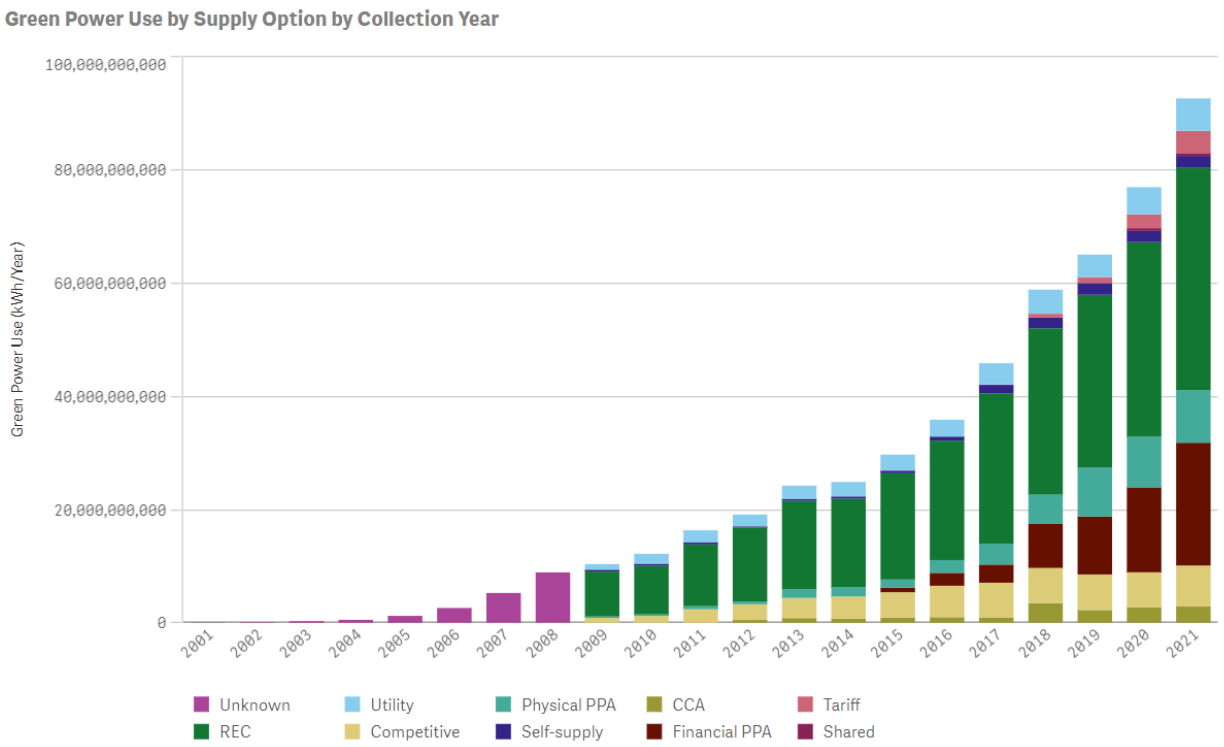
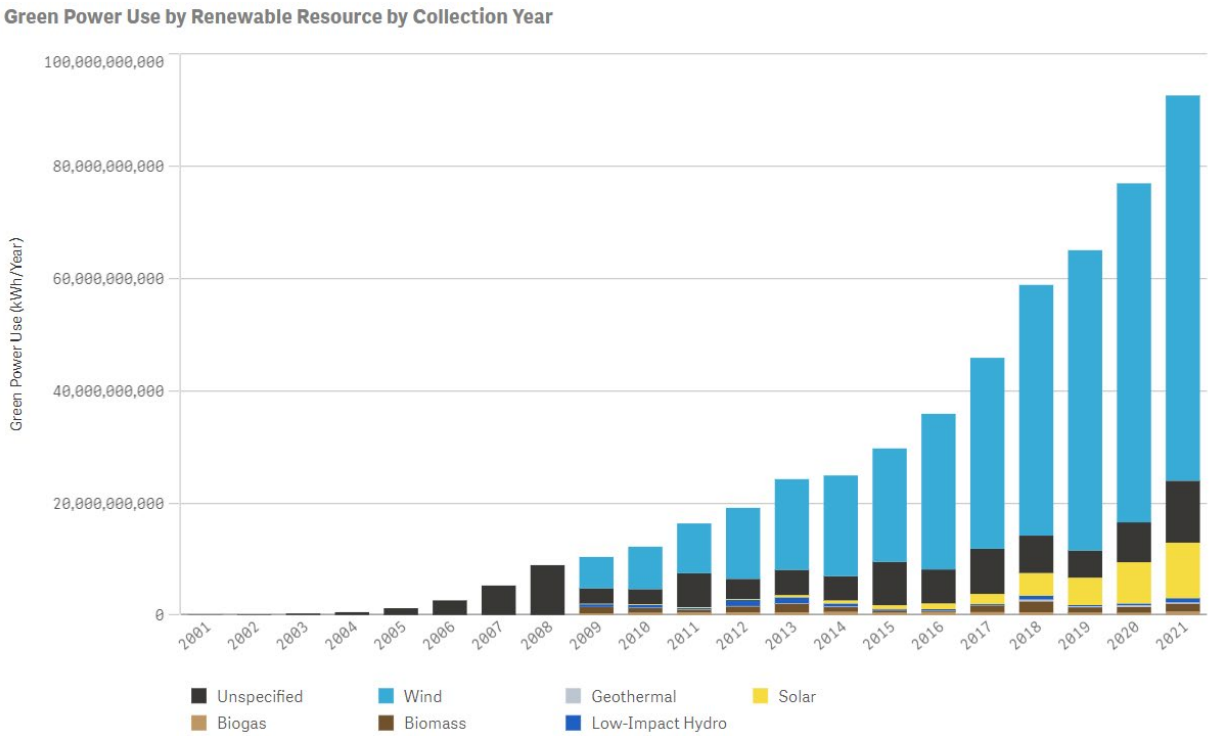
Green Power Procurement Trend





There is 20% more renewable energy procurement in 2021 from 2020
62% more renewable energy procurement through green tariff in 2021 from 2020

Image source: EPA Green Power Partnership

Low Carbon Heat: Applications & Sources

Not that many options for high-quality, large volume heat

Hydrogen

- Green: electrolysis of water from zero-C power
- Blue: From natural gas, with CCS (90%)
- Gray: From natural gas, but not low-C

