A photograph of several wind turbines standing in the ocean under a blue sky with light clouds. The turbines are white and their reflections are visible in the calm water.

LOW-CARBON FUELS POLICY DESIGN

Dan Esposito

Fuels & Chemicals Policy Lead

*Prepared for Oregon
Department of Energy*

April 30, 2025

ENERGY
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POLICY & TECHNOLOGY LLC



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- Non-partisan energy and climate policy think tank
- Our work is based on scientific assessments of climate change
- We provide customized research and policy analysis to support policy design that reduces emissions at the speed and scale required for a safe climate future
- We are working towards a climate safe future where people and the planet thrive
- Our technology-neutral policy recommendations are grounded in data, driven by our open-source and peer-reviewed Energy Policy Simulator model and our climate policy book, *Designing Climate Solutions*
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Energy Innovation Research Team

Electricity

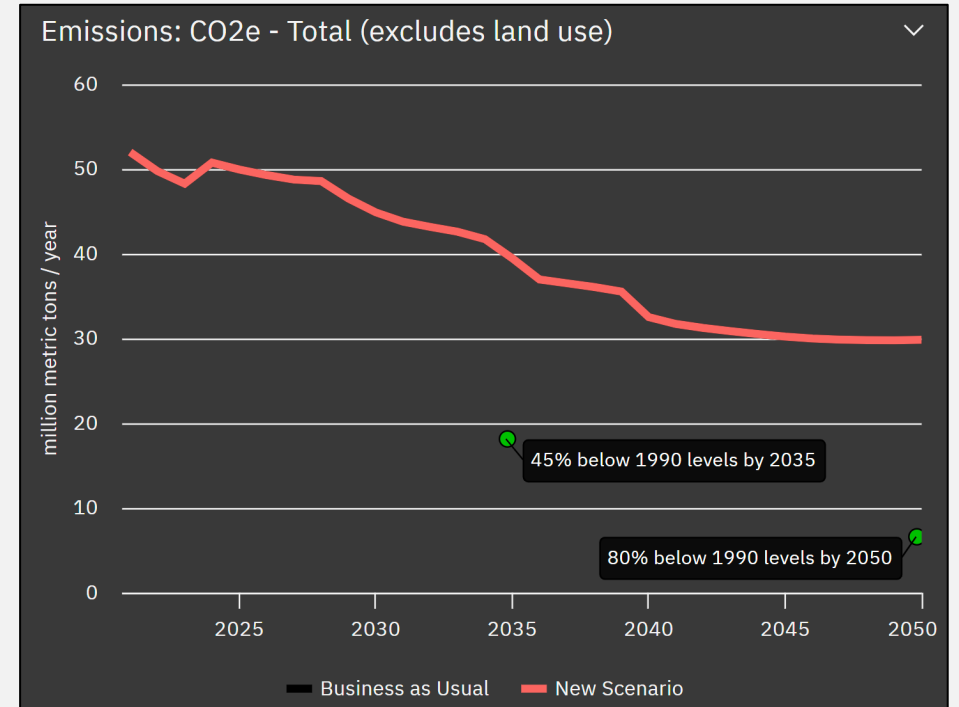
Electrification

Industry

Fuels &
Chemicals

Transportation

Energy Policy
Modeling



<https://energypolicy.solutions/home/oregon/en>

Energy Innovation's Key Hydrogen Papers

ASSESSING THE VIABILITY OF HYDROGEN PROPOSALS: CONSIDERATIONS FOR STATE UTILITY REGULATORS AND POLICYMAKERS

SARA BALDWIN, DAN ESPOSITO, AND HADLEY TALLACKSON

MARCH 2022

SUMMARY

Since 2020, natural gas and electric utilities have proposed at least 26 pilot projects across more than a dozen states involving the production and distribution of hydrogen¹ for various end-uses, including as a heating fuel in buildings and for power generation.^{1,1}

In 2021, the bipartisan Infrastructure Investment and Jobs Act (IIJA) allocated \$8 billion to support regional hydrogen demonstration hubs, including at least two hubs to explore the fuel's use for the same heating and power generation end-uses.

¹The authors would like to acknowledge peer reviewers for their input, guidance, and contributions to this paper. The contents and conclusions, including any errors and omissions, are the responsibility of the authors, and peer reviewer input does not imply their support or endorsement of the work. Energy Innovation reviewers include Michael O'Boyle, Jeff Rousman, and Eric Gimón. Other peer reviewers include Jan Rousman with the Regulatory Assistance Project, Sheri Billimoria and Alexa Thompson with RMI, Rachel Fahmy with Natural Resources Defense Council, Phoebe Sweet with Climate Nexus, and Sage Welch with Sundance Strategies.

¹Hydrogen is colorless, odorless, highly flammable gas that, when burned, emits mostly water in addition to various oxides of nitrogen. While hydrogen is the most abundant element in the universe, it is scarce in the Earth's atmosphere and does not have naturally occurring deposits. Therefore, it must be produced from other compounds, and the source of those compounds as well as the way it's produced have an impact on its lifecycle greenhouse gas (GHG) emissions (see call-out box on page 6). Today, hydrogen is primarily produced using a highly polluting process for use in oil refining and ammonia production.

^{1,1}In 2021, developers announced more than 8 gigawatts (GW) of "hydrogen-compatible" power plants in the United States. Business Council for Sustainable Energy, Sustainable Energy in America 2022 Factbook, <https://bceusa.org/factbook>.

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SMART DESIGN OF 45V HYDROGEN PRODUCTION TAX CREDIT WILL REDUCE EMISSIONS AND GROW THE INDUSTRY

DAN ESPOSITO, ERIC GIMON, AND MIKE O'BOYLE

APRIL 2023

EXECUTIVE SUMMARY

The United States cannot achieve net-zero greenhouse gas (GHG) emissions without carbon-free hydrogen. Today, this molecule serves the chemicals and refining industries, and fossil fuel-derived hydrogen production contributes about 1.5 percent of total U.S. climate pollution. Shifting to cleaner hydrogen production can replace these dirty sources while cutting GHG emissions in industries that are hard to decarbonize.

45V EXEMPTIONS NEED STRONG GUARDRAILS TO PROTECT CLIMATE, GROW HYDROGEN INDUSTRY

DAN ESPOSITO, ERIC GIMON, AND MIKE O'BOYLE

RELEASER DATE

EXECUTIVE SUMMARY

This paper summarizes new analysis and recommendations in response to a December 2022 letter of public forwarding (PFRF) from the United States Treasury Department and the Internal Revenue Service (IRS). Treasury's PFRF, which proposes updates for the Hydrogen Production Tax Credit (45V), states that the credit will be available for "qualified" hydrogen production facilities. Treasury's definition of "qualified" hydrogen production facilities is broad, including any facility that produces hydrogen using "any process." This paper argues that the credit should be limited to "clean" hydrogen production facilities, which are those that produce hydrogen using a process that is not a fossil fuel-based process.

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Smart Electric
Power Alliance

Insight Brief: Clean Hydrogen for the Electric System

April 2024

ENERGY INNOVATION
POLICY & TECHNOLOGY LLC

Evidence Shows Three Pillars Remain Crucial for 45V Hydrogen Tax Credit to Protect Climate, Consumers, Industry

Don Esposito | July 2024

SUMMARY

The Biden Administration signed the Inflation Reduction Act (IRA) into law in August 2022, which included the Section 45V Clean Hydrogen Production Tax Credit (45V). The United States Treasury Department issued draft rules for 45V in December 2023 but has yet to publish final rules. Treasury's [draft rules](https://www.irs.gov/irm/part45) require electrolyzers—which split hydrogen from water electrolysis—otherwise known as "green" hydrogen production, to receive the "three pillars" in their hydrogen production order to earn the top 25-year hydrogen production tax credit. This paper analyzes Treasury's draft rules and provides recommendations for the final rules, offering Treasury about three pillars to protect the climate, consumers, and industry. Strong rules are essential for cutting climate pollution, protecting consumers, and building a truly clean hydrogen economy while maintaining jobs.

The rules for the credit and economy are tremendous. In 2023, the U.S. was forecast to only have emissions 17 percent below 2005 levels by 2050. It is now on track to reach emissions of 20 percent below 2005 levels by 2050. The rules for the credit and economy are tremendous. In 2023, the U.S. was forecast to only have emissions 17 percent below 2005 levels by 2050. It is now on track to reach emissions of 20 percent below 2005 levels by 2050.



