Modeling Hydrogen Using GPCM

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Hydrogen Basics

- Why Hydrogen?
  - Decarbonization goals demand reduction in CO_2 emissions
  - Burning hydrogen produces useful heat energy without CO_2
  - So, some see it as a potential replacement for natural gas
- But there are challenges
  - Unlike natural gas, hydrogen is not found naturally on earth
    - Except for some very small underground deposits and not in the air
  - It can only be produced economically using natural gas!
    - But that process produces CO_2 emissions
  - Producing hydrogen from water using electrolysis is very costly
    - And, actually, it might not be all that “green” anyway

Hydrogen "Colors"

- Proponents of hydrogen have developed systems for distinguishing hydrogen by how it is produced
- Of the many "colors" of H2, we can focus on three:
  - Gray Hydrogen
    - Produced using natural gas "reforming" processes without carbon capture. All CO2 produced is released into the atmosphere
  - Blue Hydrogen
    - Produced using natural gas "reforming" processes but WITH carbon capture and storage (CCS). About 90% of the CO2 is captured.
  - Green Hydrogen
    - Produced via electrolysis of water using "green" electricity, i.e. electricity generated from renewable, non-CO2 emitting sources only

Cost of Hydrogen Production (excluding N/G cost)

Relative costs of different H2 “colors” ($/kg)

Conversion cost	Natural Gas Reforming w/CCS	Natural Gas Reforming (no CCS)	Wind Electrolysis (PEM)	Solar Electrolysis (PEM)	Grid Electrolysis (PEM)
New England	1.29	0.39	3.78	4.30	7.83
Middle Atlantic	1.15	0.43	2.91	4.24	4.95
East North Central	1.05	0.35	2.75	4.24	4.49
West North Central	0.99	0.31	2.62	4.12	4.34
South Atlantic	1.05	0.37	2.91	3.85	4.17
East South Central	0.96	0.31	2.75	3.93	3.66
West South Central	0.99	0.32	2.50	3.81	3.93
Mountain	1.01	0.33	2.63	3.93	4.18
Pacific	1.26	0.46	3.38	3.86	6.01

Note: Natural gas reforming **excludes** the natural gas feedstock cost.

Source: University of Texas, Bureau of Economic Geology

Other Important Factors

- Using reforming, 1 volumetric unit of natural gas produces about 2.6 units of hydrogen gas (at standard conditions)
- BUT: 1 unit of hydrogen gas has only about 31.4% of the heat potential of 1 unit of natural gas
- So, the heat content conversion efficiency is actually about 2.6 x 0.314 = 0.816 or 81.6%
- This means there is a heat potential loss of about 18.4% using reforming processes to make hydrogen
- Note: these are approximations based on RBAC internet research

Modeling Hydrogen in Natural Gas Markets

- GPCM users can model integrated N/G + H2 markets using the concept of "natural gas equivalent" (NGE)
- Transactions in H2 markets can be expressed in terms of the heating value of N/G: that is, their NGE
  - 1 mmcf of NGE H2 has the same heating value as 1/0.314 = 3.18 mmcf of actual H2 at the same temp. and pressure
- H2 pipelines need special treatment because of the small size of the H2 molecule compared with N/G
  - If a natural gas pipeline is converted to carry H2, its NGE capacity might be different, but we believe it will be about the same as before. More research is needed on this point.

Other Factors to Consider in Modeling

- Burning H2 in compressor stations to provide driving force for H2 transport uses 3-4 times as much as with N/G
  - Compressor stations for H2 transport will likely be electric
  - So, cost is higher, but loss factor will be zero
- There is no real economic incentive to convert from N/G to H2 unless it is provided by the market or the government
  - Possible incentives include:
    - H2 production credit (blue/green only)
    - H2 delivery / consumption mandates
    - CO2 emissions penalties
  - In the following, we use all three of these incentives

Modeling Green Hydrogen in GPCM

- As with natural gas modeling, we must address production, transportation, and delivery to market (consumption)
  - We can also address H2 storage, but not in this presentation
- Let's start with production
  - For "green" H2, we can create supply curves just as we do for natural gas. We can create single or multiple segment supply curves, and we can make them price sensitive or insensitive
  - But first we need to define a "Supply Play" in GPCM. So let's focus on Texas and define a "Supply Play" named "Green Hydrogen" in Texas Railroad Commission District 3 (Gulf Coast)
  - Do this in the Suppliers and Supplier Locations tables in GPCM

H2 Supply Curves (in NGE)