Electricity

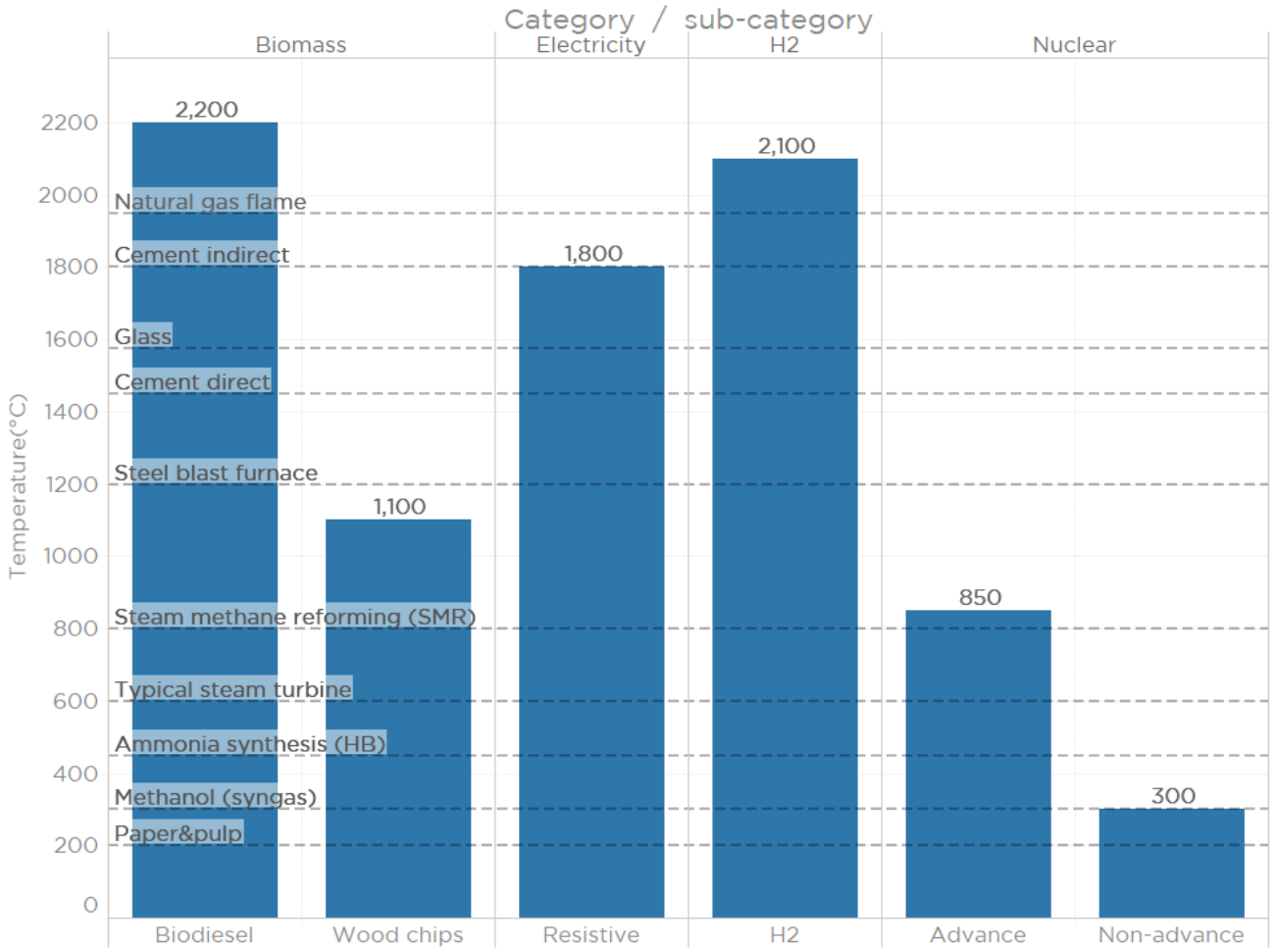
- Must be zero-C supply & 90% capacity
- Radiant & resistive heating most mature

Biomass

- Must be low-C on a life-cycle basis
- Wood chips & biofuels most mature
- Biogas supplies are problematic

Nuclear

- Heat generated by neutrons from decay
- Current processes generate steam
- Adv. Processes could do more



Source: Julio Friedmann, Low Carbon Pilot Peer Exchange Call, Webinar, December 15, 2021.