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HYDROGEN POLICY'S NARROW PATH

DELUSIONS & SOLUTIONS

Dan Esposito

August 27, 2024

Disclaimer

- This slide deck represents a non-exhaustive review of relevant low-carbon fuels (LCFs) research, questions, and example policies
- The inclusion of any given example policy does not imply an endorsement or recommendation from Energy Innovation, unless otherwise stated



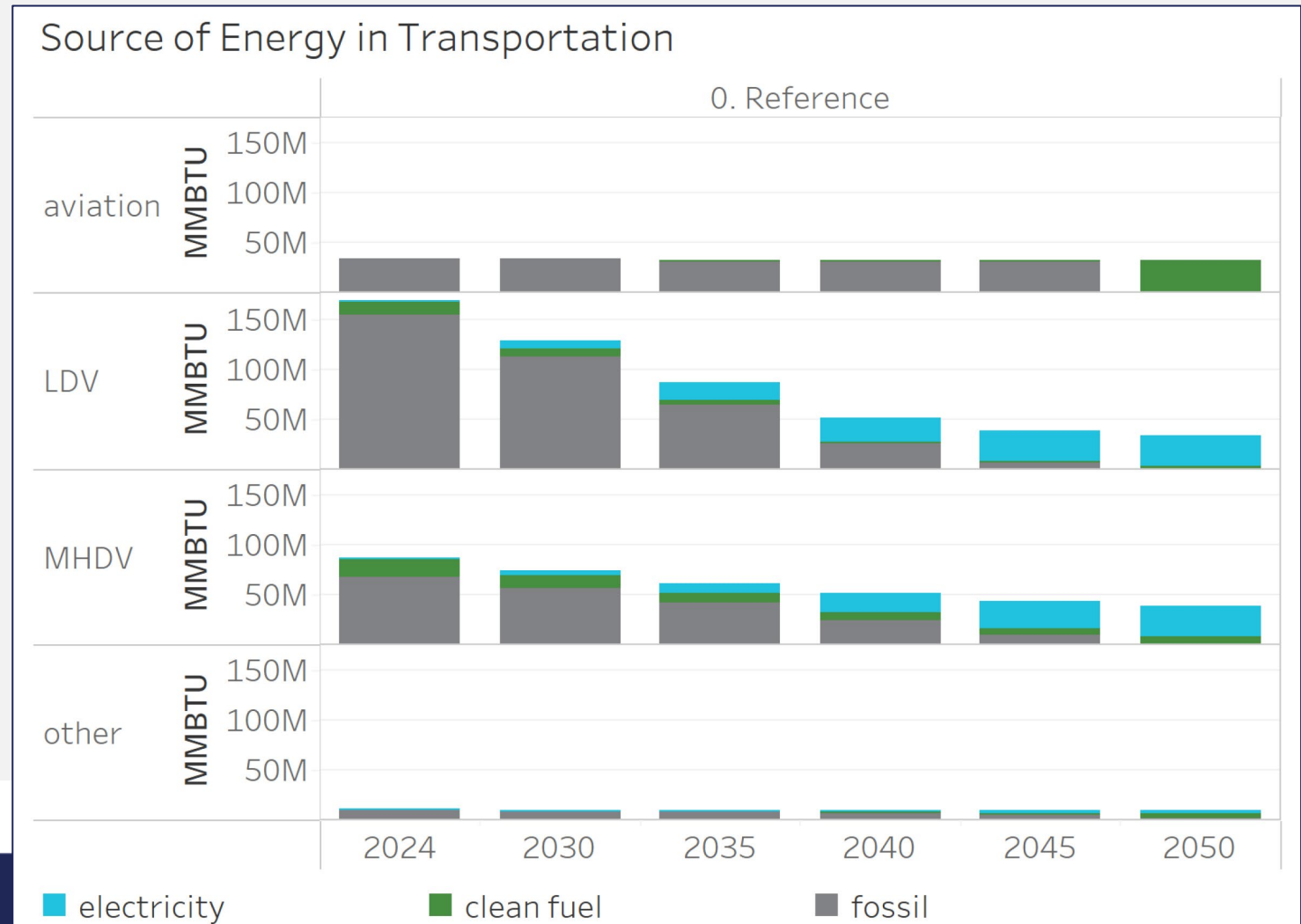
Agenda

- Guiding principles for smart low-carbon fuels policy design
- Example LCF policies
 - *LCF Growth*
 - *Electric Sector*
 - *Electrification*
 - *Gas Transition*
- Discussion



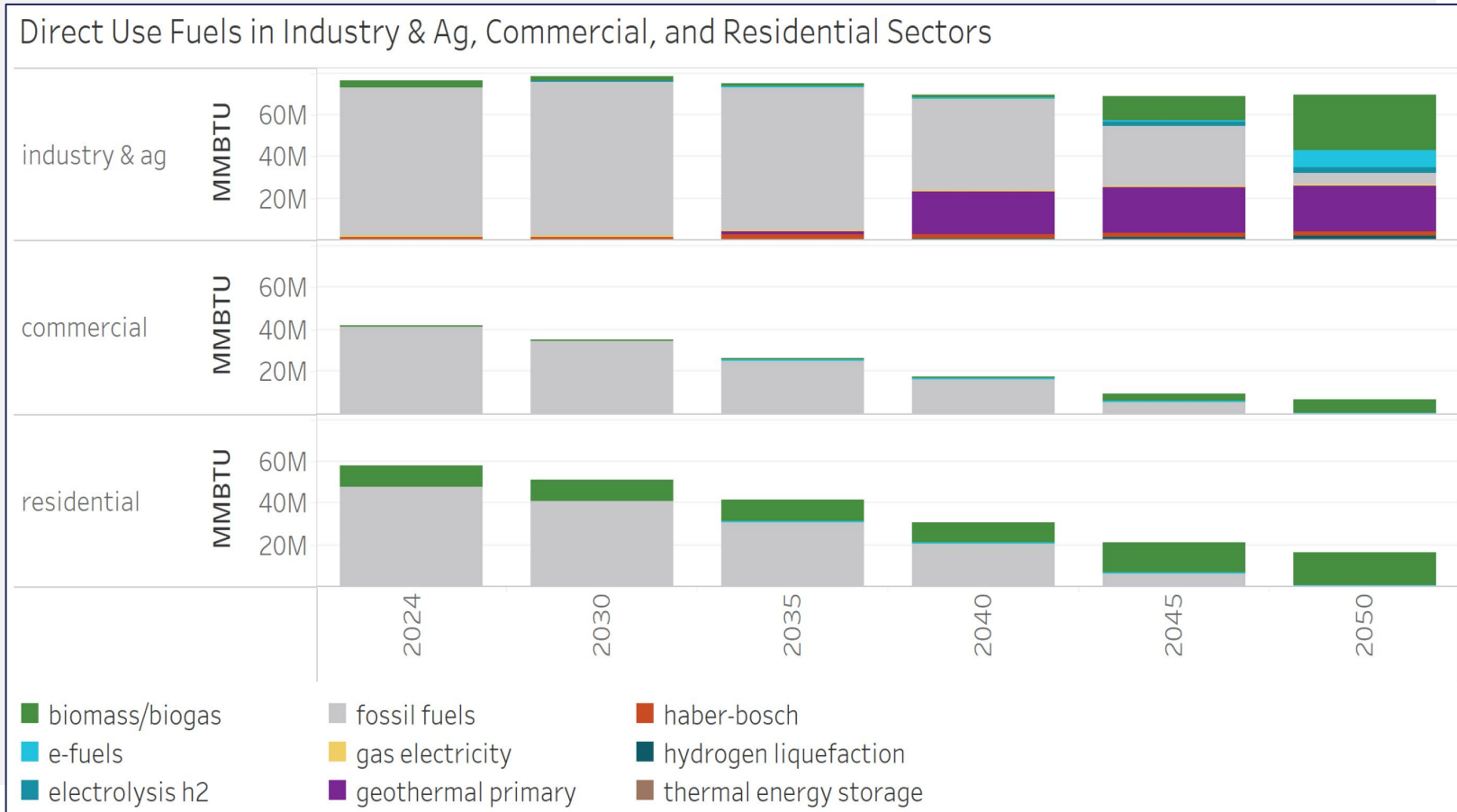
Modeling Refresher (Evolved Energy Research)

