



Clean Hydrogen and Texas

Impact of the IRA and Other Drivers on
Project Economics



October 2023

Presenter



Heather Leahey, P.Eng, CFA

Enverus Intelligence® Research

Vice President

587.315.3675

The Energy Industry **HAS CHANGED**





The IRA on a Single Slide



The legislation will invest nearly \$370 billion in energy security and climate programs over the next decade. Positive for all things energy transition. It is the **largest climate investment in U.S. history**. Extends and **expands tax credits** and **reduces ambiguity** in the market. The tax credits include additional technologies critical to meeting climate goals.



The ambiguity surrounding tax credits for wind and solar has been removed until at least 2032. The multipliers and adders mean that the PTC and ITC can be higher than previous full rates.



Standalone storage and **hydrogen also qualify** for tax credits now. The **45Q** for carbon capture technologies has been **expanded and extended**. Tax credit of up to \$7,500 for new EVs. Incentives for advanced manufacturing and mining for nearly all components necessary for energy evolution. A PTC introduced for nuclear facilities in service. Solar projects can choose the PTC in lieu of the ITC. Tax credits have become transferable for cash.

IRA Tax Credits Incentivize Clean Hydrogen Supply

Projects May Qualify for the 45V PTC, 48 ITC or 45Q Tax Credit

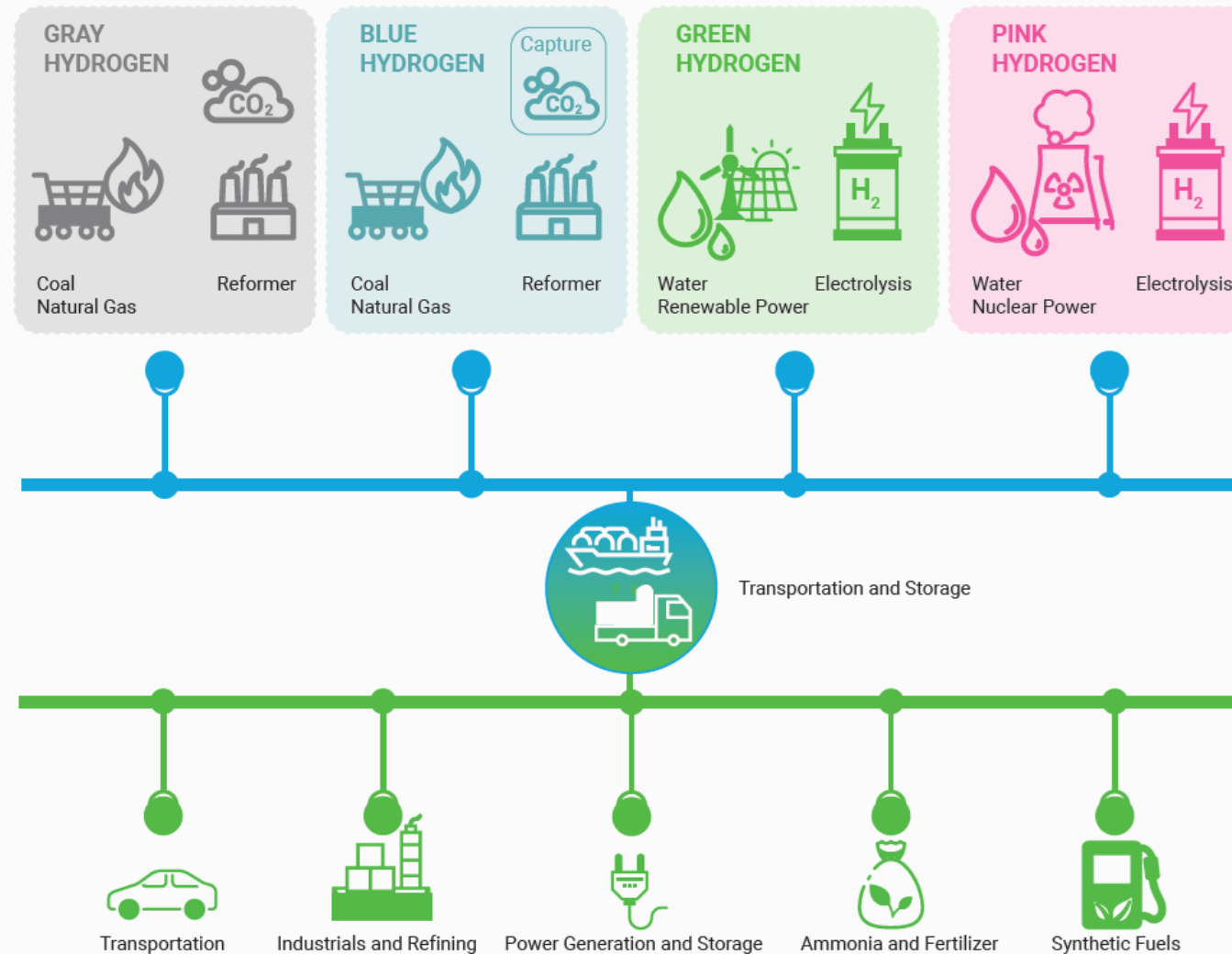
Lifecycle GHG Emissions (kg CO ₂ e/kg H ₂)	Tax Credit Value		
	45V PTC (\$/kg H ₂)	48 ITC (%)	45Q (\$/tonne CO ₂)
< 0.45	\$3.00	30%	
0.45 – 1.5	\$1.00	10%	\$85
1.5 – 2.5	\$0.75	7.5%	
2.5 – 4.0	\$0.60	6%	

Notes

- The tax credit values assume the prevailing wage and apprenticeship requirements are satisfied
- We do not consider the additional premium for domestic content or energy communities
- The 45V PTC, 48 ITC and 45Q tax credits cannot be stacked
- 45V PTC and 45Q are available for 10 years and 12 years, respectively. The 48 ITC is claimed during the first year of service. Construction must begin before 2033.
- Direct pay is accessible for the first five years.

Clean Hydrogen Can Decarbonize Value Chains

Blue Hydrogen Incorporates CCUS, Green and Pink Hydrogen Involve Low Carbon Power



Only Pink and Green Qualify for Max Hydrogen Tax Credits

Blue Hydrogen Projects Are Eligible for the 45V PTC, 48 ITC or 45Q Tax Credit

Color	Production Process	Lifecycle GHG Emissions (kg CO ₂ e/kg H ₂)
Gray	SMR without CCS	11.6
Blue	SMR with CCS	3.4
Pink	SOEC Electrolysis with Nuclear Power	0.3
Green	PEM Electrolysis	0.0

Notes

- Lifecycle GHG emissions are determined using the well-to-gate approach from the GREET model. These values are only relevant in determining 45V PTC and 48 ITC eligibility.
- We assume a 90% CO₂ capture rate for blue hydrogen leveraging SMR technology
- Individual project lifecycle GHG emissions will vary slightly based on unique process inputs and operations