Renewable Natural Gas Facilities in US

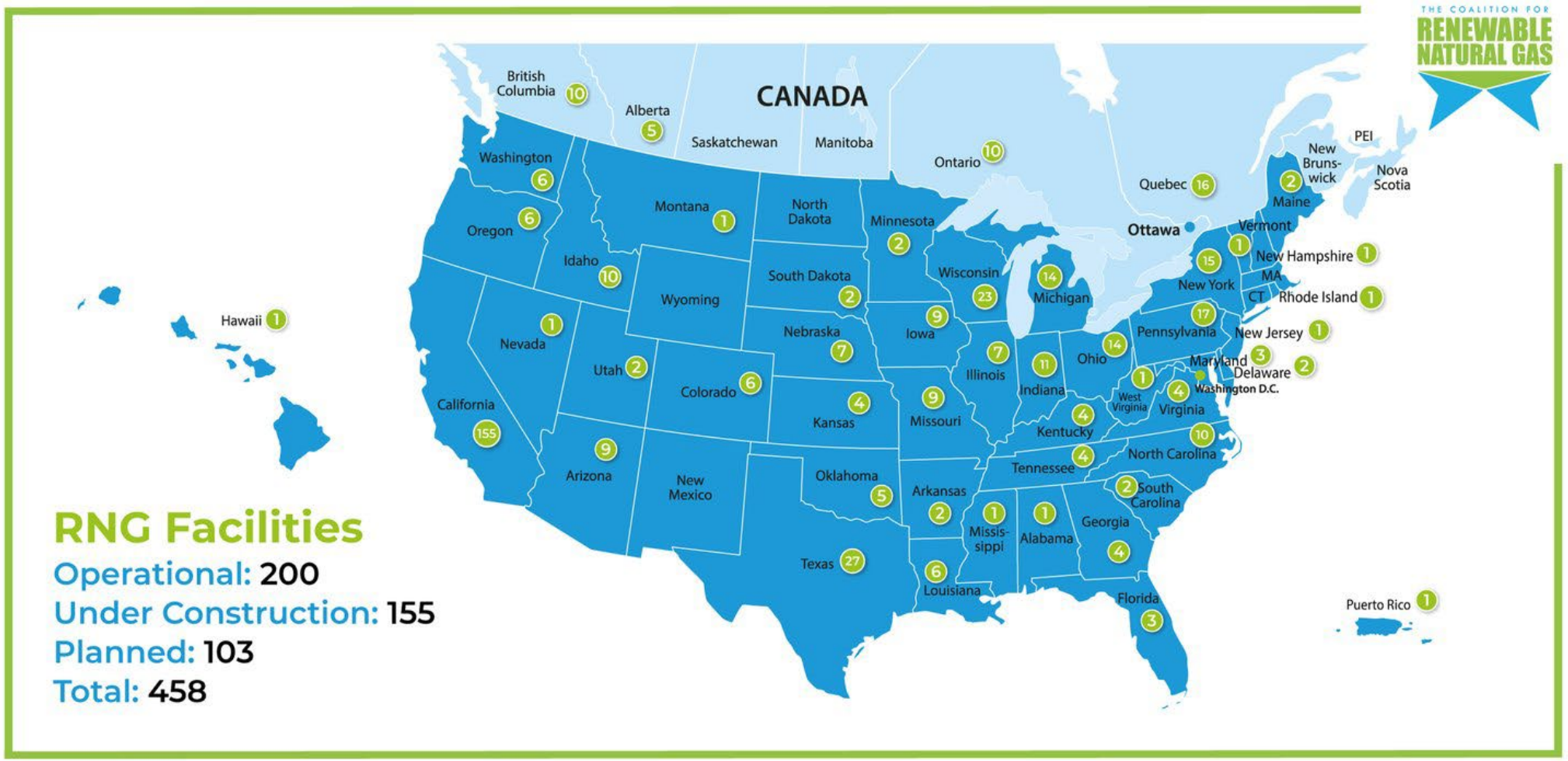
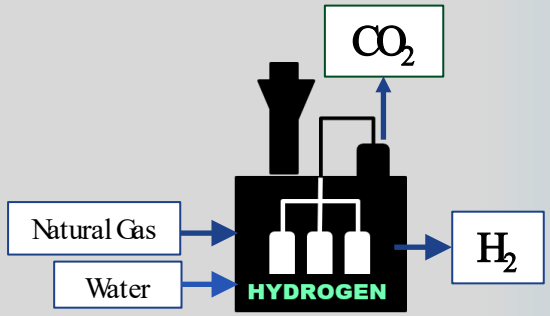


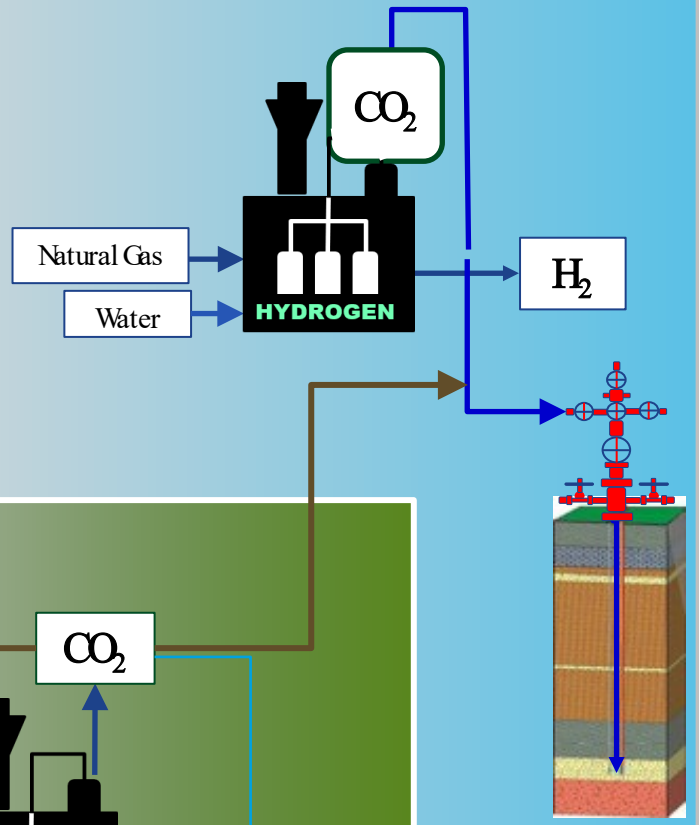
Image Source: The Coalition for Renewable Natural Gas

How hydrogen is made

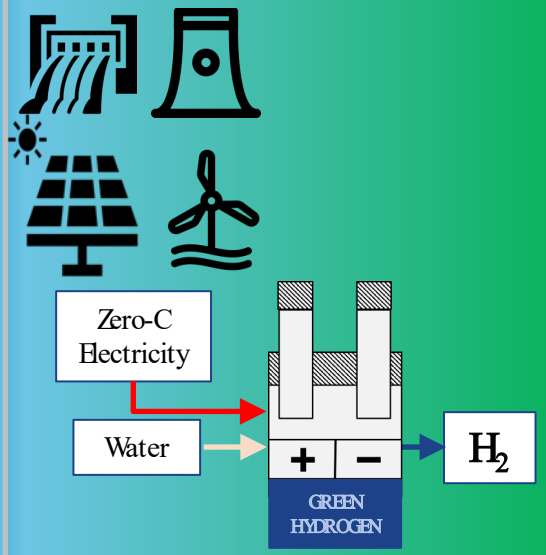
GRAY



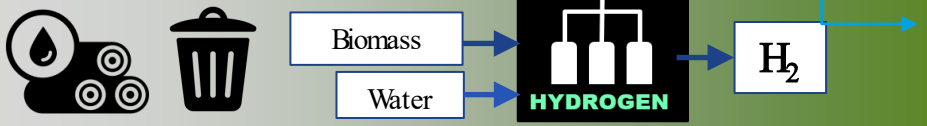
BLUE



GREEN



BIO



Source: Julio Friedmann, Low Carbon Pilot Peer Exchange Call, Webinar, December 15, 2021.