- Ground vehicles are overwhelmingly electrified



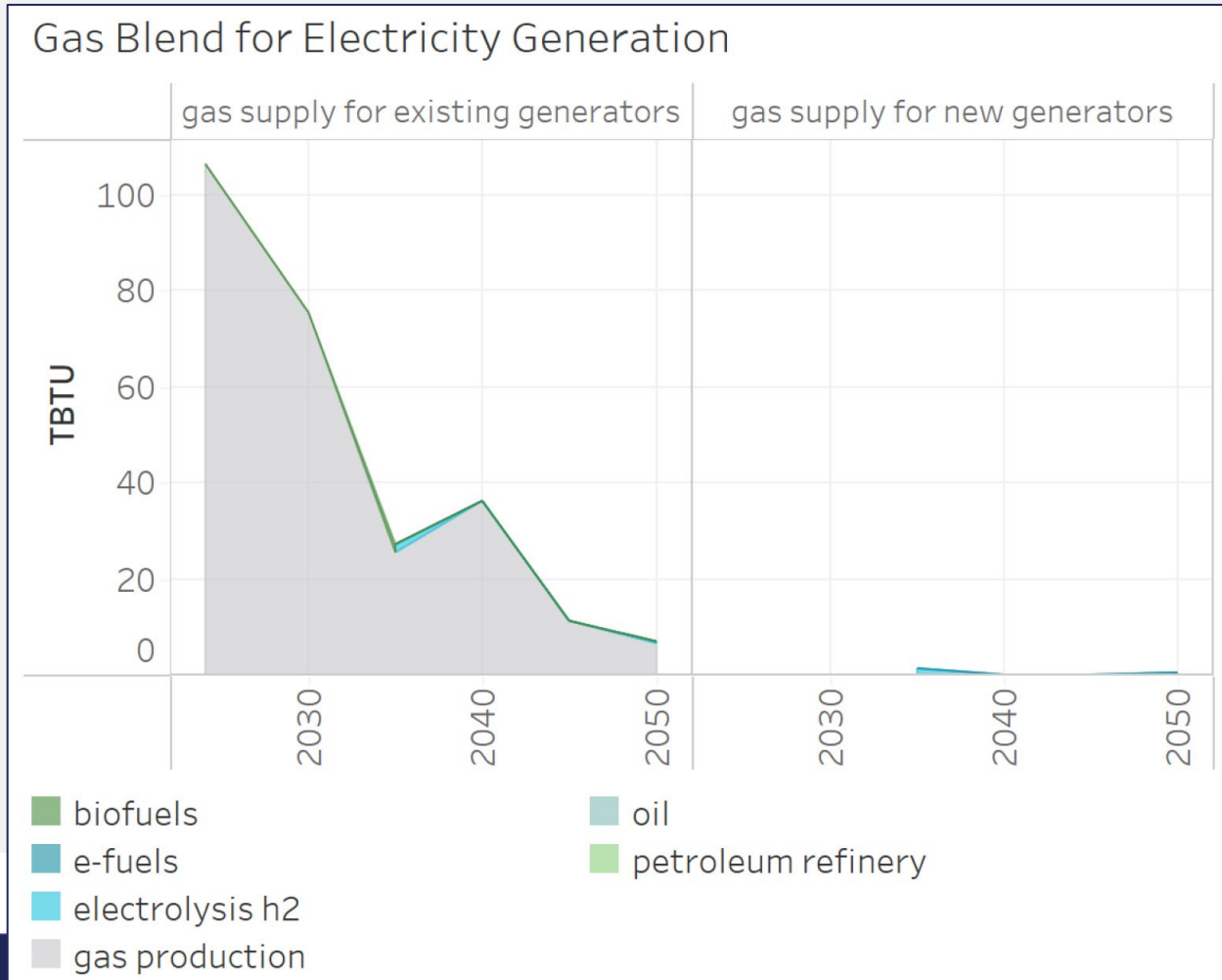
Modeling Refresher (Evolved Energy Research)

- Ground vehicles are overwhelmingly electrified
- Gas distribution volumes (for buildings) fall substantially and don't use hydrogen
- Industry uses a wide range of LCF options



Modeling Refresher (Evolved Energy Research)

- Ground vehicles are overwhelmingly electrified
- Gas distribution volumes (for buildings) fall substantially and don't use hydrogen
- Industry uses a wide range of LCF options
- Electric sector LCFs are all about capacity / timing, not volume



Guiding Principles: Landscape Analysis Lessons

- It's very easy to design LCF policies that have little-to-harmful climate impact, are difficult to unwind (i.e., have strong political inertia and infrastructure lock-in), and otherwise do not set jurisdictions up for long-term success
- Policymakers should aim to implement policies in the near term that will develop the needed LCFs and LCF-using technologies, where and when they are needed
 - But, in the grand scheme of climate policy, LCFs should take a back seat to efficiency and clean electrification given the latter's cost-effectiveness across all domains where they are applicable (e.g., buildings, ground transport)
 - It should be a red flag if a policy promotes LCFs over efficiency and/or clean electrification, even if ostensibly on a technology-neutral "level playing field"
- In lieu of shining examples to follow, it will be important to judge policy designs against a set of principles, making adjustments as needed

Guiding Principles: Overview

Policy should support truly clean and sustainable LCF production:

- Support sustainable biofeedstocks (e.g., waste biomass, cellulosic biomass) with conservative carbon intensity assumptions—while ensuring incentives do not motivate the generation of extra waste
- Cap or gradually phase out support for first-generation biofeedstocks (e.g., food crops, oils, trees)
- Prioritize truly clean hydrogen production (i.e., three-pillars electrolysis)

Policy should support LCF uptake in high-value applications and protect against its use in low-value applications:

- Bioresources should largely be limited to materials, chemicals, and aviation fuel
- Hydrogen should largely be limited to refining, chemicals, steel, aviation fuel, and marine shipping fuel (ammonia or methanol)
- Bioresources and hydrogen may have niche applications elsewhere, such as dispatchable power generation (very low capacity factors) and some instances of high-temperature industrial heat

NOT ALL BIOMASS IS 'GOOD' BIOMASS; WHAT IS SUSTAINABLE BIOMASS?

No competition
with other critical
uses of land



No deforestation
or peatland
conversion



Target degraded
land, with little
plant growth



Respect growth
periods which will
delay supply



Close-to-zero
emissions collection,
transportation and
processing

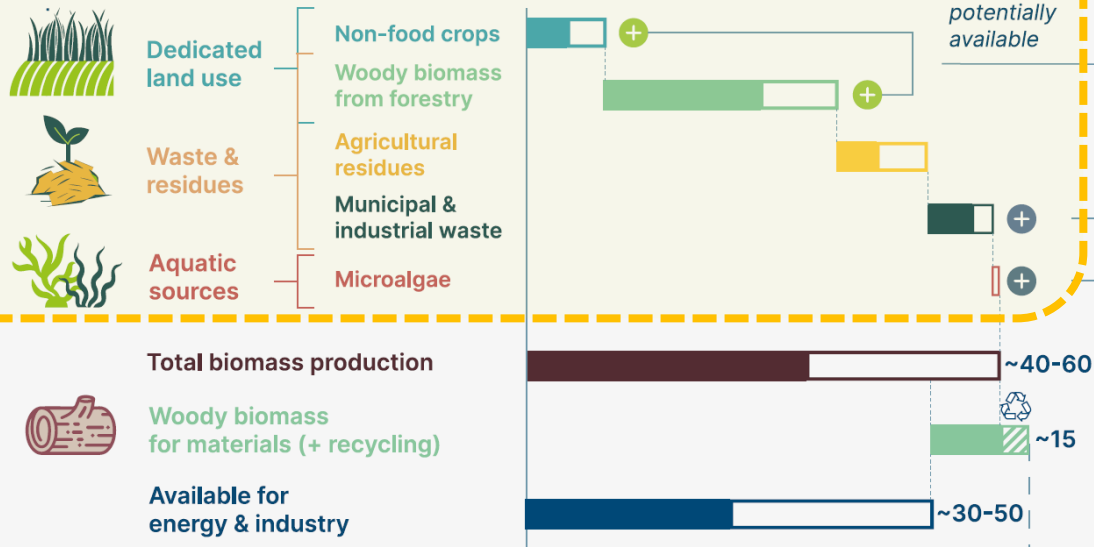


No
environmental
or social harm



WHAT WE CAN RELY ON: A CONSTRAINED SUSTAINABLE SUPPLY

Global sustainable biomass supply in 2050 – **Prudent estimate**
EJ primary energy per year – *Illustrative scenario*



EXTRA BIORESOURCES IF RADICAL CHANGE HAPPENS

More available land
(Accelerated by biotechnologies)

- Dietary shift away from meat (+ + + + + + + +)
- More productive plants (traditional crops, algae) (+ +)
- Less food waste (+ +)