Supply_Summary

Region	Sup_Code	Period	Cnt	S1	S2	P1	P2	Elasticity
TX RRC 3	Green Hydrogen	2025	0	1,000.00	1,250.00	20.00	32.00	0.47
TX RRC 3	Green Hydrogen	2026	0	1,100.00	1,375.00	19.80	31.68	0.47
TX RRC 3	Green Hydrogen	2027	0	1,207.23	1,509.04	19.60	31.36	0.47
TX RRC 3	Green Hydrogen	2028	0	1,334.05	1,667.56	19.40	31.04	0.47
TX RRC 3	Green Hydrogen	2029	0	1,464.10	1,830.13	19.20	30.72	0.47
TX RRC 3	Green Hydrogen	2030	0	1,610.51	2,013.14	19.00	30.40	0.47
TX RRC 3	Green Hydrogen	2031	0	1,767.50	2,209.38	18.80	30.08	0.47
TX RRC 3	Green Hydrogen	2032	0	1,953.18	2,441.48	18.60	29.76	0.47
TX RRC 3	Green Hydrogen	2033	0	2,143.59	2,679.49	18.40	29.44	0.47
TX RRC 3	Green Hydrogen	2034	0	2,357.95	2,947.43	18.20	29.12	0.47
TX RRC 3	Green Hydrogen	2035	0	2,587.80	3,234.75	18.00	28.80	0.47
TX RRC 3	Green Hydrogen	2036	0	2,859.65	3,574.57	17.80	28.48	0.47
TX RRC 3	Green Hydrogen	2037	0	3,138.43	3,923.04	17.60	28.16	0.47
TX RRC 3	Green Hydrogen	2038	0	3,452.27	4,315.34	17.40	27.84	0.47
TX RRC 3	Green Hydrogen	2039	0	3,788.80	4,736.00	17.20	27.52	0.47
TX RRC 3	Green Hydrogen	2040	0	4,186.82	5,233.52	17.00	27.20	0.47
TX RRC 3	Green Hydrogen	2041	0	4,594.97	5,743.71	16.80	26.88	0.47
TX RRC 3	Green Hydrogen	2042	0	5,054.47	6,318.09	16.60	26.56	0.47
TX RRC 3	Green Hydrogen	2043	0	5,547.18	6,933.98	16.40	26.24	0.47
TX RRC 3	Green Hydrogen	2044	0	6,129.92	7,662.40	16.20	25.92	0.47
TX RRC 3	Green Hydrogen	2045	0	6,727.50	8,409.38	16.00	25.60	0.47
TX RRC 3	Green Hydrogen	2046	0	7,400.25	9,250.32	15.80	25.28	0.47
TX RRC 3	Green Hydrogen	2047	0	8,121.63	10,152.04	15.60	24.96	0.47
TX RRC 3	Green Hydrogen	2048	0	8,974.81	11,218.52	15.40	24.64	0.47
TX RRC 3	Green Hydrogen	2049	0	9,849.74	12,312.17	15.20	24.32	0.47
TX RRC 3	Green Hydrogen	2050	0	10,834.71	13,543.38	15.00	24.00	0.47

Note: this scenario assumes a modest cost reduction of 25% between 2025 and 2030 with increasing production capacity.

H2 Demand (in NGE)

- Now define one or more customers to receive the H2
- In the following example, we define a new GPCM customer named “Texas H2 Demand”, Cust Type = H2

Customer

Cust_Name	Cust_Code	Cust_Type
Texas H2 Demand	IND073	H2

- We located this customer in Texas South (ERCOT)

Customer_Location

Cust_Code	Loc_Code	Census_Region	Cust_Type
Texas H2 Demand	Texas South (ERCOT)	WSC	H2

- Then we created Demand records for this customer

H2 Demand (in NGE)

Region	Sector	Period	Cnt	D1	D2	P1	P2	Elasticity
Texas South (ERCOT)	H2	2025	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2026	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2027	0	919.06	1,007.86	40.00	10.00	0.07
Texas South (ERCOT)	H2	2028	0	923.34	1,012.57	40.00	10.00	0.07
Texas South (ERCOT)	H2	2029	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2030	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2031	0	919.06	1,007.86	40.00	10.00	0.07
Texas South (ERCOT)	H2	2032	0	923.34	1,012.57	40.00	10.00	0.07
Texas South (ERCOT)	H2	2033	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2034	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2035	0	919.06	1,007.86	40.00	10.00	0.07
Texas South (ERCOT)	H2	2036	0	923.34	1,012.57	40.00	10.00	0.07
Texas South (ERCOT)	H2	2037	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2038	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2039	0	919.06	1,007.86	40.00	10.00	0.07
Texas South (ERCOT)	H2	2040	0	923.34	1,012.57	40.00	10.00	0.07
Texas South (ERCOT)	H2	2041	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2042	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2043	0	919.06	1,007.86	40.00	10.00	0.07
Texas South (ERCOT)	H2	2044	0	923.34	1,012.57	40.00	10.00	0.07
Texas South (ERCOT)	H2	2045	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2046	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2047	0	919.06	1,007.86	40.00	10.00	0.07
Texas South (ERCOT)	H2	2048	0	923.34	1,012.57	40.00	10.00	0.07
Texas South (ERCOT)	H2	2049	0	921.16	1,010.15	40.00	10.00	0.07
Texas South (ERCOT)	H2	2050	0	921.16	1,010.15	40.00	10.00	0.07