Electrification Potential for Manufacturing Process

Operating Temperature	Example Process	Technology Status
Low Temperature Heat (<100ºC)	Washing, Rinsing, Food Preparation	Available today
Medium Temperature Heat (100-400ºC)	Drying, evaporation, distillation	Available today
High Temperature Heat (400-1000ºC)	Steam reforming and cracking in petroleum industry	Available today
Very High Temperature Heat (>1000ºC)	Melting in glass furnace, calcination of limestone for cement production	Research or Pilot Phase

Process Heat Electrification in Manufacturing Industry

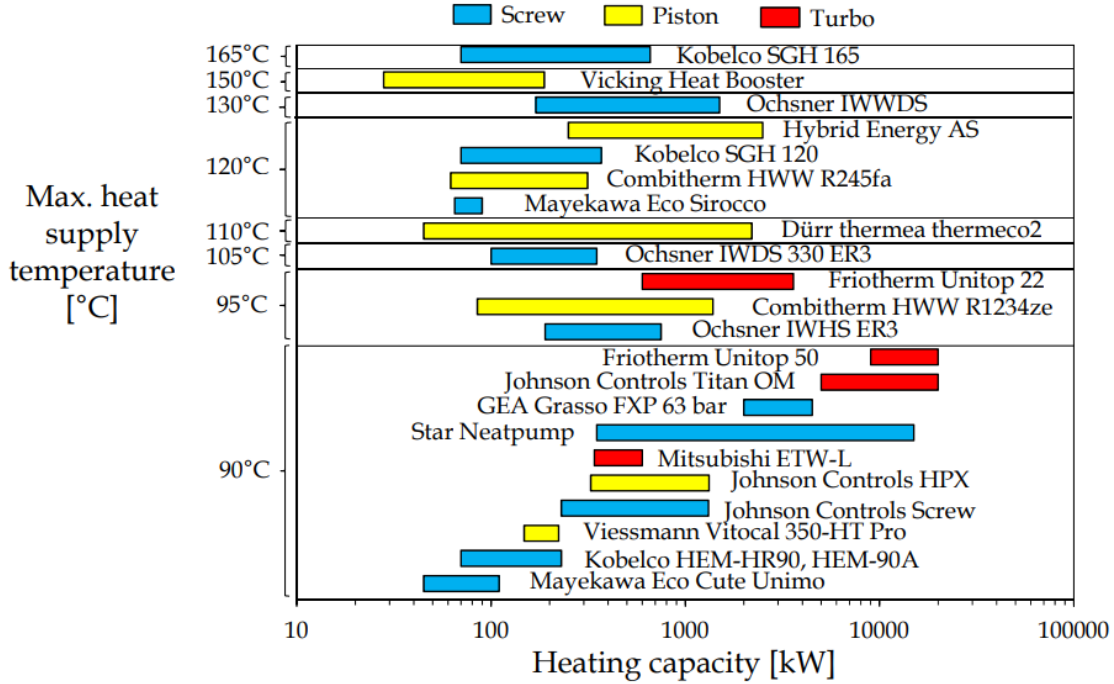
- Preliminary matching of commonly used fuel-fired PH applications with currently available ETs that might replace or supplement them.

No.	Thermal process	RH	IH	EAH	EIP	MWH	RFH	EBP	UVP	PH	LH
1	Fluid heating	■	■		■	■					
2	Steam generation	■									
3	Metal heating	■	■		■						
4	Metal melting		■	■						■	
5	Metal heat treating	■	■		■						
6	Smelting, agglomeration etc.	■									
7	Nonmetal heating, heat treating					■	■	■	■		
8	Nonmetal melting	■	■							■	
9	Calcining	■				■	■				
10	Drying	■			■			■	■		■
11	Curing and thermal forming	■	■		■		■		■		
12	Thermal reactors	■	■		■	■			■		
13	Other heating	■	■		■	■	■	■	■		■

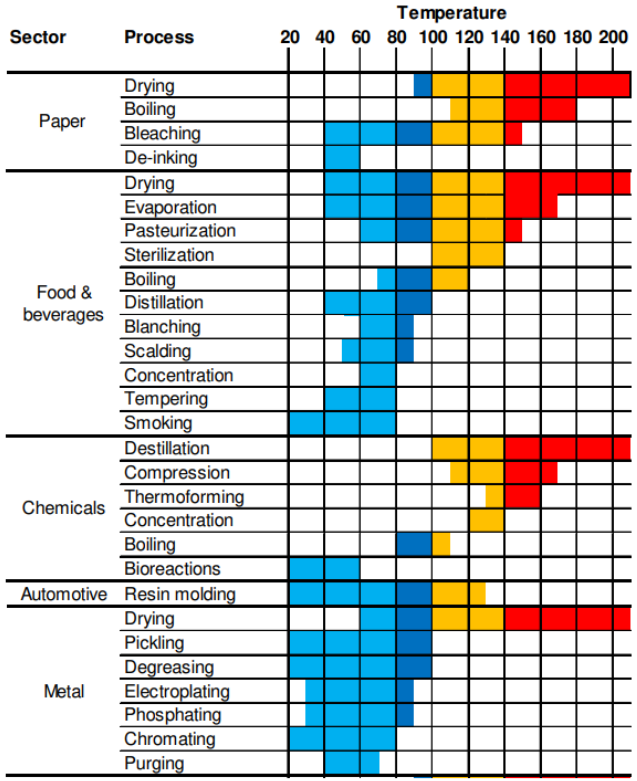
RH: resistance heating; IH: induction heating and melting; EAH: electric arc heating; EIP: electric infrared processing; MWH: microwave heating; RFH: radiofrequency heating; EBP: electron beam processing; UVP: ultraviolet processing; PH: plasma heating; LH: laser heating

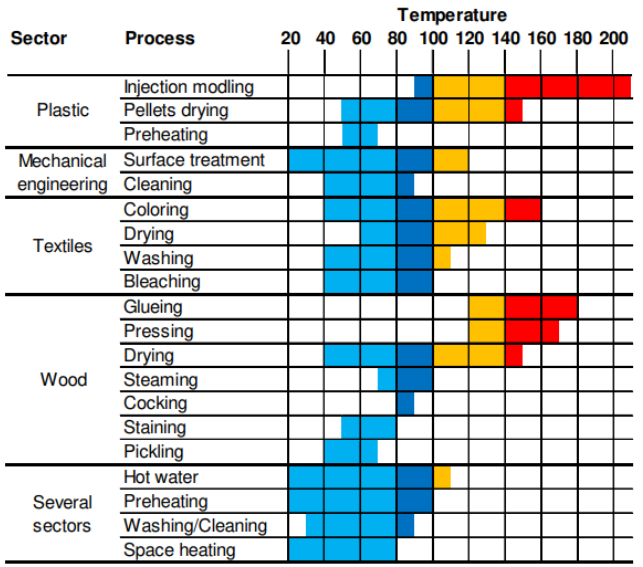
High Temperature Heat Pumps

> 20 industrial HTHPs with heat supply temperature above 90 °C exits



(Arpagaus et al., 2017, 2018)