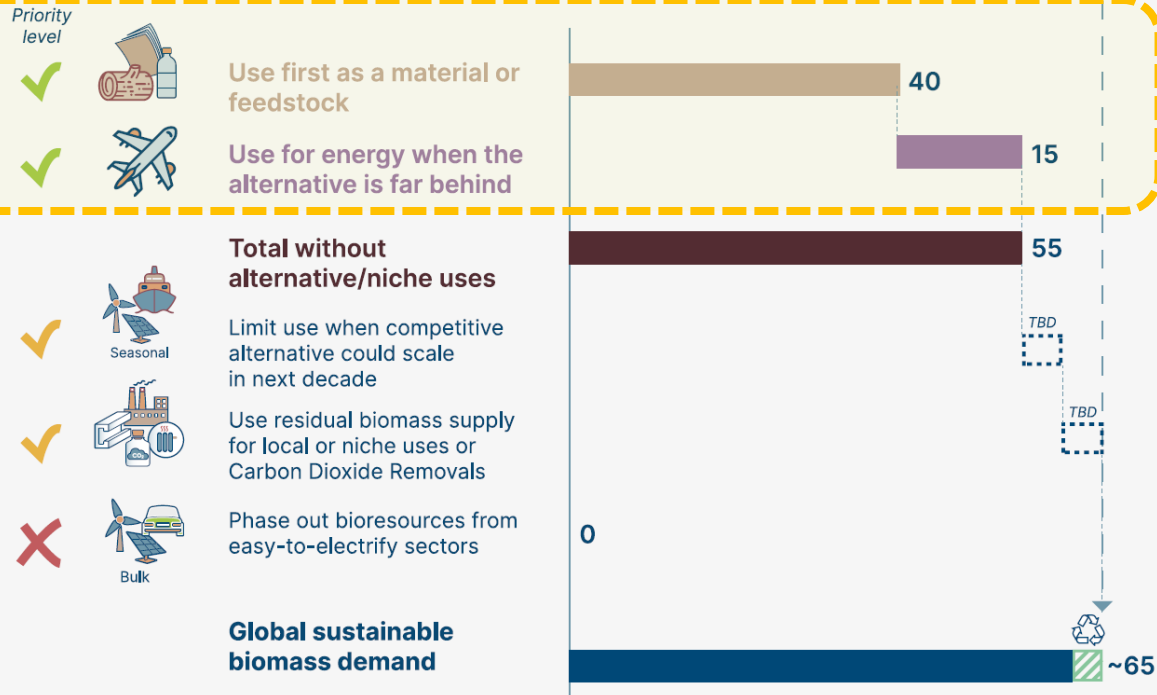
New sources available

- Increase collection of organic waste (+ +)
- Development of macroalgae (seaweed) for energy (+ + +)



HOW TO PRIORITISE USES OF BIORESOURCES?

Global biomass demand (2050) – EJ primary energy per year – *Illustrative scenario*



CLEAN ELECTRICITY: THE CORE OF A NET-ZERO ECONOMY

Final energy demand in 2050
EJ primary energy per year – *Illustrative scenario*

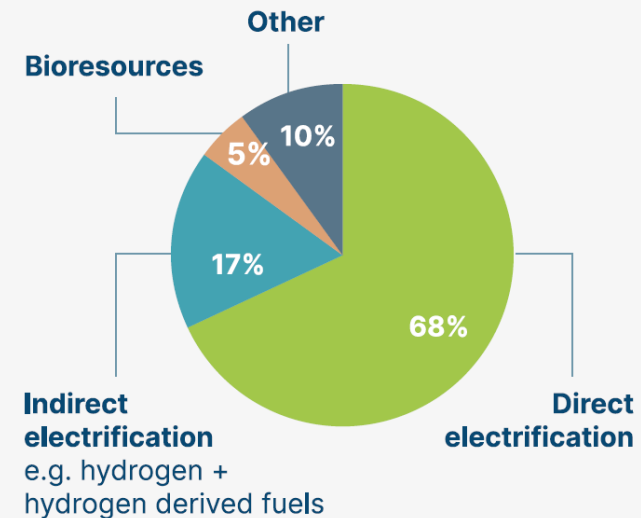
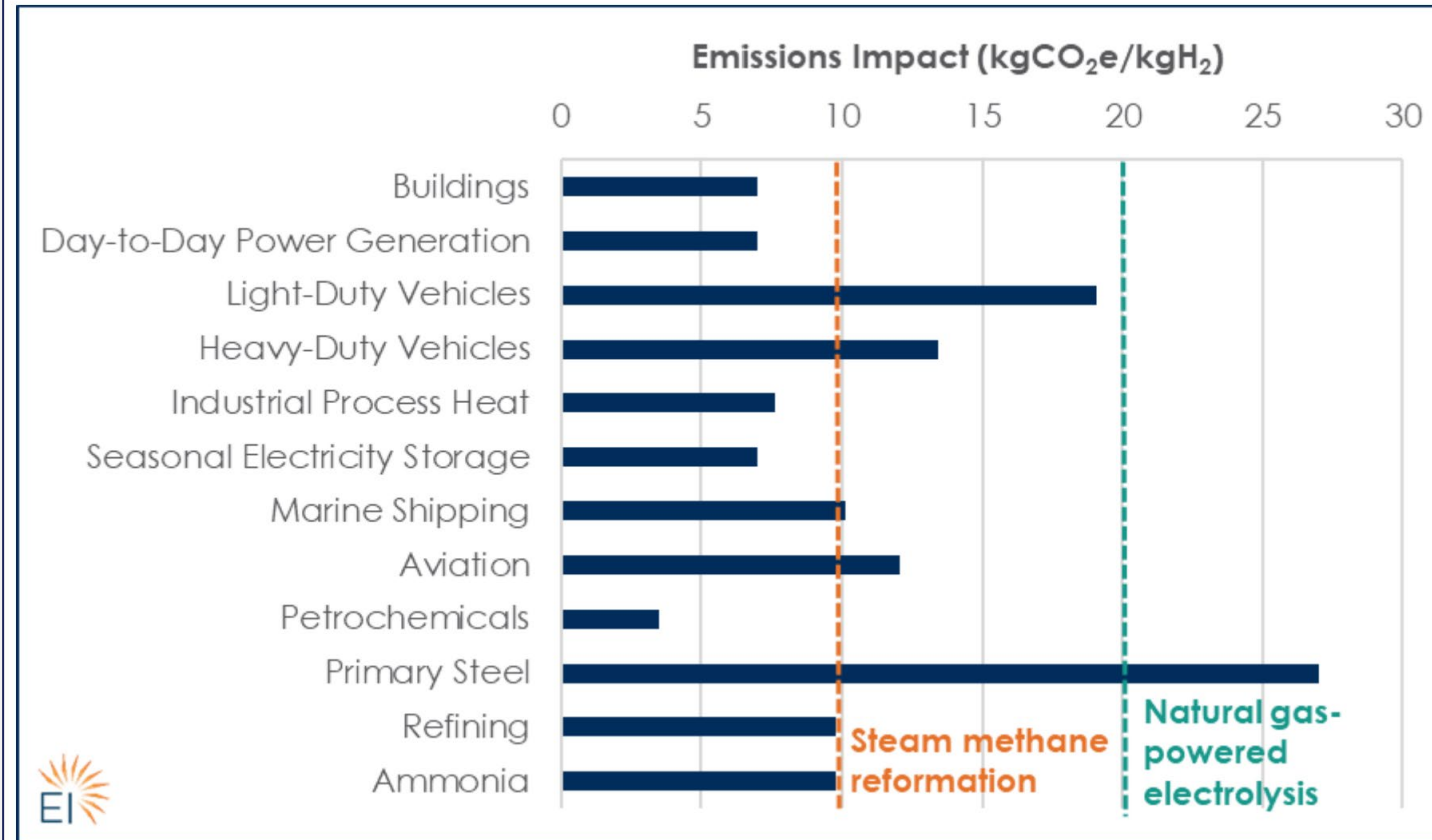


Figure 4. Net climate pollution impact from hydrogen production and use^{vii}



The blue bars represent the GHGs that would be avoided by the use of hydrogen in place of the incumbent fossil fuel for each application. The dashed lines represent the GHGs that would be emitted by today's hydrogen production (orange) and by electrolysis if not using new, deliverable, hourly matched clean power (turquoise).