Note: we computed a fraction of the 24Q3 IND N/G demand for Texas South (ERCOT) to use in this example.

Modeling Green Hydrogen Transport

- To connect the new NGE H2 supply and demand curves we need a new pipeline
- We can do this using the GPCM Pipeline Builder
- We recommend designing the new pipeline with three zones: one each for supply, transport, and delivery to customers
- The next slide shows how we did this:

Building a New Pipeline with Three Zones

New Pipeline Builder
(follow the directions below)

To build a new pipeline, enter the relevant data in each tab below, beginning with the Pipeline tab and proceding from left to right. above to load your new pipeline to GPCM for use.

Pipeline | Pipeline Zones | Pipeline Links | Supply Links | Demand Links | Intx Links | Storage Links | Pipeline State Connectivity

Pipe Name: Texas H2 Pipeline
Beg_Date: Jan-2024
Location: US L48
Pipe Type: Intrastate
Status: Hypothetical
Pipe_Code PL803

Begin a new pipeline by entering a pipe name. Next, select the pipeline's starting date, location, type, and status.

Next select the Zone tab and add one or more zones. After adding your Zones, you can then add links by clicking the appropriate tabs and entering the data.

After entering all of the data to build your pipeline, press the Build button to load out the data to GPCM.

New Pipeline Builder
(follow the directions below)

Clear | Build

To build a new pipeline, enter the relevant data in each tab below, beginning with the Pipeline tab and proceding from left to right. When all data is entered, click the Bui above to load your new pipeline to GPCM for use.

Pipeline | Pipeline Zones | Pipeline Links | Supply Links | Demand Links | Intx Links | Storage Links | Pipeline State Connectivity

Zone	State	Beg_Date	Project_ID	Capacity	Min_Cost	Max_Cost	Fuel %	FDQ%	ZDQ%	NDQ%	NDQ_Mult
Texas H2 Trans	TX	Jan-2024		2,600	$0.0000	$0.0000	0.000%	50.0%	80.0%	95.0%	3.00
Texas H2 Supply	TX	Jan-2024		2,600	$0.0000	$0.0000	0.000%	50.0%	80.0%	95.0%	3.00
Texas H2 Deliv	TX	Jan-2024		2,600	$0.0000	$0.0000	0.000%	50.0%	80.0%	95.0%	3.00
				0	$0.0000	$0.0000	0.000%	50.0%	80.0%	95.0%	3.00

But we also need to create the links between the zones and to supply and demand

Pipeline Zone, Supply, and Demand Links

New Pipeline Builder
(follow the directions below)

Clear | Build

To build a new pipeline, enter the relevant data in each tab below, beginning with the Pipeline tab and proceding from left to right. When all data is entered, click the Build above to load your new pipeline to GPCM for use.

Pipeline | Pipeline Zones | Pipeline Links | Supply Links | Demand Links | Intx Links | Storage Links | Pipeline State Connectivity

From_Zone	To_Zone	Beg_Date	Project_ID	Capacity
Texas H2 Trans	Texas H2 Deliv	Jan-2024		2,600
Texas H2 Supply	Texas H2 Trans	Jan-2024		2,600
				0

New Pipeline Builder
(follow the directions below)

Clear | Build

To build a new pipeline, enter the relevant data in each tab below, beginning with the Pipeline tab and proceding from left to right. When all data is entered, click the Buil above to load your new pipeline to GPCM for use.

Pipeline | Pipeline Zones | Pipeline Links | Supply Links | Demand Links | Intx Links | Storage Links | Pipeline State Connectivity

Zone	Supply Area	Supplier	Beg_Date	Project_ID	Capacity
Texas H2 Supply	TX RRC 3	Green Hydrogen	Jan-2024		2,600
					0

New Pipeline Builder
(follow the directions below)

Clear | Build

To build a new pipeline, enter the relevant data in each tab below, beginning with the Pipeline tab and proceding from left to right. When all data is entered, click the Bui above to load your new pipeline to GPCM for use.