Technology Readiness Level (TRL):

- conventional HP < 80°C, established in industry
- commercial available HP 80 - 100°C, key technology
- prototype status, technology development, HTHP 100 - 140°C
- laboratory research, functional models, proof of concept, VHTHP > 140°C

Data sources: Brunner et al. (2007), Hartl et al. (2015), IEA (2014), Kalogirou (2003), Lambauer et al. (2012), Lauterbach et al. (2012), Noack (2016), Ochsner (2015), Rieberer et al. (2015), Watanabe (2013), Weiss (2007, 2005), Wolf et al. (2014)

Source: High temperature heat pumps: Market overview, state of the art, research status, refrigerants, and application potentials

DOE Resources

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Technical Assistance: Technical Account Manager

- Helps Partners develop a roadmap to achieve their goals
- Helps Partners set energy baselines, track data, and identify energy savings opportunities
- Inform about DOE and external resources

"Like having a free consultant on retainer"
--Andy Terrey, City of Phoenix Water Services

In-Plant Trainings (In-person and Virtual)

Purpose: *Learn how to conduct assessments, use DOE tools, and implement projects*

Existing Training Topics

- Compressed Air
- Pumping
- Steam
- Process heating
- Fans
- Energy Treasure Hunt Exchanges
- EE in Water/Wastewater Treatment
- Industrial Refrigeration
- 50001 Ready
- Water Efficiency

- ❑ Open to employees from host plant, peer companies, suppliers
- ❑ ~140 INPLTs, 2600 participants since 2011
- ❑ Identified $50+ million in energy savings between 2011 and 2020
- ❑ Virtual-INPLT webinars available on program website

Everything is currently Virtual!

Treasure Hunt Toolkit

PHASE 1 — Preparation
- Agenda - Template
- Pre-event Data Collection Form
- Plant Energy Profiler (PEPEx) Tool

PHASE 2 — Event
- Kick off Presentation
- Handouts
- Energy Efficiency Calculators
- Opportunity Sheet and Summary Report Generator

PHASE 3 — Follow-up
- Event Certificate - Template
- Evaluation Form - Template
- Project Implementation Tracker

Key Aspects:

- Empower and enable plant personnel
- Focus on low-cost/no-cost opportunities
- Observing the idle facility
- Facility employees conduct and have ownership of the ideas / opportunities

Field Validation & Diagnostic Equipment Program

USA Only

Helping Better Plants Partners measure operating data to evaluate equipment performance and quantify energy performance improvement






Field data is best for evaluating system performance

- Free of charge, including shipping
- Use equipment for one day, or up to four weeks
- Technical assistance to help w/ selection, tool use
- First come, first serve application

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https://betterbuildingssolutioncenter.energy.gov/better-plants/diagnostic-tools

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Technical Assistance Complementary Programs

50001 Ready
U.S. DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY
CHP Technical Assistance Partnerships

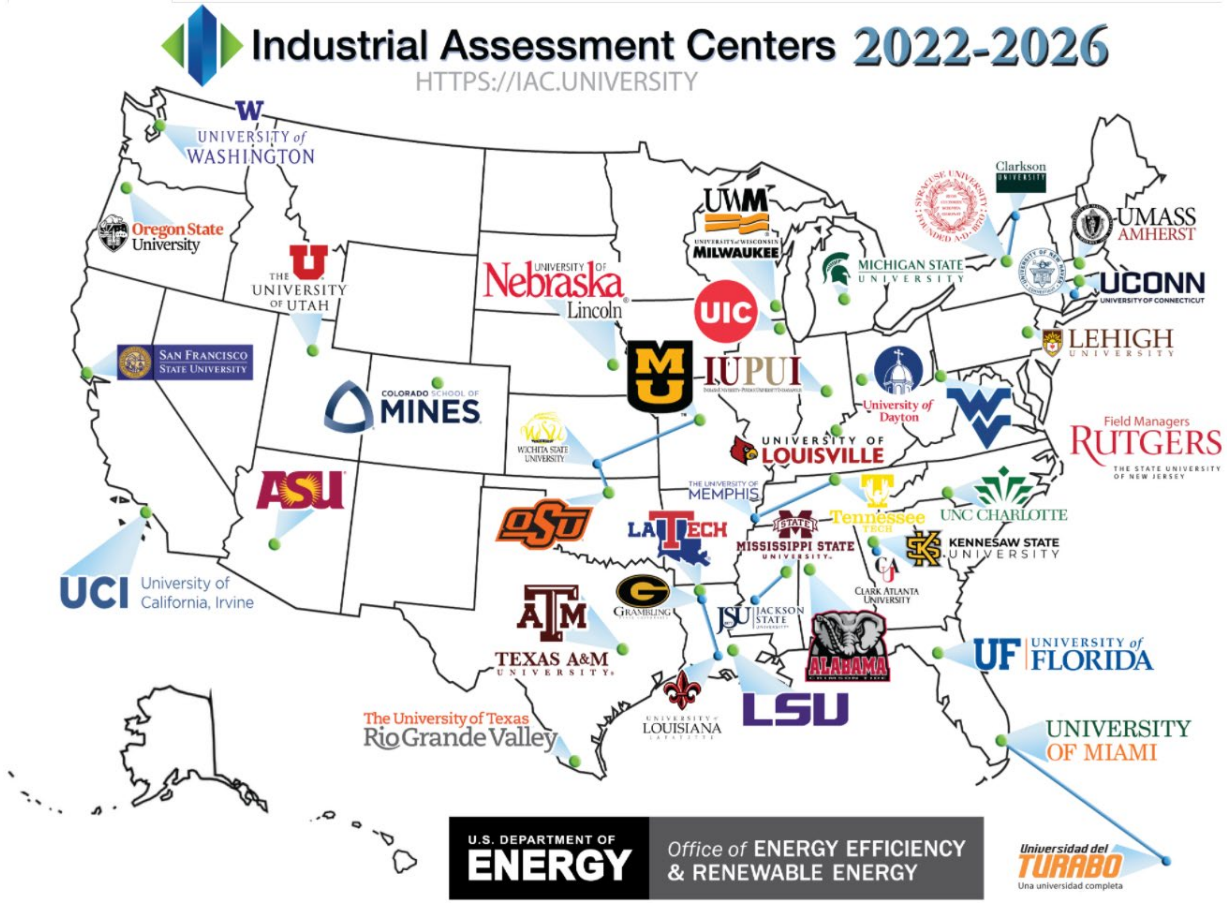
Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

Industrial Assessment Centers

Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

USA Only

- **Free Energy Assessments** for Small and Medium Manufacturing Plants
- Full Assessment and 1 year follow-up
- **Public database** contains over 17,600 assessments with 134,000+ recommendations
- Average IAC Client saves $47,000
- Average assessment leads to **5-7% implemented** savings



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https://iac.university/

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Energy Management & Recognition!