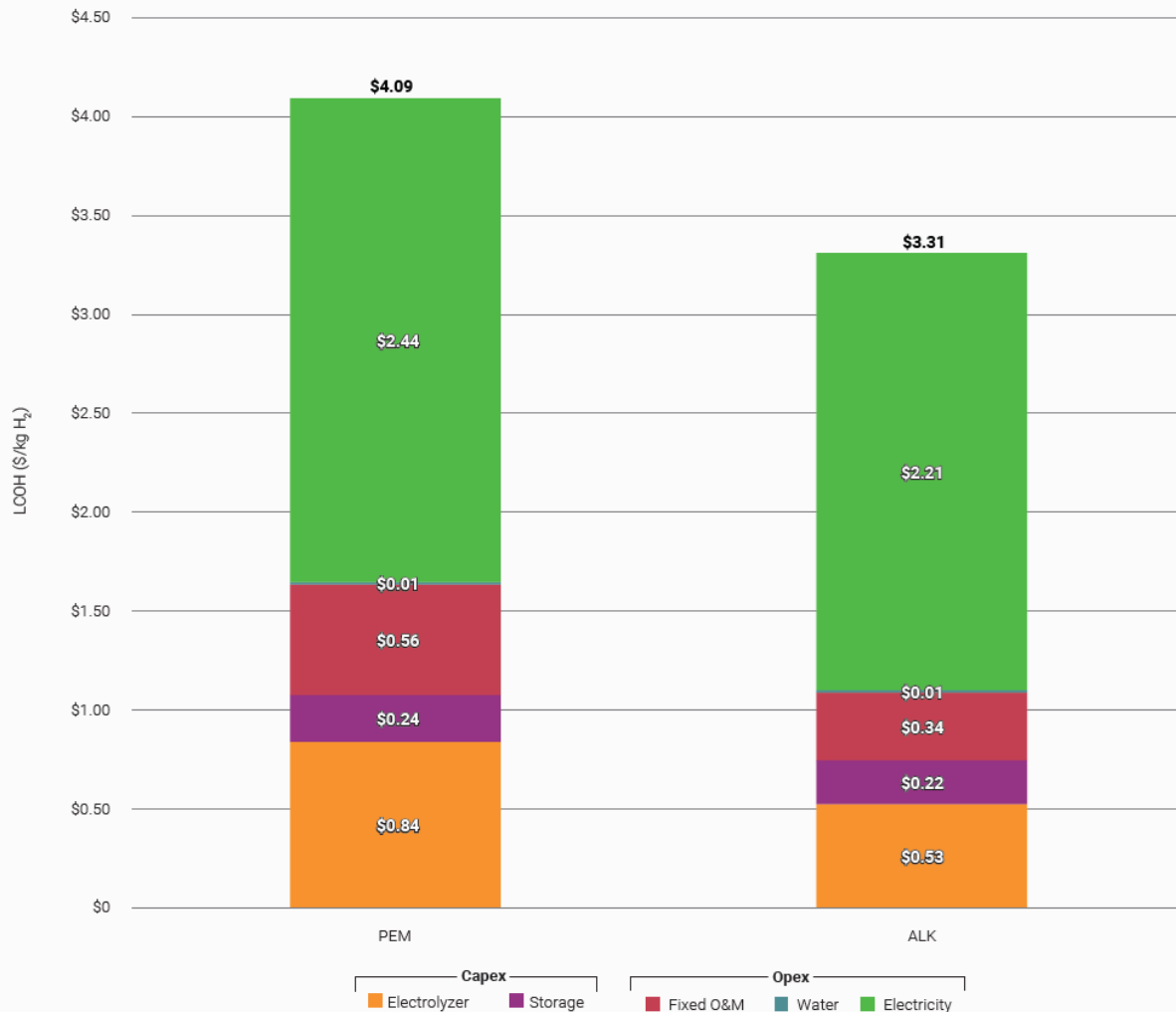
Green Hydrogen

Pathways to Paradise



Electricity Drives Unsubsidized Green Hydrogen Costs

Capex Only Contributes ~25% of Overall Costs and Limits Impact of 48 ITC vs. 45V PTC

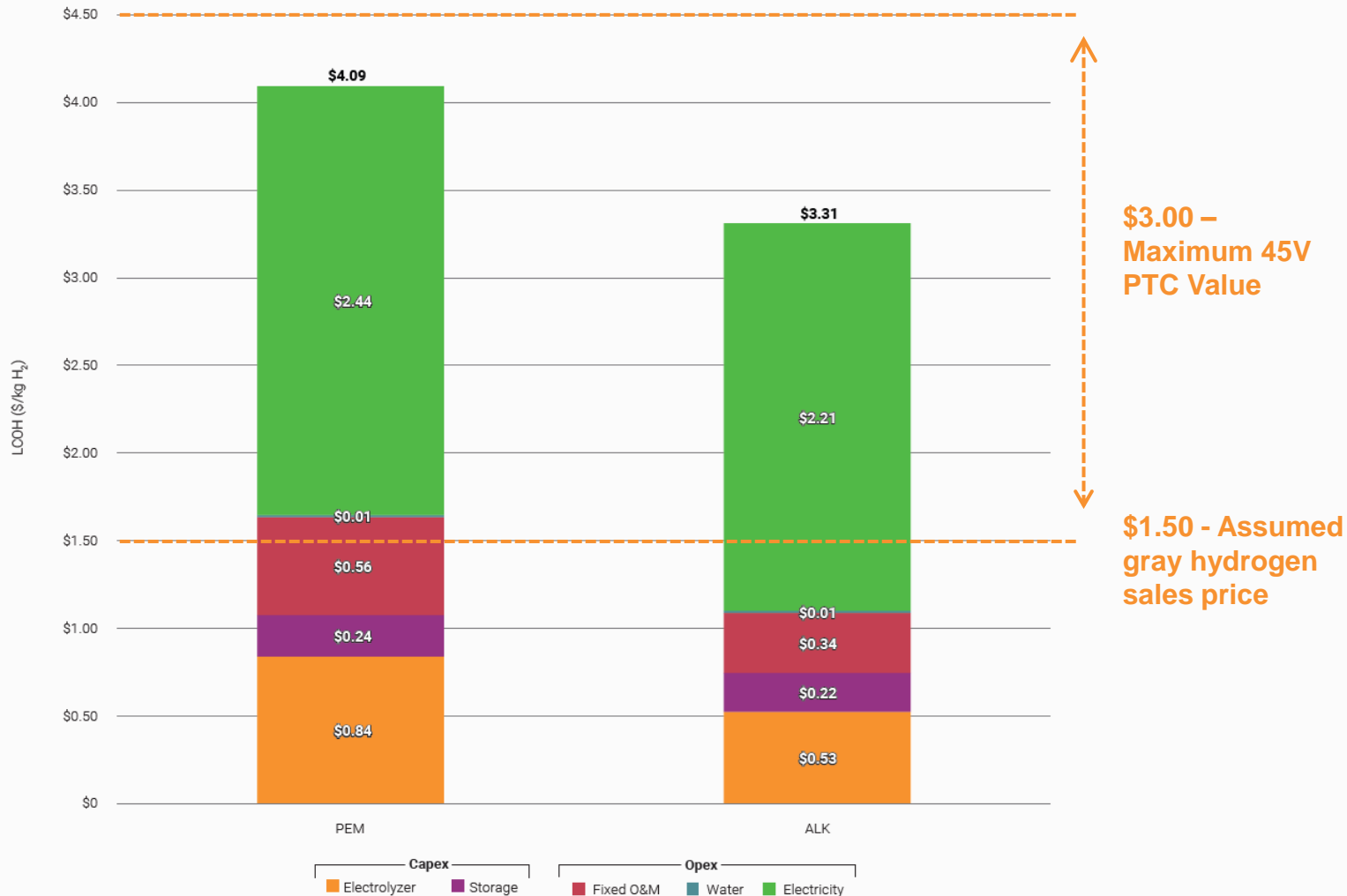


Assumptions

- Levelized Cost of Hydrogen (LCOH) is inclusive of taxes and is calculated for **50 MW** facilities over a **30-year** project life using a 10% discount rate
- We assume a **55% capacity factor** and **\$40/MWh** 30-year PPA and include 10 days of on-site storage

Electricity Drives Unsubsidized Green Hydrogen Costs

Capex Only Contributes ~25% of Overall Costs and Limits Impact of 48 ITC vs. 45V PTC