Hydrogen's competitive prospects for decarbonization by end-use sector

EXCELLENT**GOOD****UNCERTAIN****POOR****TERRIBLE**

Refining



Primary Steel



Seasonal Electricity Storage



Heavy-Duty Vehicles



Day-to-Day Power Generation



Ammonia



Aviation (Long-Haul)



Aviation (Short-Haul)



Industrial Process Heat



Light-Duty Vehicles



Marine Shipping (Long-Haul)



Marine Shipping (Short-Haul)



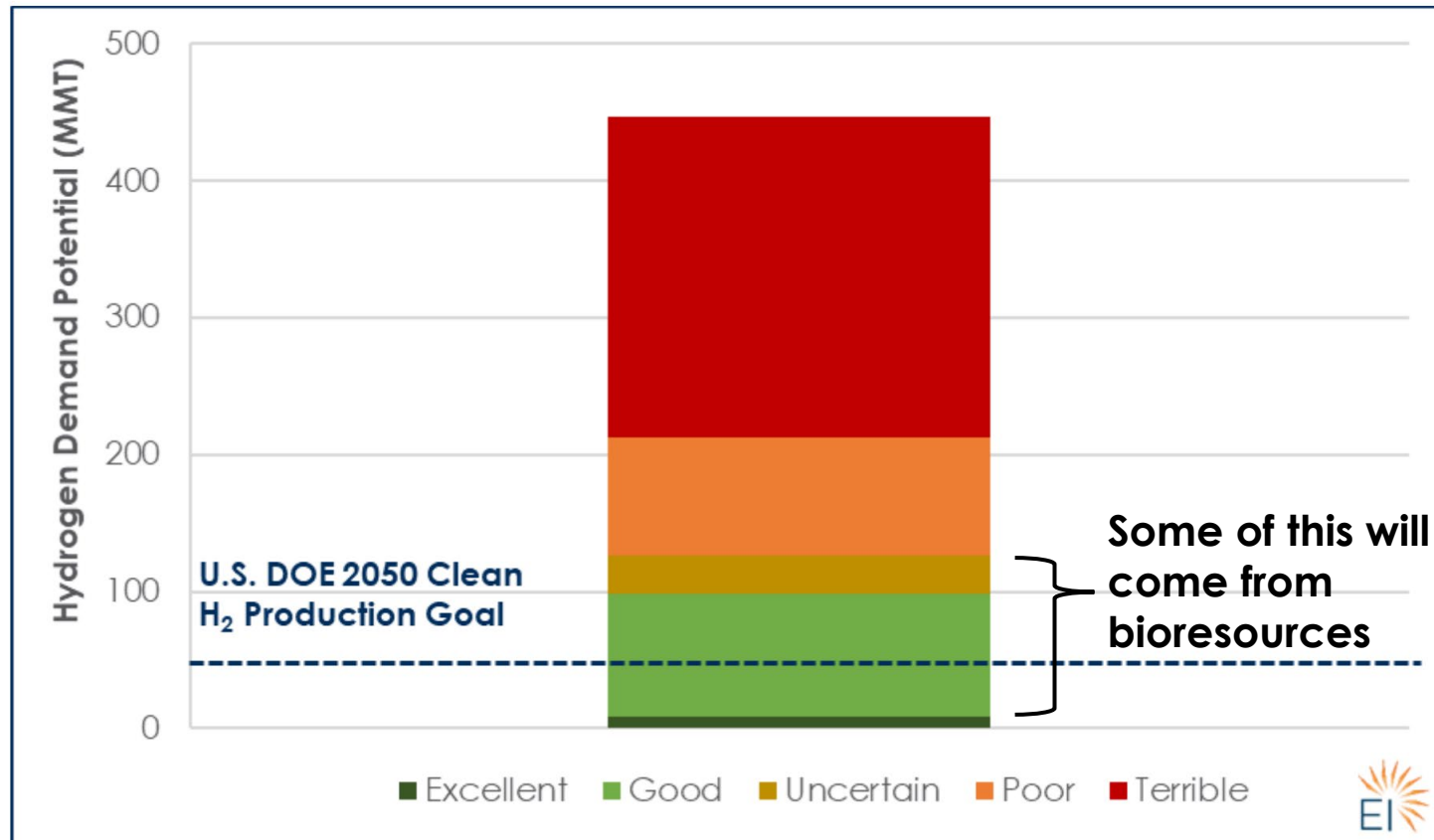
Buildings



Petrochemicals

**Download report
and fact sheets**

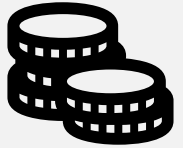
Figure 6. U.S. hydrogen demand potential by prospect category



The hydrogen demand potential for high-value uses (“excellent” and “good”) is approximately double the DOE’s 2050 clean hydrogen production goal—meaning achieving a net-zero economy by 2050 will likely require directing hydrogen to these high-value uses while also relying on alternatives (e.g., efficiency, biofuels).



H2 Analysis Qualitative Takeaways



Hydrogen's low-value uses are all when used for energy, while its high-value uses are all when used as a feedstock



Hydrogen's low-value uses are much more dependent on the development of sprawling hydrogen pipelines and end-use equipment than its high-value uses



Hydrogen's low-value uses often increase the risk of social harms and inequitable outcomes, while its high-value uses generally do the opposite



Hydrogen's uptake in high-value uses will require targeted demand-side policies—supply-side subsidies alone will not ensure this outcome (and may make better alternatives for low-value uses look worse)



H2 Policy Recs: Boosting H2's High-Value Uses



Advance market commitments (AMCs)



Contracts for difference (CfDs)



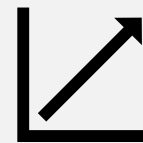
Reverse auctions



Subsidies for end-use equipment or utilization



Research and development (R&D) support for emerging technologies



Performance standards



H2 Policy Recs: Minimizing H2's Low-Value Uses



Focus midstream infrastructure on tight industrial clusters



Hedge bets on hydrogen infrastructure investments



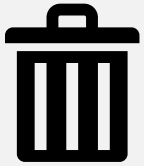
Require a high burden of proof of value and community benefits agreements



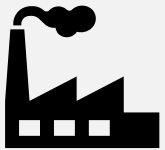
Set rigorous health and safety standards



Example Policies Overview



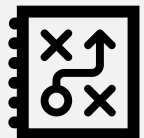
[1] Targeted Low-Carbon Fuels Development and Use



[2] Dispatchable Capacity for the Electric Sector



[3] Coordinating Electrification and LCFs



[4] Decreasing Fuels Demand and Pivoting Business Models

[1] Clean Fuels Standards – Problems

[Evidence](#) suggests California's LCFS (as an example):

- Favors biofuels over electrification (e.g., ~80% of credits have gone to biofuels)
- Causes environmental harm by:
 - Primarily supporting crop-based fuels (driving land use change)
 - Crediting biofuels that would have been produced regardless
 - Awarding deeply negative CI scores to dairy biogas instead of regulating in-state methane emitters – encouraging larger herd sizes and poor practices
 - Incentivizing the shipping of waste lipids from across the world
- Raises retail fuel prices for consumers and businesses

[1] Clean Fuels Standards – Recommendations

Make adjustments as to what can qualify for the CFS (and to CI accounting):

- Cap crop-based biofuel, lipid, and biogas credits, disallow palm oil, and require biogas to be delivered in state
- Update CI scores with latest best evidence (incl. for biogas counterfactual)
- Increase funding for electric vehicle charging infrastructure (incl. heavy-duty)

Make adjustments that help direct biofuels to sectors that will need it long term:

- “Designate intrastate aviation fuel as a mandatory reporting fuel and explore stricter regulation options,” especially for intrastate flights ([RMI](#))
- “Designate maritime fuel as an opt-in fuel with a defined ramp-up” ([RMI](#))

Ideally bioresources would go ~exclusively to materials, feedstocks, and aviation

[1] Production of Sustainable Bioresources

COLORADO: Wood to Energy Program

- Provides technical assistance and education on wood-to-energy opportunities in Colorado
- Related programs (e.g., Wildfire Risk Mitigation Loan Fund) provide funding for select projects
- **Good** to collect wood waste, and worth exploring uses in wood products, composting or mulching, biochar, and conversion to chemicals
- **But**, need to guard against overharvesting or poor forest management, and wood for energy can drive substantial local air pollution

MINNESOTA: Bioincentive Program

- Uses incentive payments to boost the production of “advanced biofuels, renewable chemicals, and biomass thermal energy”
- Requires that agricultural and forestry biomass is harvested in “ways that do not harm the environment”

[1] Industrial Fuel-Switching (Priority)

Priority policies to promote industrial fuel-switching (to electricity or LCFs)

Option	Examples
Carbon price and/or standards limiting GHG emissions from industrial processes	<ul style="list-style-type: none">• EU Emissions Trading System + CBAM• EU Renewable Energy Directive (RED) III• South Coast Air Quality Management District (SCAQMD) Rule 1146.2
Policies to lower the cost of clean electricity	<ul style="list-style-type: none">• Feed-in tariffs, clean electricity standards, government auctions for renewables, green banks, ...
Production tax credit / subsidy for cleanly manufactured products	<ul style="list-style-type: none">• Carbon contracts for differences (CCfDs) in EU/Germany• Stimulation of sustainable energy production and climate transition (SDE++) in the Netherlands

[1] Industrial Fuel-Switching (Ancillary)

Ancillary policies to promote industrial fuel-switching (to electricity or LCFs)