50001 Ready
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STEP 1: Start Implementation of ISO 50001 principles

Use the 50001 Ready Navigator Online Tool

- ✓ The Navigator walks you through the process of implementing an energy management system and prepares you to be 50001 Ready.

STEP 2: Analysis of energy and emissions reductions

Adopt Valid Tool to Present Energy Performance

- ✓ DOE offers the EnPI Lite tool for 50001 Ready.
- ✓ EPA's Portfolio Manager can also be used
- ✓ Other tools can be approved by DOE

STEP 3: Request 50001 Ready recognition

Submit information to DOE for Review

- ✓ Self-attestation of completion of Navigator, executed by team leader and executive
- ✓ Submit energy performance data

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https://www.energy.gov/eere/amo/50001-ready-program

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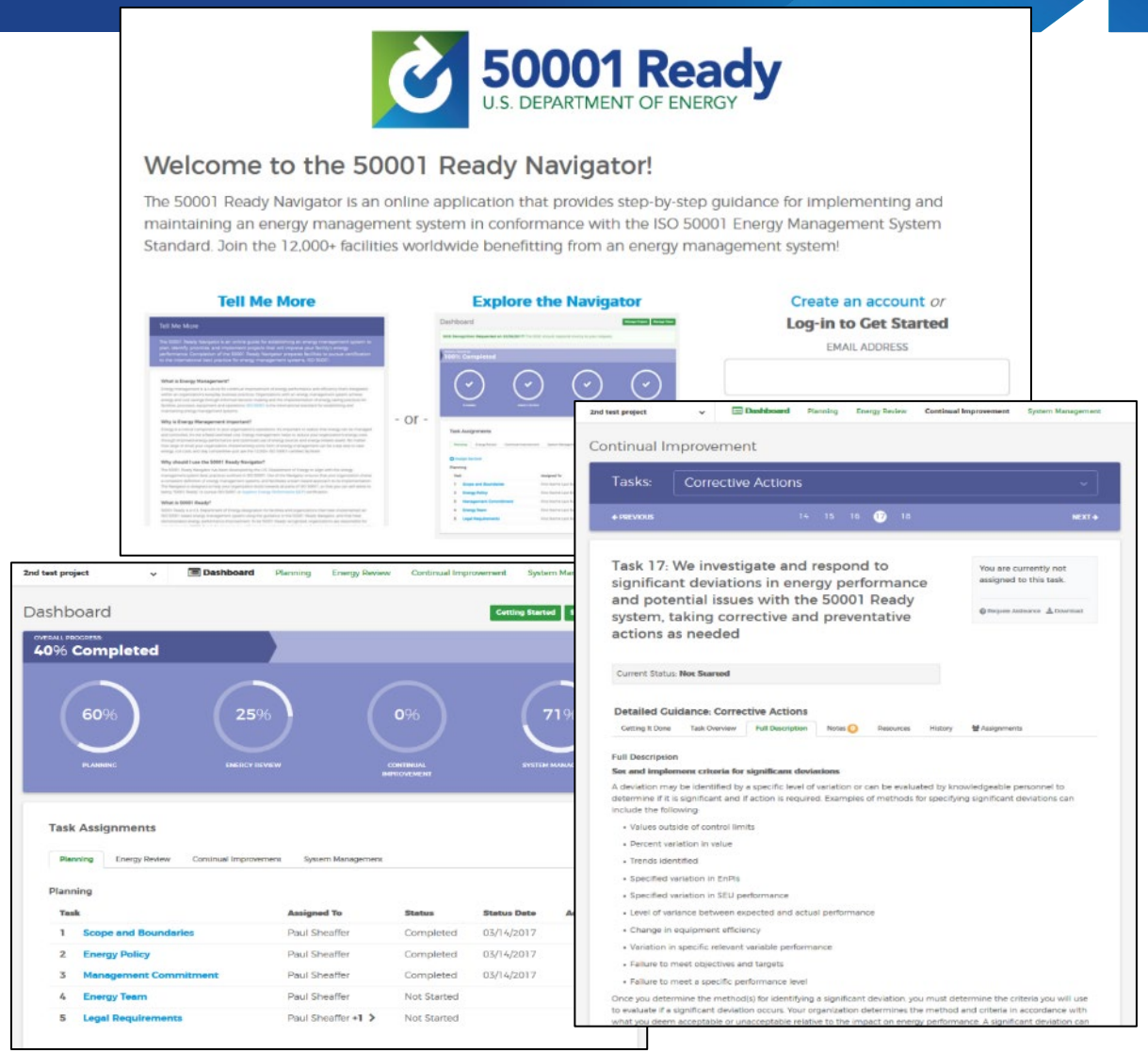
DOE Software Tools