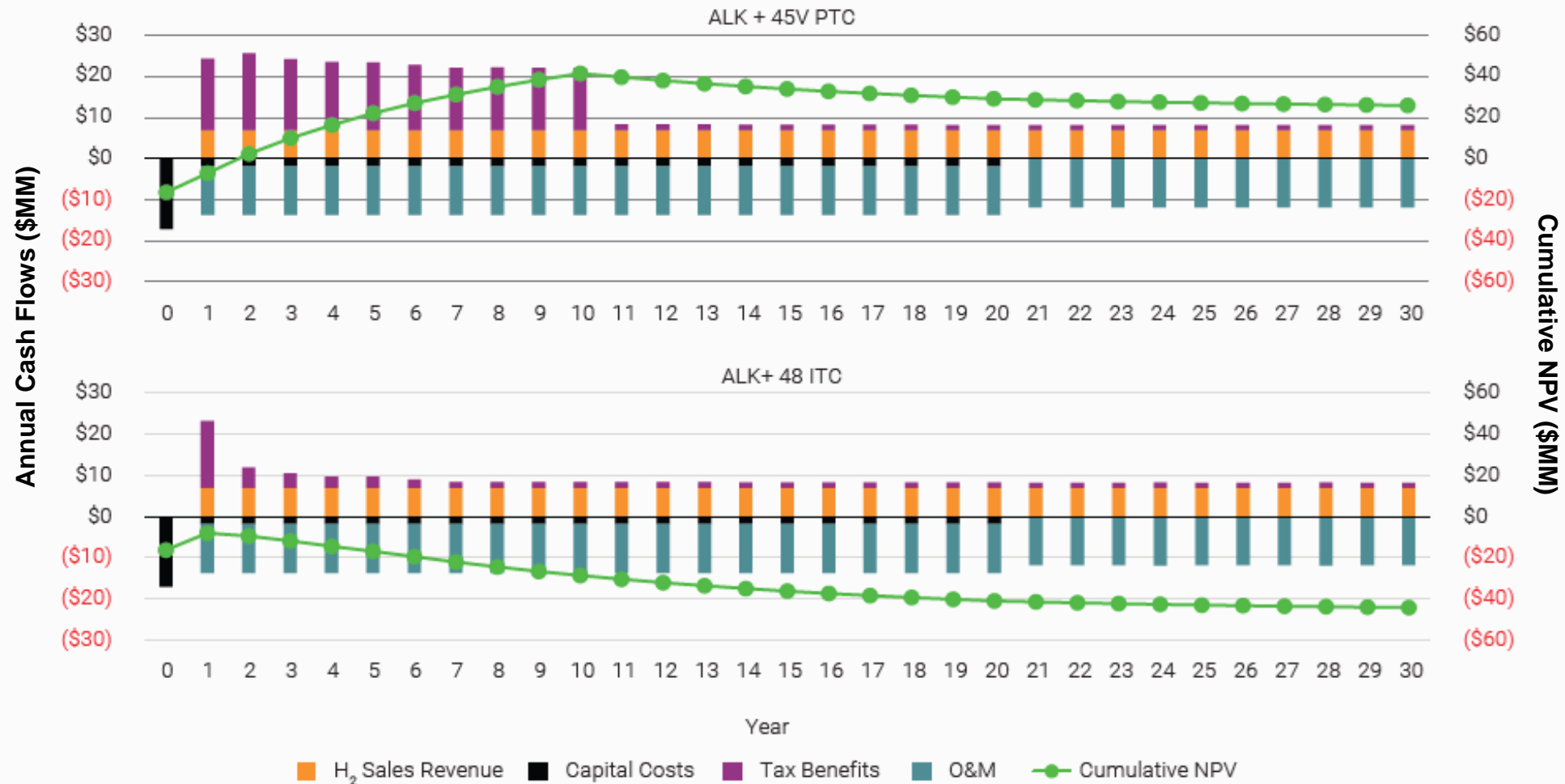


Assumptions

- Levelized Cost of Hydrogen (LCOH) is inclusive of taxes and is calculated for **50 MW** facilities over a **30-year** project life using a 10% discount rate
- We assume a **55% capacity factor** and **\$40/MWh** 30-year PPA and include 10 days of on-site storage

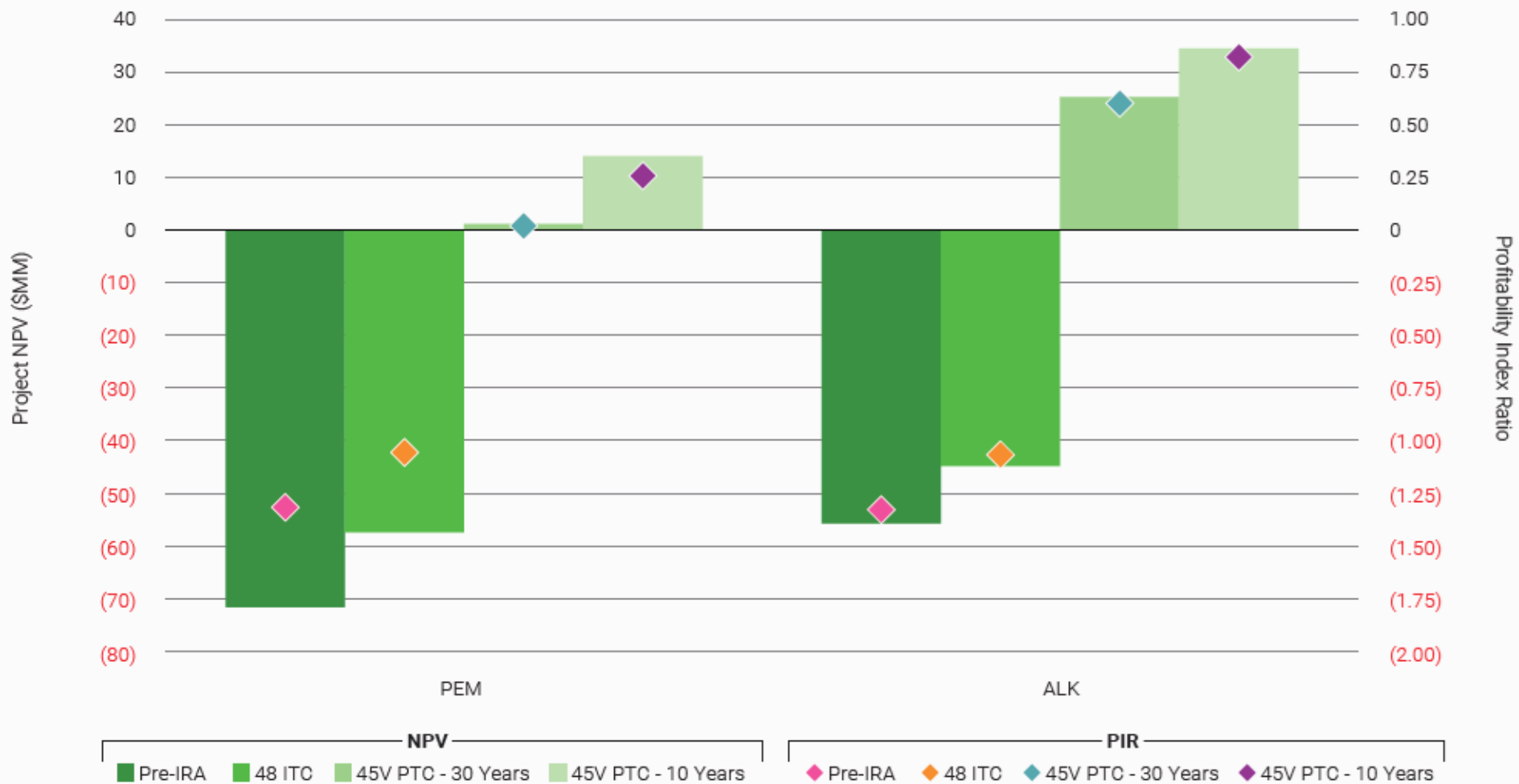
Net Cash Flows Turn Negative After Incentives End

Continued Production is Justified by Renegotiating Lower PPAs, Extensions to 45V PTC or Securing Green Hydrogen Premiums



Cumulative NPVs Peak in the Final Year of Incentives

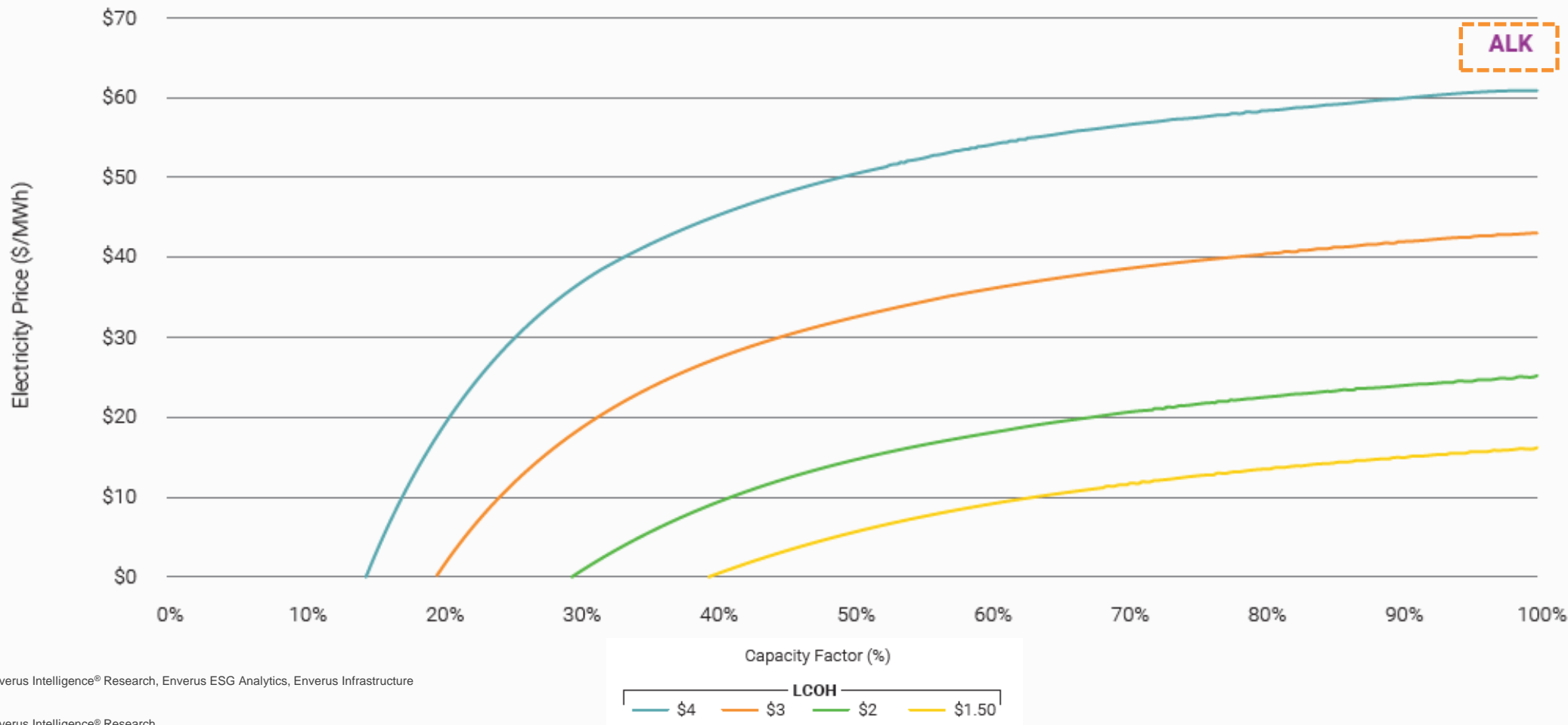
45V PTC Significantly Improves Green Hydrogen Project Economics, 48 ITC Fails to Drive Positive Returns