Option	Examples
Grants for pilot and demonstration projects	<ul style="list-style-type: none"> U.S. Industrial Demonstrations Program (IDP) Japan Green Innovation Fund Pilot and demonstration projects in China
Investment tax credit for industrial decarbonization projects	<ul style="list-style-type: none"> U.S. 48C Advanced Energy Project Credit
Loans and loan guarantees for early deployments	<ul style="list-style-type: none"> U.S. Loan Programs Office (LPO) Title 17 Clean Energy Financing Program (CEFP)
Standard on the GHG-intensity of fuel production	<ul style="list-style-type: none"> Germany GHG Reduction Quota (THG Quota) Canada Clean Fuel Regulations (CFRs)
Tax credit / subsidy for the production of LCFs	<ul style="list-style-type: none"> U.S. 45V Clean Hydrogen Production Tax Credit
Workforce training and development programs	<ul style="list-style-type: none"> U.S. Industrial Training and Assessment Centers (ITAC) Australia Vocational Education and Training (VET) Program Germany industrial apprenticeships

[1] Aviation and Marine Shipping Fuel-Switching

Challenging to decarbonize without federal support (e.g., Federal Aviation Administration has regulatory power over aviation fuel requirements) – but states can still make progress

Aviation ([UC Berkeley, April 2025](#))

- Extend LCFS to all fuel sold in state, with carbon content reduction rate designed to not require modification to jet engines
- Use indirect source rule authority under Clean Air Act to set requirements on airports in state implementation plans
- Set and increase taxes and/or landing fees on high-carbon jet fuel, using revenue to fund SAF incentives

Marine Shipping ([RMI, July 2024](#))

- Adjust LCFS to include fuels used by ocean-going vessels (if only for generating credits) and cap conventional biofuels
- Use targeted incentive to close cost gap, such as via tax credits for marine fuel offtakers, a sales and use tax incentive, or a contract-for-difference mechanism
- Invest in port transition planning and implementation

[2] Dispatchable Capacity for the Electric Sector

A clean electricity system in Oregon will likely rely on high shares of variable renewable energy (solar and wind) as well as hydropower. It will need resources that can provide flexibility over daily, seasonal, and multi-annual timeframes.

Dispatchable Resources

- Explore the option set with Requests for Information, Requests for Proposals, and procurement targets (see NYSERDA's efforts on [long-duration storage](#), [hydrogen](#), and [advanced nuclear](#))
- Oregon's geology suggests a role for enhanced geothermal systems (ESG)

Proactive Transmission

- Explore transmission development and upgrading existing lines to bring energy from areas of high resource quality to load centers (see Texas' [Competitive Renewable Energy Zone](#) projects, research on [reconductoring](#))

Flexible Demand

- Tariffs giving large loads access to wholesale electricity rates can promote price-responsive behavior (see [controllable load resources](#) in Texas, EDFR's [Project Arete RFP](#))
- [Energy parks](#) can co-optimize variable generation and flexible demand (see Colorado's [Comanche replacement discussion](#))

[2] Very Low Capacity Factor Power Plants

Policies or market frameworks to shift utility business models to support building and running gas- and clean gas-fired power plants at very low volumes as a reliability resource.

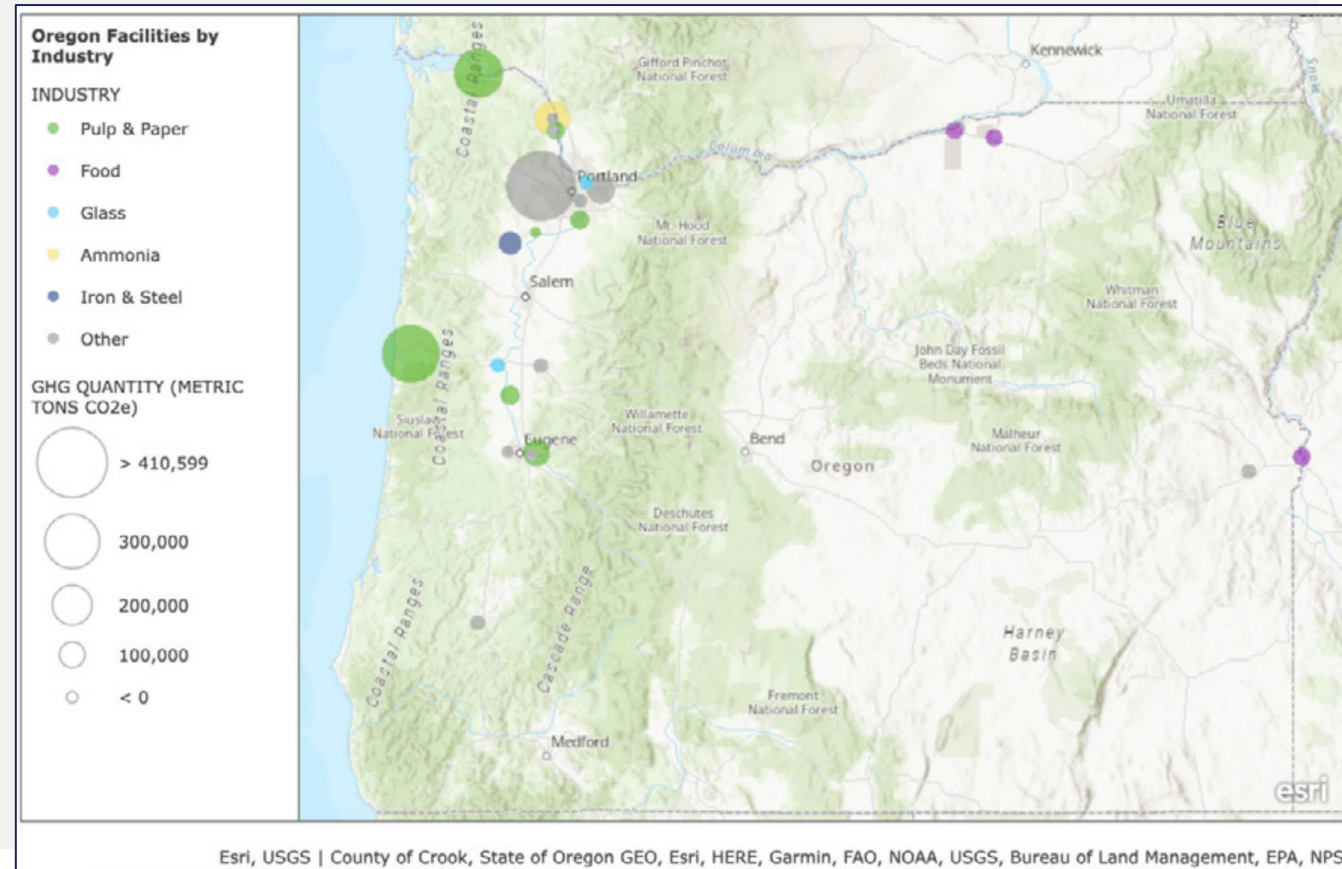
- **Strategic reserve:** compensates capacity to supply power during emergencies, but otherwise, these resources do not participate in the market (**see: [Australia, Germany – p.12](#)**)
- **Capacity investment scheme:** helps underwrite investment in clean dispatchable capacity via a long-term revenue safety net (using competitive tender bids) (**see: [Australia](#) + [analysis](#)**)
- **Coordinated gas/electric system planning:** joint planning helps arrive at the right investments (e.g., which pipelines need attention as parts of the system electrify) (**see: [PJM](#), [RAP/LBL](#)**)
- **Resource adequacy planning:** for PNW, such planning can help navigate hydroelectric variability and drought risk, extreme weather risk (e.g., heat waves), demand growth (e.g., electrification, data centers) and opportunities for demand flexibility, and climate and carbon policy (**see: [GridLab](#), [ESIG](#), [LBL](#)**)

[3] Opportunities to Electrify Industry

A [resource](#) from Global Efficiency Intelligence, Renewable Thermal Collaborative, and David Gardiner and Associates assesses industrial electrification opportunities in Oregon. Key insights:

- Electrifying ammonia and pulp and paper production “can significantly reduce emissions”
- Electrifying recycled plastic, milk powder, container glass, soybean oil, cast aluminum, or beer production may “reduce energy costs per unit of production”