www.energy.gov/eere/amo/software-tools

50001 Ready Navigator

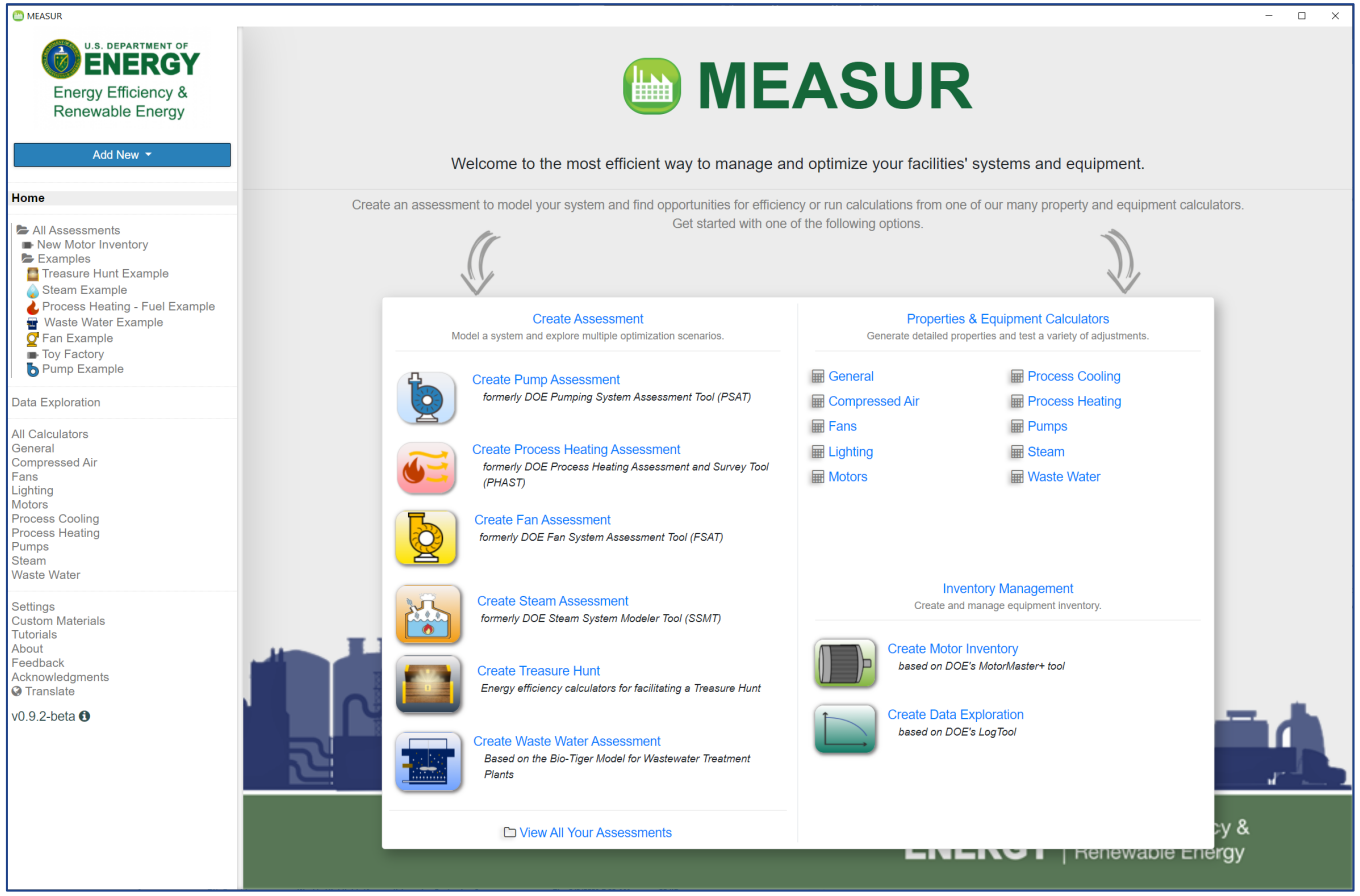
- ✓ Step-by-step “Turbo Tax” approach to ISO 50001
- ✓ 25 tasks divided into 4 sections
- ✓ Extensive guidance available in each module
- ✓ Self-attest to completion of 50001 Navigator
- ✓ Create teams and track task progress
- ✓ Over 100 templates & resources



https://navigator.lbl.gov/

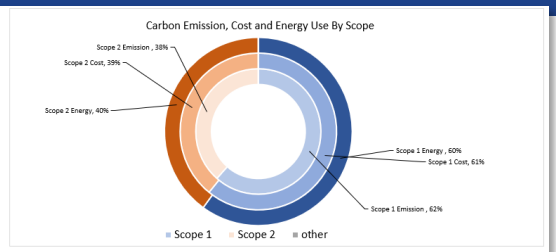
MEASUR Software Suite

- Quickly identify and quantify savings opportunities!
- Multiple Assessment Modules
  - Pumps, fans, process heating, steam, motors, wastewater, treasure hunts, Compressed Air
  - Process Cooling – coming soon
- 70+ Stand alone Calculators
  - Pumps, fans, heating, steam, compressed air, motors, lighting, CHP, etc.

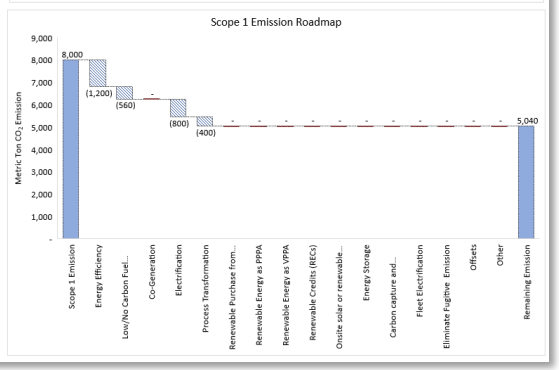


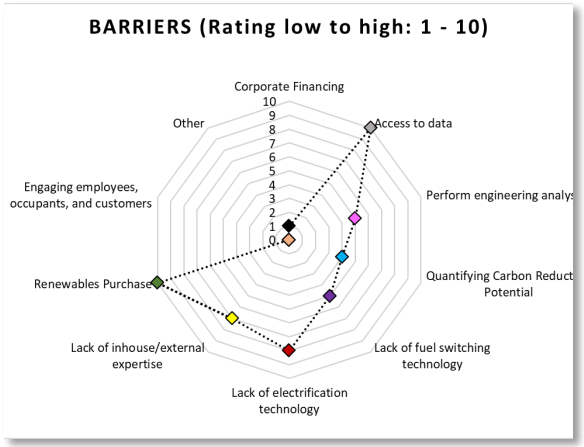
Decarbonization Tools

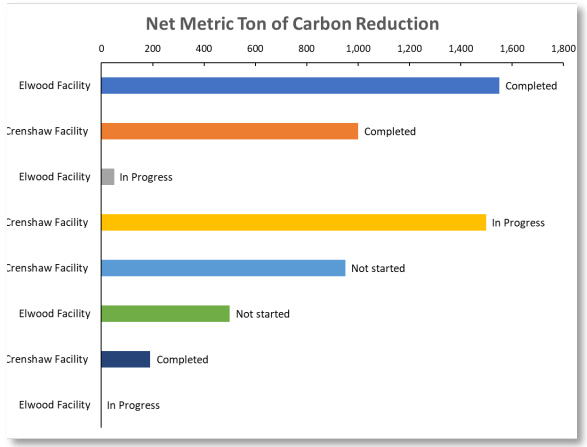
Showcase Plant Name	Elwood Facility			
Scope of Emission	Description	Energy Source (MMBTU)	Energy Cost ($)	CO_{2eq} Emission (Metric Ton)
Scope 1 Emission		15,000	7,000	8,000
Stationary Emission		15,000	7,000	8,000
Natural Gas		15,000	7,000	8,000
Mobile Emission		-	-	-
Fugitive Emission				
Scope 2 Emission		10,000	4,500	5,000
Purchased Electricity		10,000	4,500	5,000
Other				