Source | Enverus Intelligence® Research

Unsubsidized ALK LCOH by Capacity Factor and Electricity Price

Projects Require PPAs < \$15/MWh, Capacity Factors > 40% to Compete with Gray Hydrogen

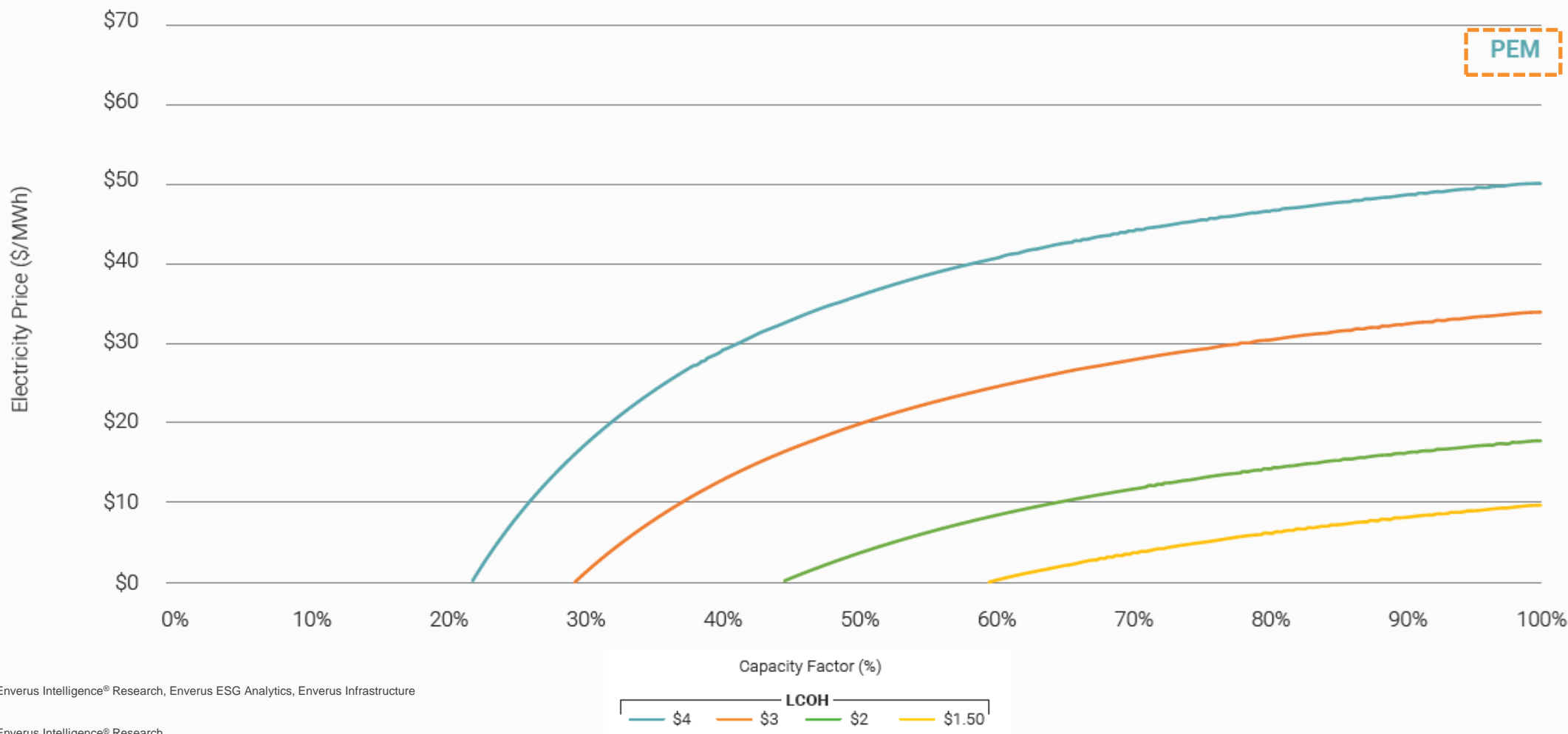


Source | Enverus Intelligence® Research, Enverus ESG Analytics, Enverus Infrastructure

Source | Enverus Intelligence® Research

Unsubsidized PEM LCOH by Capacity Factor and Electricity Price

Projects Require PPAs < \$10/MWh, Capacity Factors > 60% to Compete with Gray Hydrogen



Source | Enverus Intelligence® Research, Enverus ESG Analytics, Enverus Infrastructure