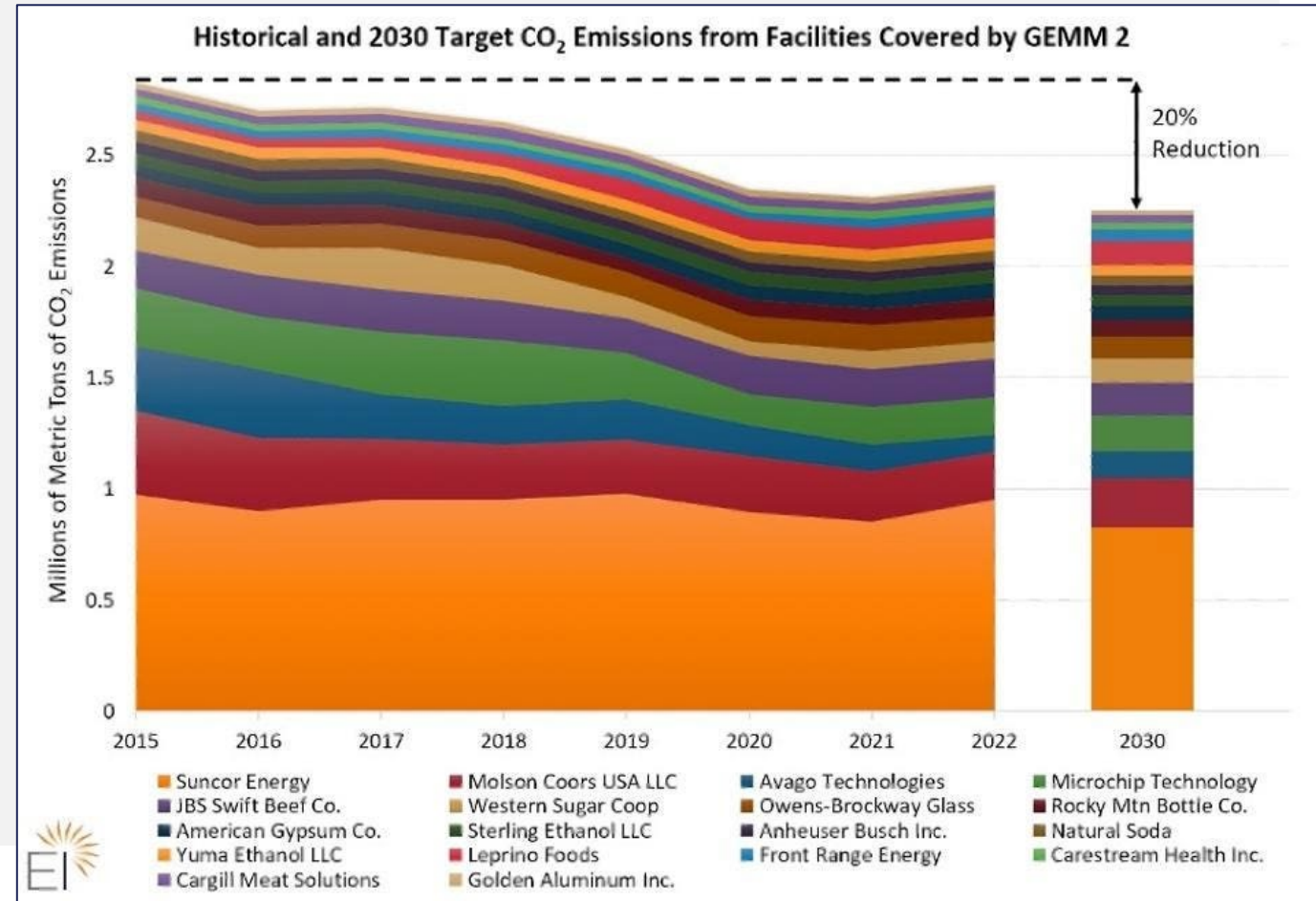
Includes discussion of technologies and policy recommendations.



[3] Policies Driving Industrial Electrification

COLORADO: Greenhouse Gas Emissions and Energy Management for Manufacturing (GEMM) 1 and GEMM 2 rulings





- GEMM 2 targets 20% emissions reductions by 2030 from 2015 levels from 18 individual facilities
- Each facility has its own tailored target, but facilities must meet the goal as a group (i.e., via credit-trading)
- Facilities must prioritize on-site measures; off-site options only available if the former prove insufficient
- Recommended improvements: weight emissions reductions by production; set targets out to 2050 to provide clarity



[3] Policies Driving Industrial Electrification

MASSACHUSETTS: [Clean Energy and Climate Plan \(CECP\)](#) for 2050 sets target for industrial and nonenergy sectors of 76% GHG reductions by 2050 (relative to 1990 levels)

- **Mass Save** commercial and industrial programs in both efficiency and electrification (1% EE increase year-over-year + electrification of 52% of final energy in industry)
- **MassDEP regulations limiting SF₆ leaks** in new equipment and scheduling a phaseout for SF₆ use in electric T&D system
- **Gas System Enhancement Plans (GSEP) Working Group** to propose legislative reform regarding gas pipelines
- **Solid Waste Master Plans** to prepare and implement in 2030, 2040, and 2050 (reduce waste disposal 90% by 2050)

Energy Efficiency 	Electrification 
<p>Increases in efficiency in the sector average 1% total energy savings year over year.</p> <p>Efficiency remains a cost-effective way to reduce GHG emissions.</p>	<p>Nearly all HVAC and manufacturing machinery and about 50% of all process heat and steam production are electrified.</p> <p>Electricity use nearly doubles in the entire sector.</p>
Clean Fuels 	Carbon Capture & Storage 
<p>Total fuel use decreases by roughly 75%.</p> <p>Hydrogen and advanced bio-based fuel blends enable lower emissions from continued fuel use.</p>	<p>Carbon capture and storage technologies can be deployed at certain difficult-to-decarbonize industrial facilities as technologies improve and become more economic.</p>

[3] Policies Driving Industrial Electrification

Industrial decarbonization incentives

Funding programs

- Colorado's [Clean Air Program \(CAP\) Grants](#)
- California's [Industrial Decarbonization and Improvement of Grid Operations \(INDIGO\) program](#)
- New York's [Commercial and Industrial \(C&I\) Carbon Challenge](#)
- Pennsylvania's [Reducing Industrial Sector Emissions in Pennsylvania \(RISE PA\) program](#)

Grant programs for energy efficiency in industrial facilities

- Maine's [Commercial and Industrial Prescriptive Initiatives](#)
- Maryland's [Commercial, Industrial, and Agricultural Grant Program](#)
- Mississippi's [Industrial Energy Efficiency Program](#)

Low-carbon building materials tax exemptions and credits

- New Jersey's [purchase and use of low embodied carbon concrete](#)
- Colorado's [Exempt Eligible Decarbonizing Building Materials](#)

Buy Clean and Green Public Procurement programs

- Numerous states (including Oregon) have such programs
- But, materials coverage could be expanded – e.g., Oregon's program covers steel and concrete but not wood (while Washington's program does also include wood)

[3] Policies Driving Agricultural Electrification

Key resource: Farm and Energy Initiative's [Agricultural Electrification Program Database](https://farmandenergyinitiative.org/projects/beneficial-electrification-in-agriculture/utility-programs/)

- Programs often target specific technologies like pumping/irrigation, heating, vehicles, processing, drives, etc.
- Programs typically offer discounted rate structures for ag businesses or incentives for efficiency upgrades
- Programs are primarily run by utilities and rural co-ops, but some state agencies are also involved (e.g., [Connecticut grants](#), [Michigan incentive program](#))
- Database includes three existing programs in Oregon

The screenshot displays the 'Utility Programs' section of the database in a gallery view. It features three program cards for Alliant Energy (Iowa), Alliant Energy (Wisconsin), and Arkansas Energy (Arkansas). Each card lists details such as State, Type of Utility, Program Type, Targeted Technology, Farm Type/Product, Program Details, and Eligibility.

Utility	State	Type of Utility	Program Type	Targeted Technology	Farm Type/Product	Program Details	Eligibility
Alliant Energy	Iowa	Investor-owned	Rebate	Space Heating, Cooling, or Ventilati...	Agriculture: General, Dairy, Swine	Alliant Energy Agriculture Custom Rebates	Eligibility:...
Alliant Energy	Wisconsin	Investor-owned	Rebate	Rewiring	Livestock, Dairy	Alliant Energy's Farm Wiring Program	Farms, especially those with ...
Arkansas Energy	Arkansas	Investor-owned	Agricultural Service Base Rate	None	Agriculture: General	General Farm Service (GFS) Rate	Farms only, using a single meter ...

Other utilities visible at the bottom include Avista, Black Hills Energy, and Central Coast Community Ene... The interface includes filters, sort options, and an Airtable logo with a 'View larger version' link.