Pillars of Decarbonization	Opportunity	Barrier	Scope 1 % Carbon Reduction	Scope 2 % Carbon Reduction
Energy Efficiency			15%	30%
Low/No Carbon Fuel Switching			7%	
Co-Generation				
Electrification			10%	-20%
Process Transformation			5%	
Renewable Purchase from Utility				10%
Renewable Energy as PPPA				15%
Renewable Energy as VPPA				
Renewable Credits (RECs)				30%
Onsite solar or renewable energy generation				20%
Energy Storage				
Carbon capture and sequestration				
Fleet Electrification				







The Action Plan Tool aids industrial LCP partners in reporting and visualizing their scope 1 and scope 2 carbon emissions, both at the corporate and facility levels.

Other Useful Resources

Electrification for Decarbonization
Electrification.ORNL.gov

Carbon Emissions Calculator
Carboncalc.ORNL.gov

Electrification Bottom-up Analysis Tool

https://energyefficiency.ornl.gov/wp-content/uploads/2021/12/LCP-Action-Plan-Tool_Final.xlsx

Recognizing and Amplifying Leadership

To date, Better Plants has recognized over 60 **Goal Achieving Partners!**

Better Project and Practice Awards

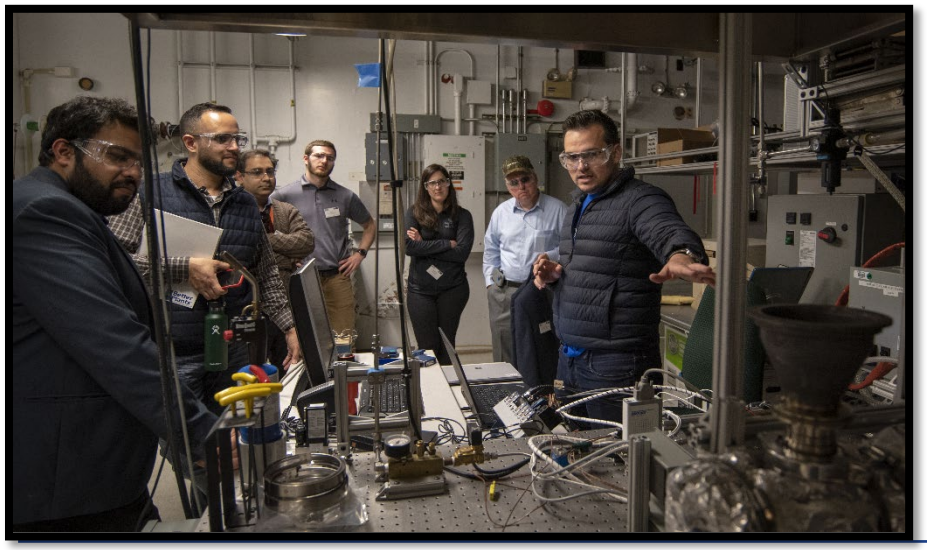
USA Only

- Recognize facilities, projects and activities
- Applications Due March 25

Other: AEE World International Awards – Due Feb 22

Recognition: Better Practice and Project Awards

Emerging Technologies



Partners visit DOE National Labs to:

Tour World-Class Lab Facilities

View Demonstrations of innovative Technologies

Hear from Experts from the Lab and Industry

Learn how to easily partner and leverage technology

Network with BP partners and lab technologists

https://betterbuildingssolutioncenter.energy.gov/labs

Industrial Technology Validation Program

The DOE's Industrial Technology Validation (ITV) program aims to help industry better identify and evaluate innovative technologies by hosting field validation testbeds.

- Engage in a full-scale pilot with M&V managed by National Lab experts
- Receive independent insights regarding technology suitability for industrial processes
- Inform public-and private-sector investment decisions through publicly available M&V findings
- Increase market acceptance of emerging technologies by validating real-world performance

Better Buildings Solution Center

More than 2,500 solutions are available publicly in the Better Buildings Solution Center

Showcase Projects:

- Successful Energy Savings Case Studies

Implementation Models (Playbooks):

- Overcome barriers: finance, data, energy management, staff training, partnering with utilities, and more
- Multi-faceted and applicable across sectors

Technology Focus Area Pages

- 13 focus areas, from compressed air to renewables
- DOE tipsheets and publications, software tools, webinars, and contact information for a subject matter expert

Additional Resources, Toolkits, Case Studies

NEW: Energy Intensive Industry Pilot

- DOE is starting a two-year initiative to trial a wide range of technical assistance resources for energy-intensive (EI) companies
- **Goal**: engage EI's to better understand the specific needs and issues
  - Make it easier for EI companies to save energy and decarbonize
- Identify/develop the resources will be most helpful to inform future DOE technical assistance offerings

- We NEED to hear from you! https://www.surveymonkey.com/r/JNGFFFS

US EIA's Energy Intensives List

- Food (food and beverage manufacturing)
- Pulp and paper (paper manufacturing, printing and related support activities)
- Chemicals (inorganic chemicals, organic chemicals (e.g., ethylene propylene), resins, and agricultural chemicals; includes chemical feedstocks)
- Iron and steel (iron and steel manufacturing, including coke ovens)
- Nonferrous metals (primarily aluminum and other nonferrous metals, such as copper, zinc, and tin)
- Nonmetallic minerals (primarily cement and other nonmetallic minerals, such as glass, lime, gypsum, and clay products)

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Questions?

Thank you!

For More Information:

Thomas Wenning, wenningtj@ornl.gov, 865-576-9257

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