Source | Enverus Intelligence® Research



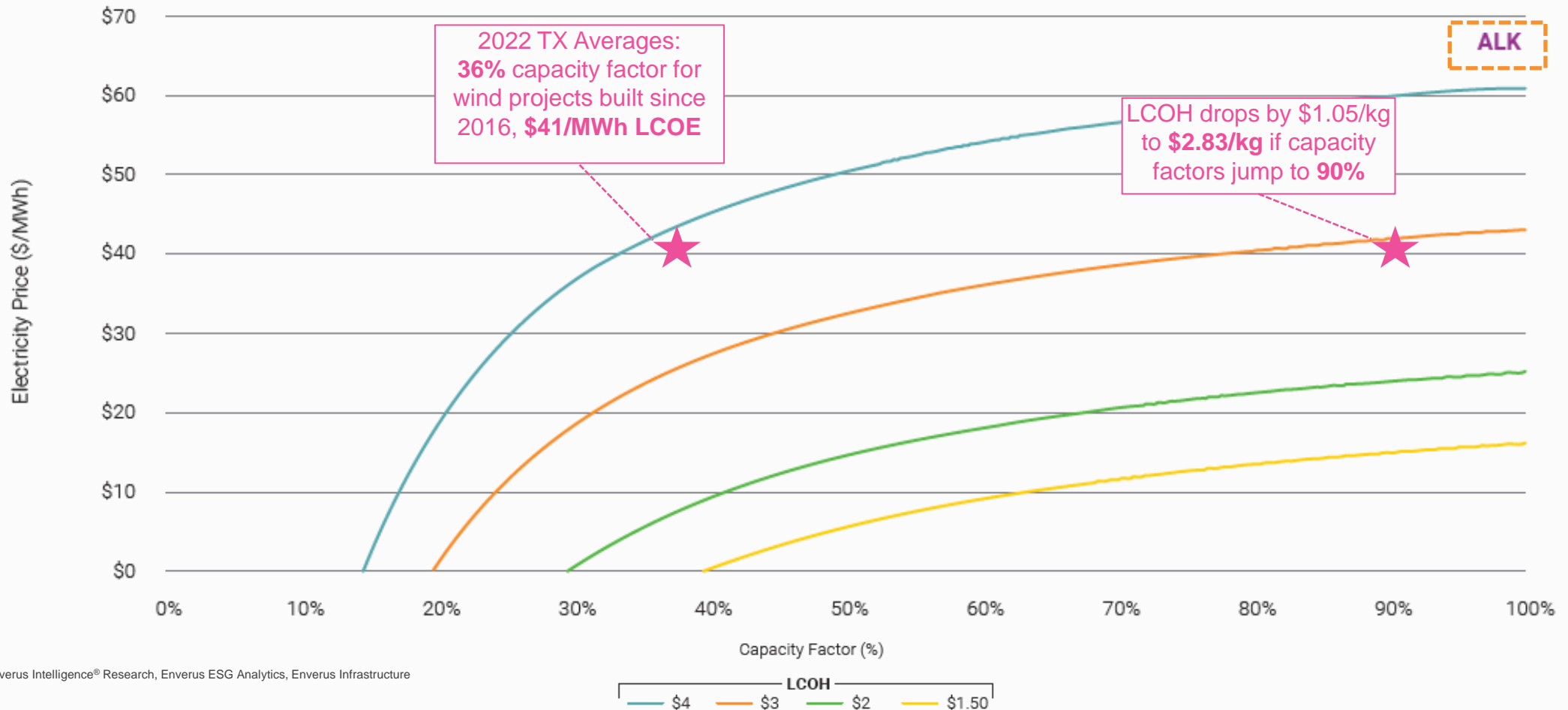
All Eyes on the Upcoming IRS Guidance

IRA Incentive Eligibility Hinges on Yet-to-be-Announced Lifecycle GHG Emissions Calculation

- **Additionality:** Green hydrogen production can only draw power from **new sources** of clean electricity
- **Deliverability:** Green hydrogen production must use **local sources** of clean electricity that are physically deliverable to the electrolyzer
- **Time-matching:** Green hydrogen production can only occur at the **same time** when the specified power source is generating electricity

Average 2022 Texas Inputs Lead to \$3.88/kg ALK LCOH

Grid Electricity + RECs Would Support Higher Capacity Factors, Meet CI Requirements



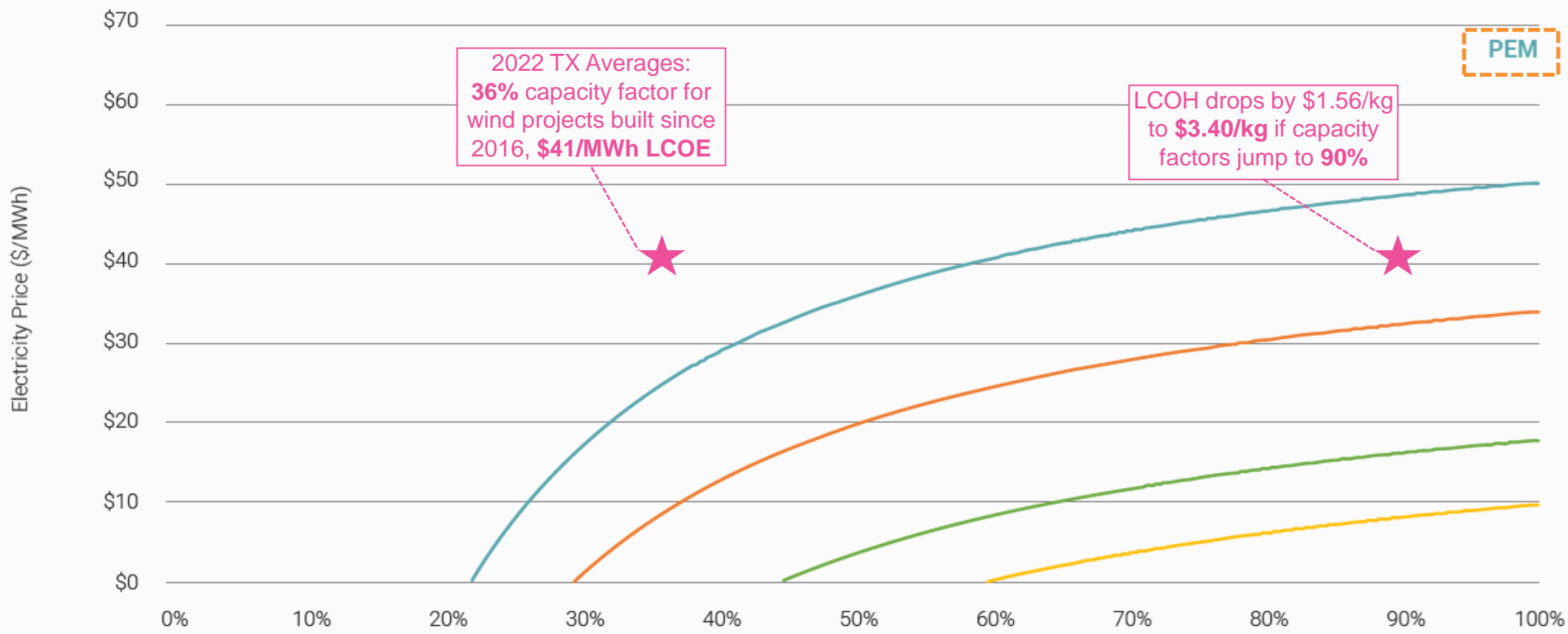
Source | Enverus Intelligence® Research, Enverus ESG Analytics, Enverus Infrastructure

Source | Enverus Intelligence® Research



Average 2022 Texas Inputs Lead to \$4.96/kg PEM LCOH

Grid Electricity + RECs Would Support Higher Capacity Factors, Meet CI Requirements



2022 TX Averages:
36% capacity factor for wind projects built since 2016, **\$41/MWh LCOE**

LCOH drops by **\$1.56/kg** to **\$3.40/kg** if capacity factors jump to **90%**

PEM

Source | Enverus Intelligence® Research, Enverus ESG Analytics, Enverus Infrastructure