[3] Policies Driving Agricultural Electrification

Farm and Energy Initiative's [Policy Opportunities for Beneficial Electrification on the Farm](#) (2024)

- Includes a range of case studies on utility incentives targeting agricultural end uses (pages 17-33)
- Includes detail on beneficial electrification legislation in ME and CO (pages 43-45)

National Rural Electric Cooperative Association's [Farm Beneficial Electrification: Opportunities and Strategies for Rural Electric Cooperatives](#) (2018)

- Includes county-level indicators of the sales potential for tractor, irrigation pump, and space heating electrification (suggesting the former two could be good for Oregon)

Navigant's [Electrified Agriculture: Best Practice Guide for Farmers](#) (2019)

- Identifies key of making electricity cheaper than diesel – fuel costs are just as or more important than equipment capital costs
- Pairing electrification w/ distributed generation allows farms to act as microgrids

Simple programs with intuitive webpages can help with implementation – see:

- Central Coast Community Energy's (CA) [landing page on ag electrification](#)
- Connecticut Department of Agriculture's [grant programs w/ technical assistance](#)

[3] Coordinated Electric and Gas Utility Planning

Three key resources:

- Electricity Advisory Committee's [Natural Gas and Electric Critical Infrastructure Coordination: Recommendations for the Department of Energy](#) paper (2024)
 - Joint RTOs' [Strategies for Enhanced Gas-Electric Coordination: A Blueprint for National Progress](#) paper (2024)
 - Regulatory Assistance Project and Lawrence Berkeley National Lab's [Opportunities for Integrating Electric and Gas Planning](#) paper (2025)
- Focused more on demand side—steps to increase coordination among electric and gas utilities as they plan their respective distribution systems in the face of greater electrification and reduced gas demand
 - Such planning efforts have largely been limited to a few dual-fuel utilities where relevant service territories have significant overlap, such as Pacific Gas & Electric (**CA**), Xcel Energy (**CO**), and ConEdison and Central Hudson Gas & Electric (**NY**)
 - Massachusetts and Washington have emerging requirements for electric-gas collaboration
 - **MA:** utilities must consider integrated planning
 - **WA:** Puget Sound Energy (dual-fuel utility) must use integrated planning (though statute has since been amended by a ballot initiative)

[4] Managing Existing Gas Network Costs

This is a nascent but important area for more research and experience.

- Starting point policies should focus on ways to **limit expansion of the existing natural gas distribution system** – for example, via:
 - **Eliminating subsidies for natural gas line extensions and new gas hookups** (e.g., [CA](#), though looks like [Oregon has already done this](#))
 - **Adjustments to depreciation schedules** that reduce incentives to build new long-life infrastructure (e.g., [Colorado](#) requires stranded asset risk assessment + potential changes to these schedules)
 - **Clean heat standards** (e.g., [Colorado](#), with decisions for [Xcel](#) and [Black Hills](#), predominantly supporting electrification and efficiency, with some support for RNG and little-to-none for H2)
 - **Frameworks for achieving decarbonization goals** (e.g., [MA DPU decision](#), rejected RNG and H2)
 - **Building performance standards and energy codes** (e.g., [NYC Local Law 97](#)) (see also: [ACEEE](#))
- There may also be opportunities to begin **unwinding parts of the system**, such as via [California's SB 1221](#), which establishes 30 pilot projects (beginning in 2026) to identify and transition entire neighborhoods off of gas—especially where gas pipeline repairs would be needed

[4] Pivoting Pipeline Business Models

There are several potential options that can help gas utilities and pipeline companies evolve:

- **District heating or thermal energy networks** using pipes to move heat rather than gas/fuel
 - E.g., Eversource's [geothermal pilot project](#) in Framingham, MA
 - Other thermal energy network provisions in MN, NY, CO, WA, MD, VT, CA (see [table](#))
- **Enhanced geothermal systems** (for providing power or heat)
 - E.g., Colorado's [Geothermal Energy Grant Program](#) and [Geothermal Energy Tax Credit Offering](#)
- **New or repurposed hydrogen pipelines** for industrial-scale purposes, i.e., moving H₂ from producers or other states to peaking power plants, steel plants, e-fuels facilities, etc.
- **Renewable natural gas** to serve niches (e.g., identified by EER) that may struggle to electrify
- **Carbon transport and storage** to serve CCUS needs (if any)

Concluding Thoughts

- There is still a lot of work to do in promoting electrification of vehicles, buildings, industry, and agriculture – and this (plus cleaning the grid) should take priority
- Seek ways to change the types of biomass being procured and begin redirecting it from vehicles to aviation, industry, and (maybe) marine shipping
- There is lots of room for research, planning, and early procurement, including RFIs and RFPs for dispatchable electric capacity (for seasonal/multi-annual storage) as well as for enhanced geothermal and thermal energy networks
- Look toward long-term infrastructure needs – based on modeling results, avoiding higher/stranded costs might mean at least slowing growth of gas distribution system and situationally unwinding it alongside electrification, plus being careful about what types of hydrogen infrastructure are developed



Discussion

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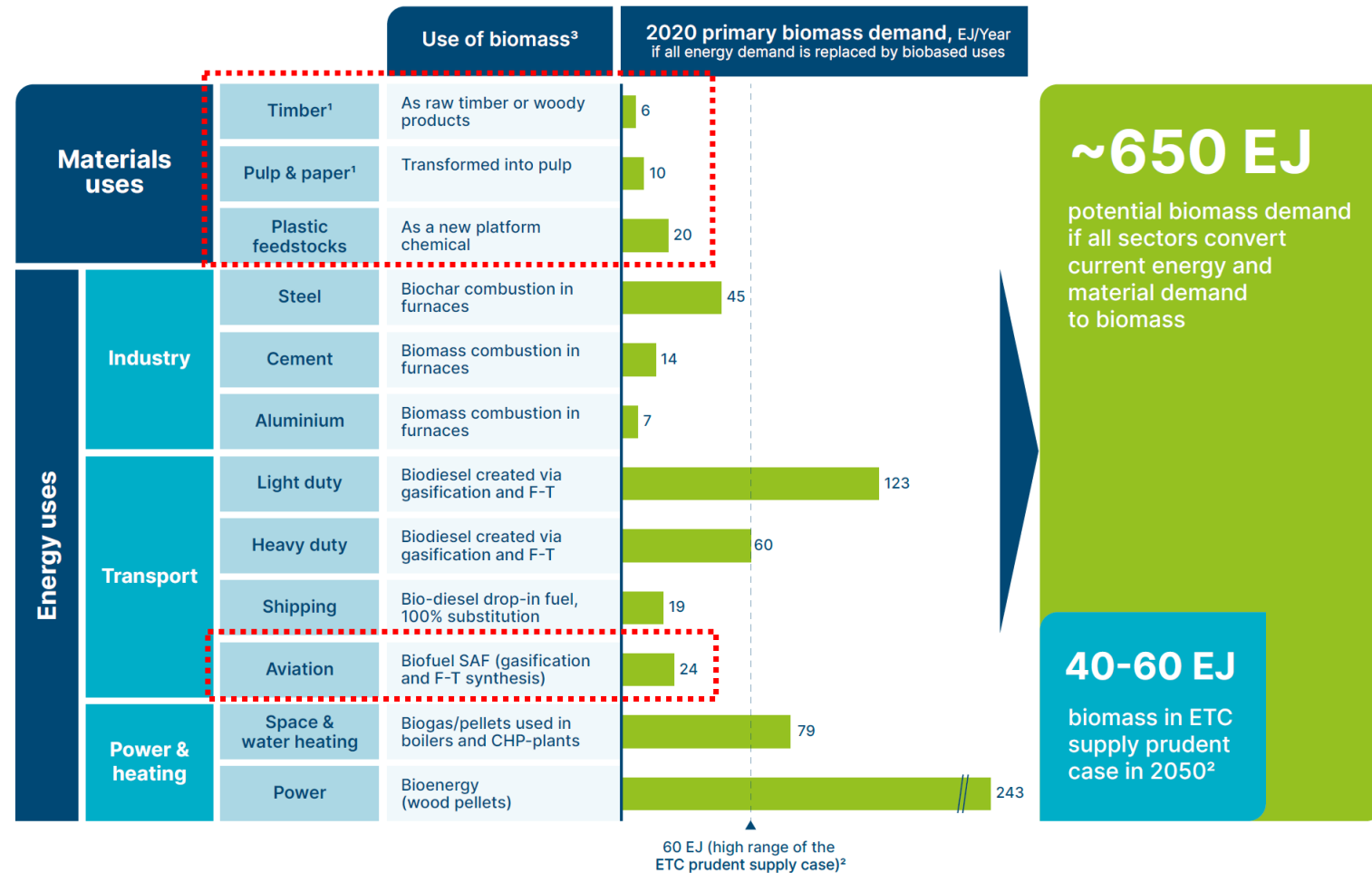
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Appendix

Bio-based decarbonisation can only be a small share of the decarbonisation technology mix



NOTE: F-T: Fischer-Tropsch. ¹ Wood resource balances show a ~13% gap between FAO sources (c.14 EJ/year, primary and secondary resources) and uses of woody biomass; ² Excludes c.4 EJ of recycled woody biomass. ³ Example bioresource for comparison; not exhaustive.

SOURCE: IEA ETP 2017 & 2020; Material Economics