Source | Enverus Intelligence® Research



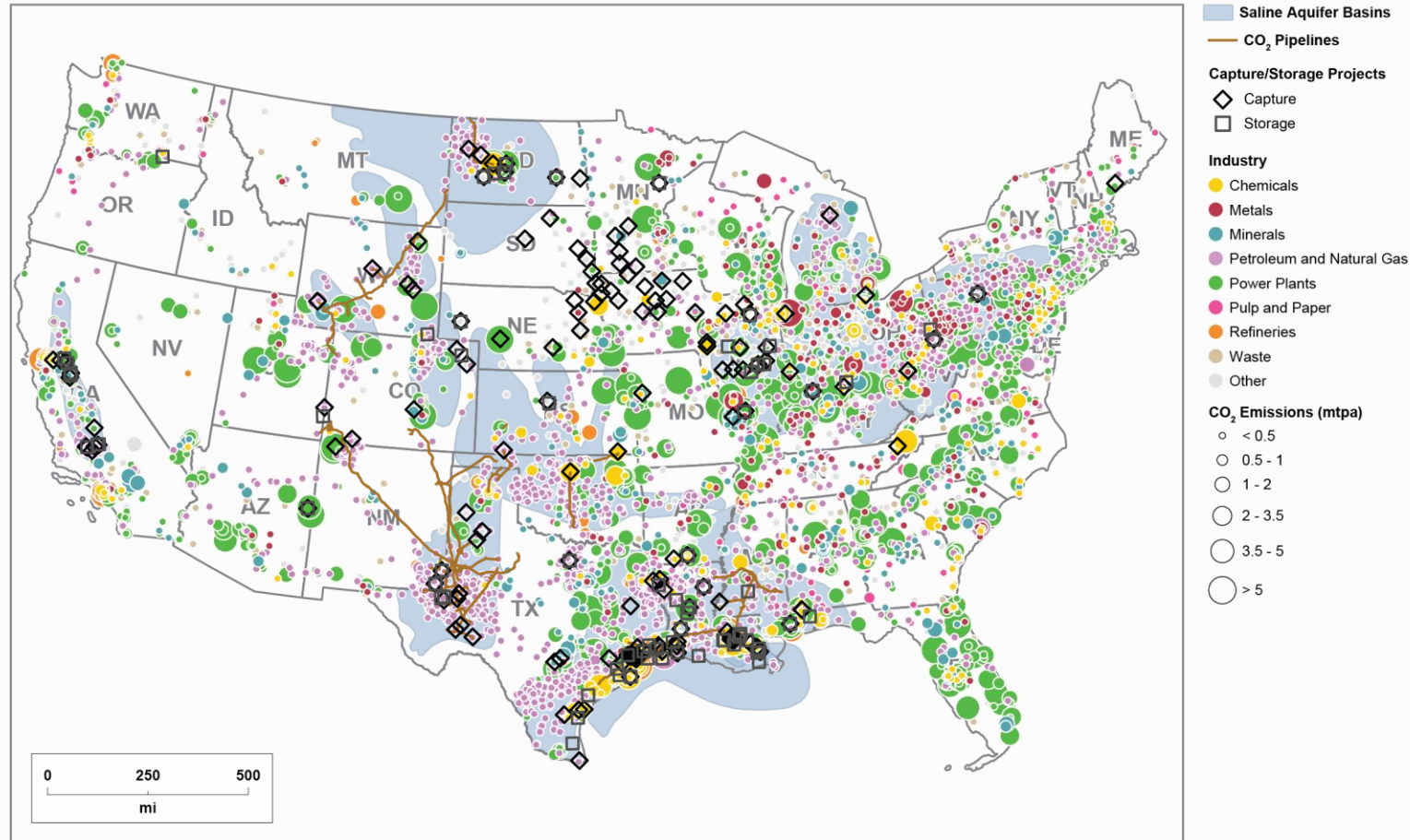
Blue Hydrogen

Not All Projects Are Created Equal



45Q Tax Credit Must be Spread Across Source-to-Sink Value Chain

Quality of Combined Capture, Transportation and Storage Resource Drives Project Economics

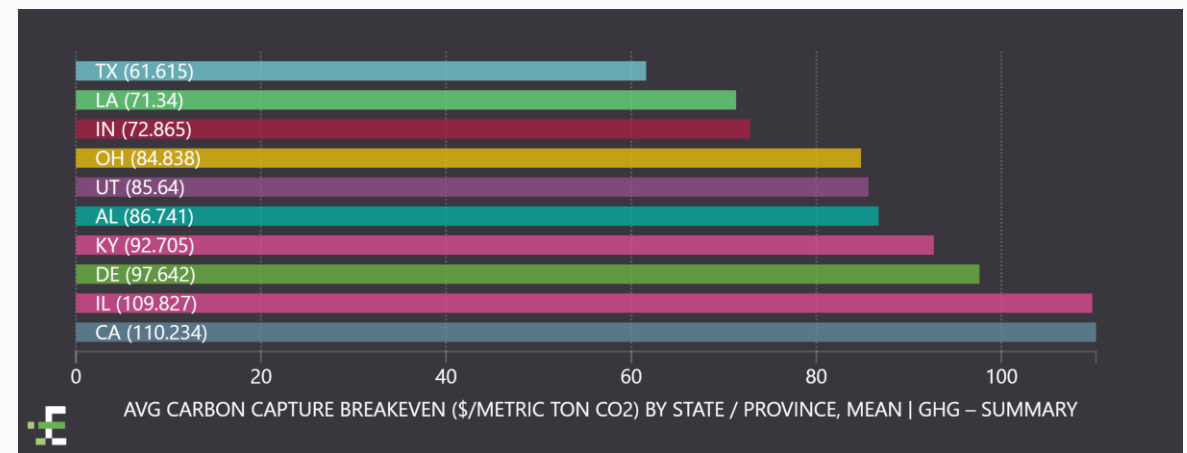
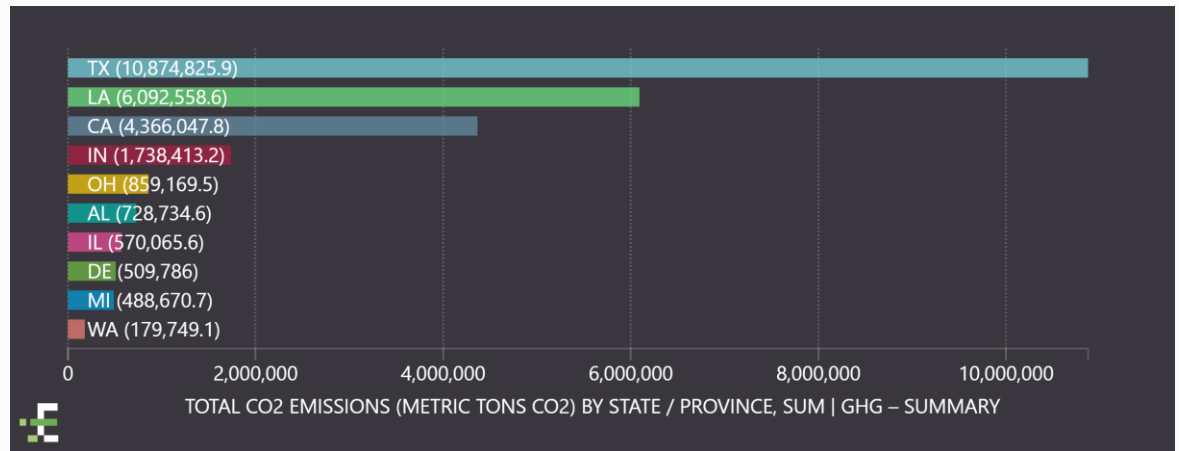
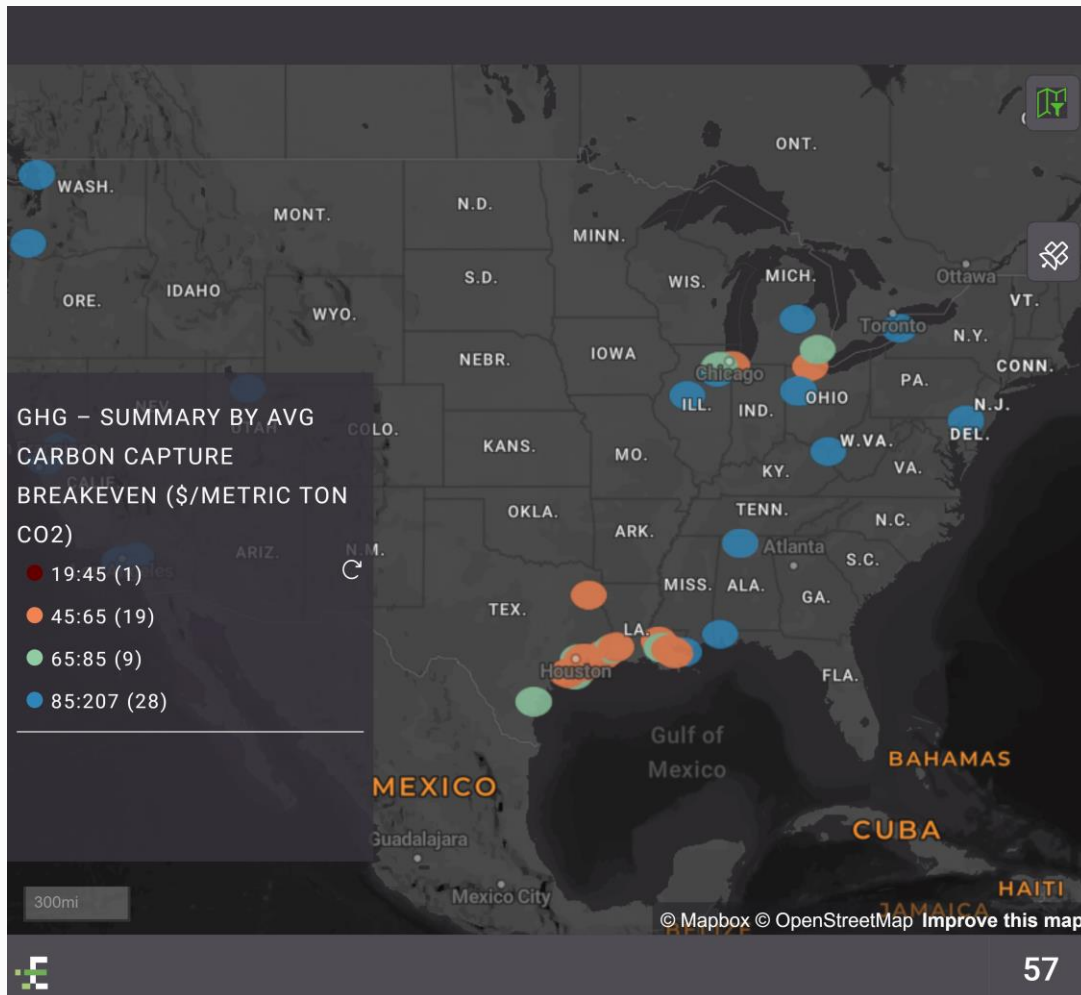


Note | Figure reflects operational and planned projects disclosed up to the end of September 2022. Emissions reflect 2021 point source data.

Source | Enverus Intelligence® Research, Enverus ESG Analytics

Leading Brownfield Hydrogen Capture Economics in Texas

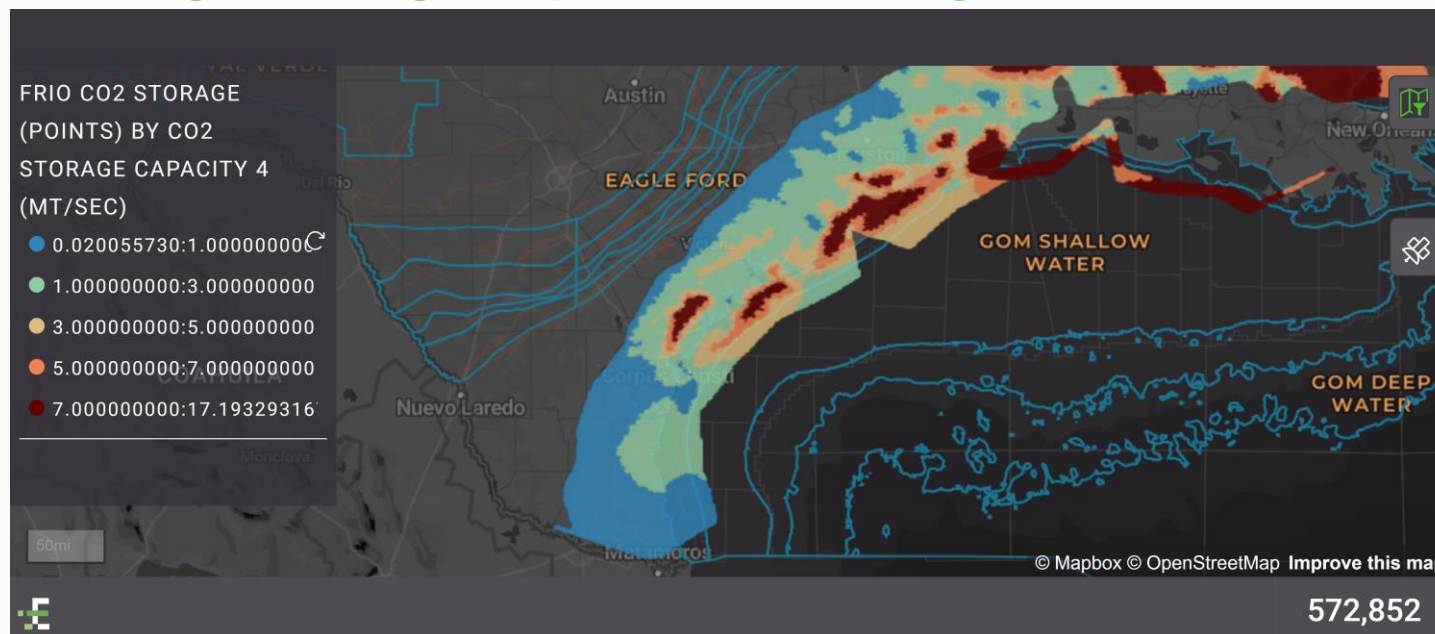
Labor, Material and Utility Cost Advantage Realized Along the Gulf Coast



Source | Enverus Intelligence® Research, Enverus ESG Analytics

Texas Frio Offers World Class CO₂ Injection Reservoirs

Although Average Capture and Storage Economics Leave Little Room for Transportation

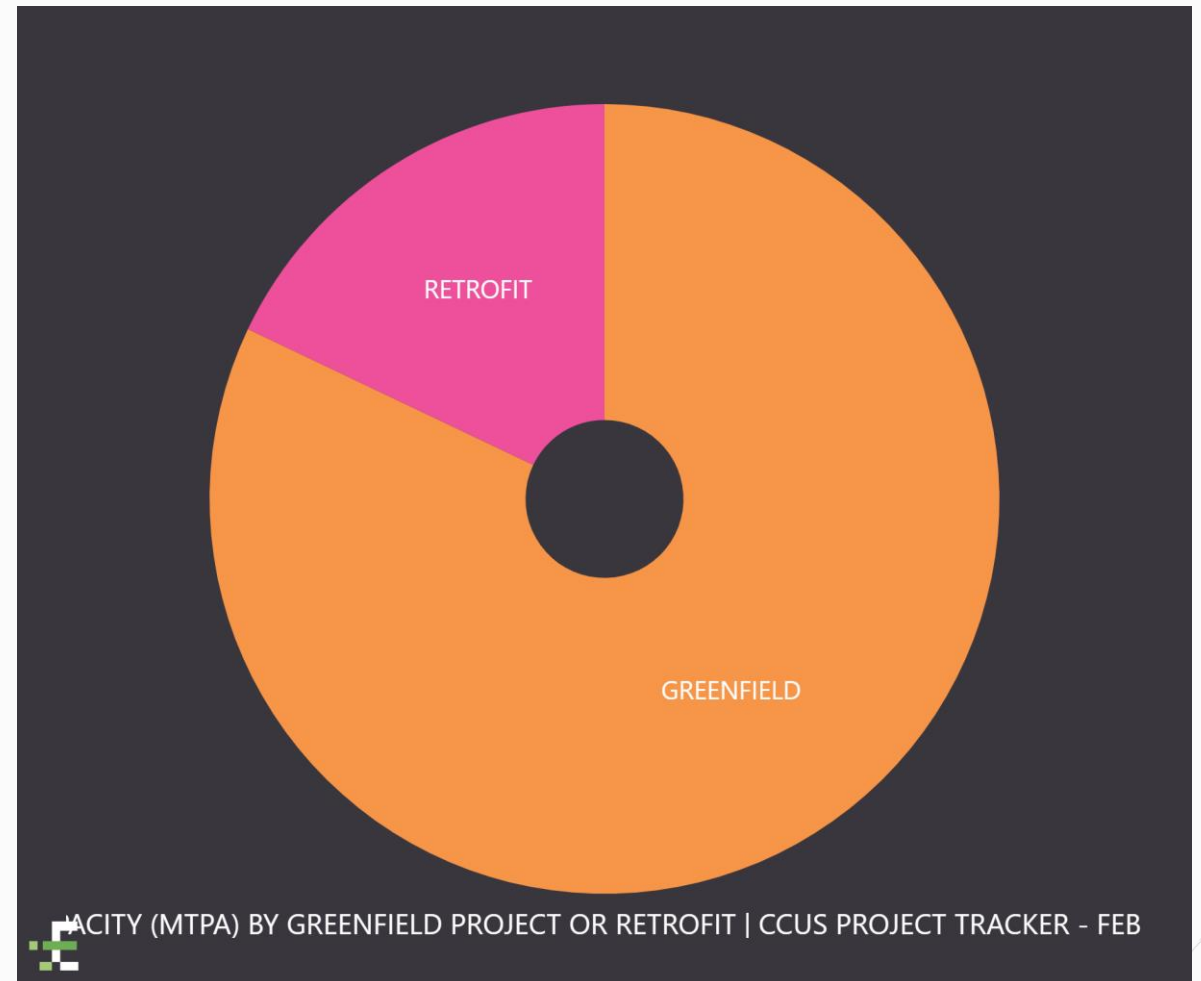
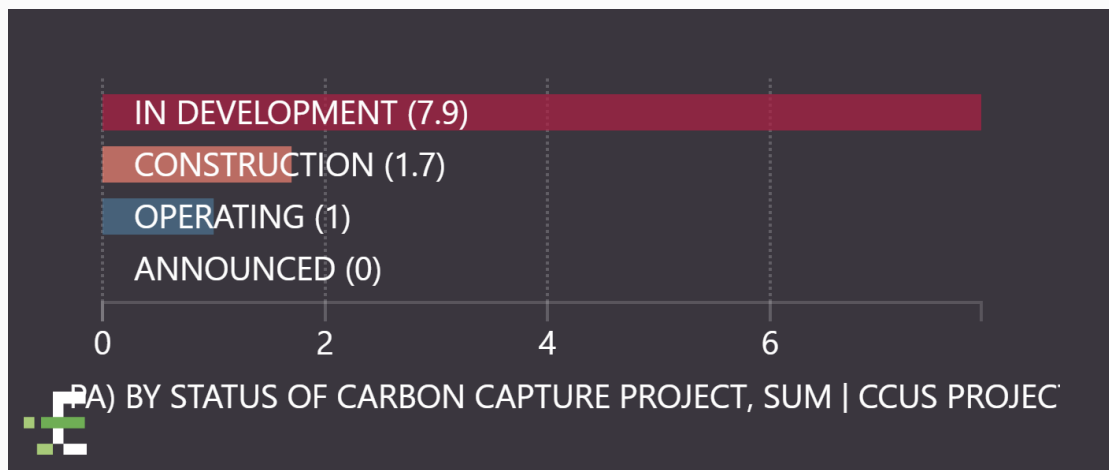
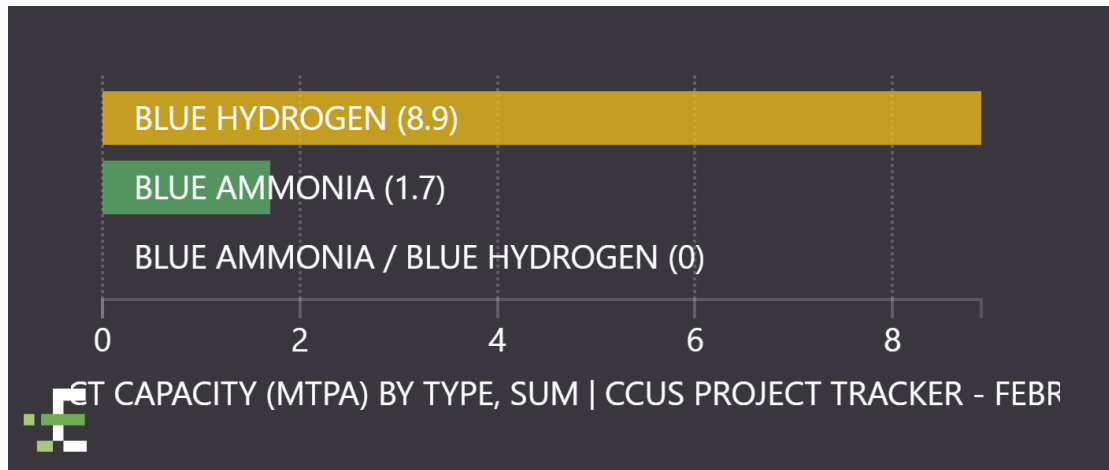


Formation	Reservoir Thickness (ft)	Porosity (%)	Permeability (mD)	Surface Area (Million Acres)	Storage (Mt/Sec)	Injectivity (Mt/Well/Year)	Total Storage (Gt)	Storage Breakevens (\$/tonne)	Efficiency Factor (%)
Appalachia Oriskany Sandstone	0-100	1-10	0.1-100	40	0.01-0.1	0.001-0.13	0.6	\$55-\$4,158	5
North Dakota Broom Creek	10-240	15-27	50-850	9.6	0.1-1.2	0.05-0.7	7.5	\$13-\$217	4
Texas Frio	200-1,625	16-30	200-2,000	21	1.2-16	0.27-3.9	117	\$10-\$18	4
Louisiana Oligocene-Miocene Sands	250-1,420	20-28	500-1,000	16	5.2-34	0.3-2.6	416	\$10-\$15	4
Basal Cambrian Sands	25-360	2-23	10-5,700	72	0.06-2.9	0.001-0.78	47.5	\$12-\$533	9.1

Source | Enverus Intelligence® Research, Enverus ESG Analytics

Greenfield Development Dominates Hydrogen Projects in TX

Greenfield Projects Prioritized Where Possible Due to Lower Cost Structure

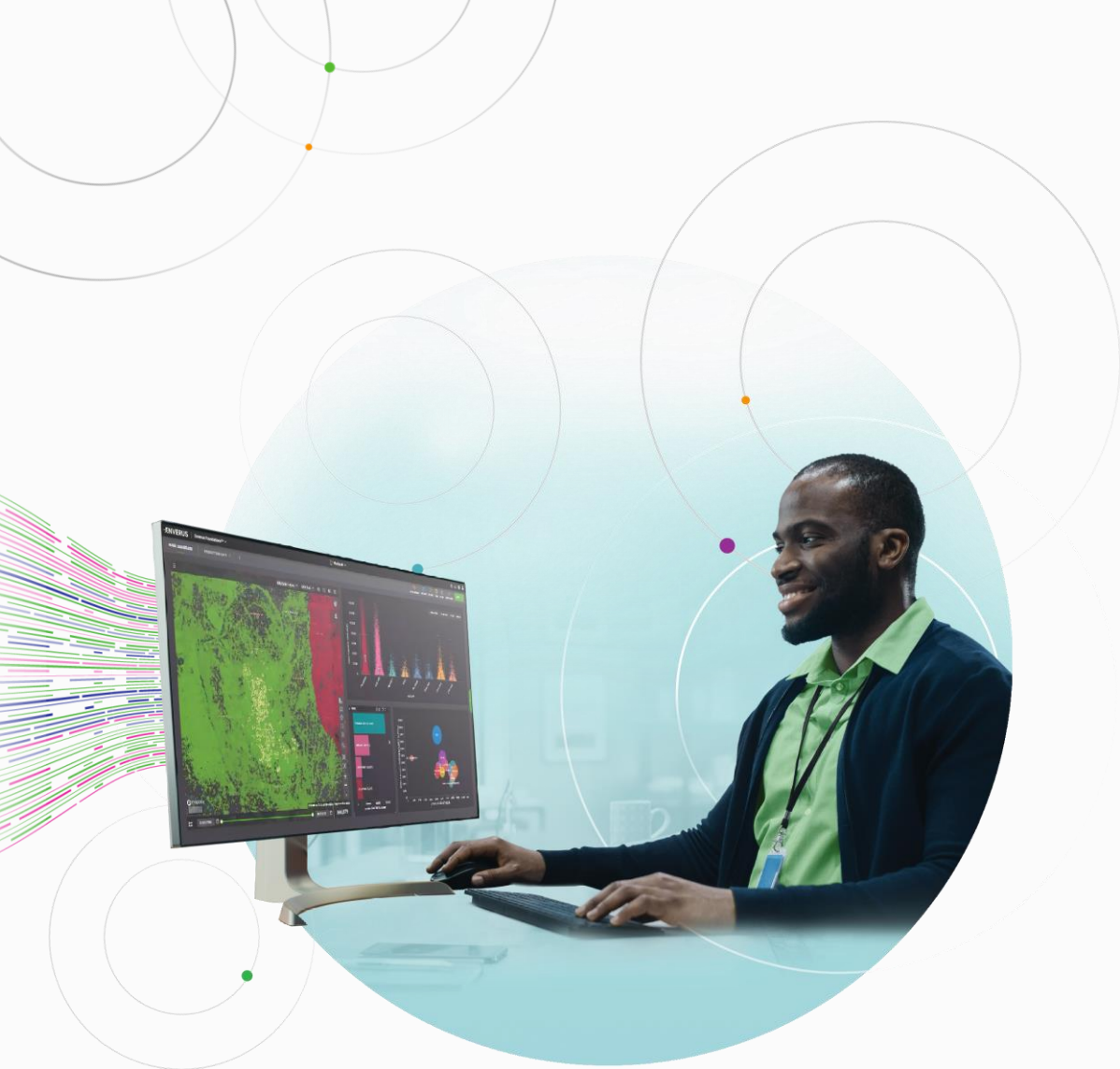


Source | Enverus Intelligence® Research, Enverus ESG Analytics

Please reach with any additional questions to **Heather Leahey** at heather.leahey@enverus.com

A circular graphic with a dark green background. It features silhouettes of a power transmission tower, solar panels, and a wind turbine against a lighter green, cloudy sky.

Signup for [Energy Transition Today](#), a weekly note where we spotlight our favorite ideas.



ENVERUS INTELLIGENCE® | RESEARCH DISCLOSURE STATEMENT:

© Copyright 2023 Enverus Intelligence Research, Inc., a part of Enverus. All rights reserved.

Investment advisory products and services, including research reports authored by the presenters, are provided by Enverus Intelligence Research, Inc., a registered investment advisor and a subsidiary of Enverus.

Visit www.Enverus.com/disclosures for additional information.

The information presented is provided for information purposes only and is not to be used or considered as investment advice or a recommendation or offer to buy, hold or sell any securities or other financial instruments. Enverus and its affiliates make no representation or warranty expressed or implied as to the accuracy or completeness of the information. Any opinions expressed reflect the judgment as of the date of recording, are subject to change at any time, and will not necessarily be updated. To the full extent provided by law, neither Enverus nor any of its affiliates accepts any liability whatsoever for any direct or consequential loss arising from any use of the information.