Pipeline | Pipeline Zones | Pipeline Links | Supply Links | Demand Links | Intx Links | Storage Links | Pipeline State Connectivity

Zone	Demand Area	Customer	Beg_Date	Project_ID	Capacity
Texas H2 Trans	Texas South (ERCOT)	Texas H2 Demand	Jan-2024		2,600
					0

H2 Transport Details

- We also need to add costs and losses to our model of H2 transportation
  - For this example, we chose to include transport costs on the Texas H2 Trans zone only. We also chose to use electricity for compression so there are no losses
  - Note the credit of $5.67 to account for no CO2 with green H2

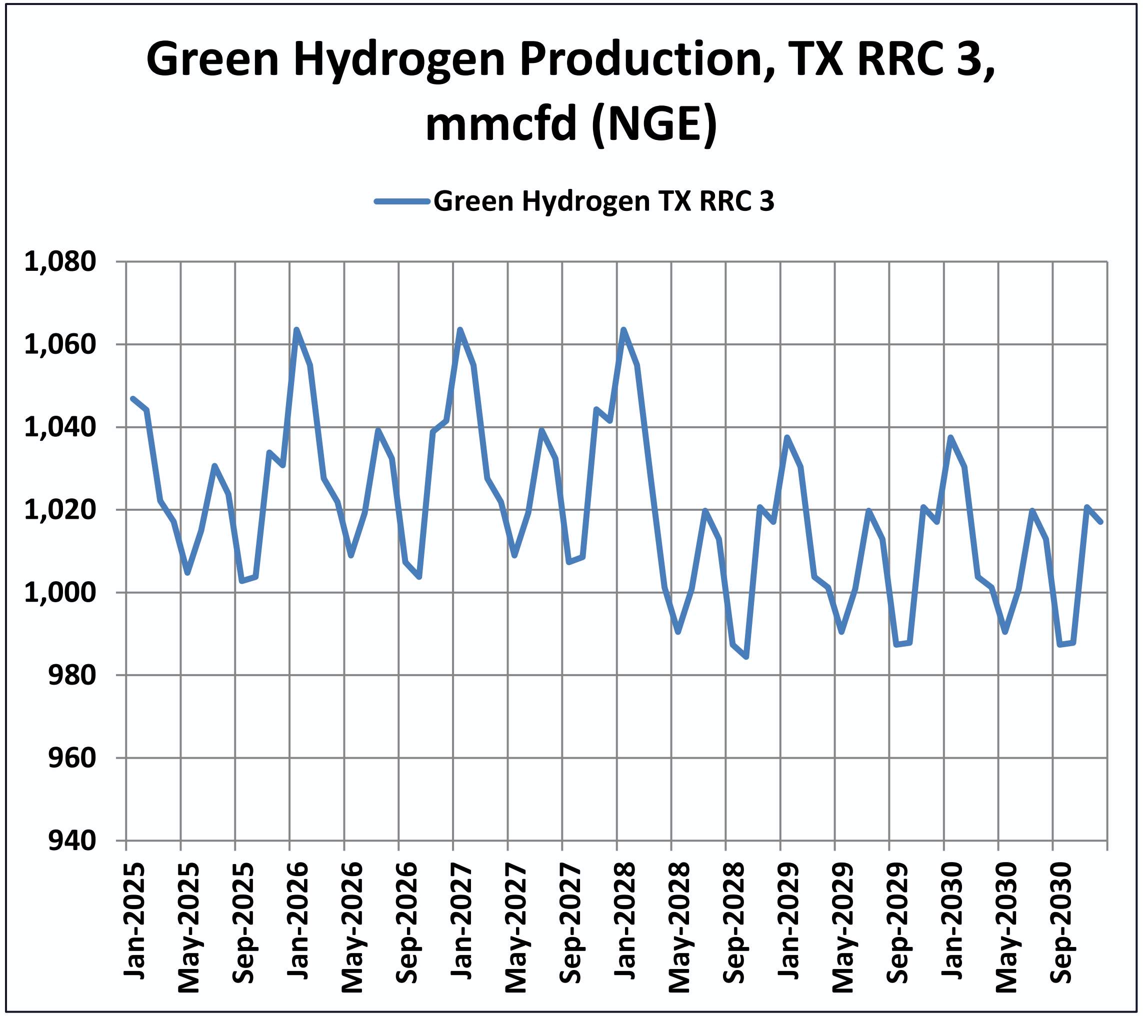
Transport_Zone_Subform

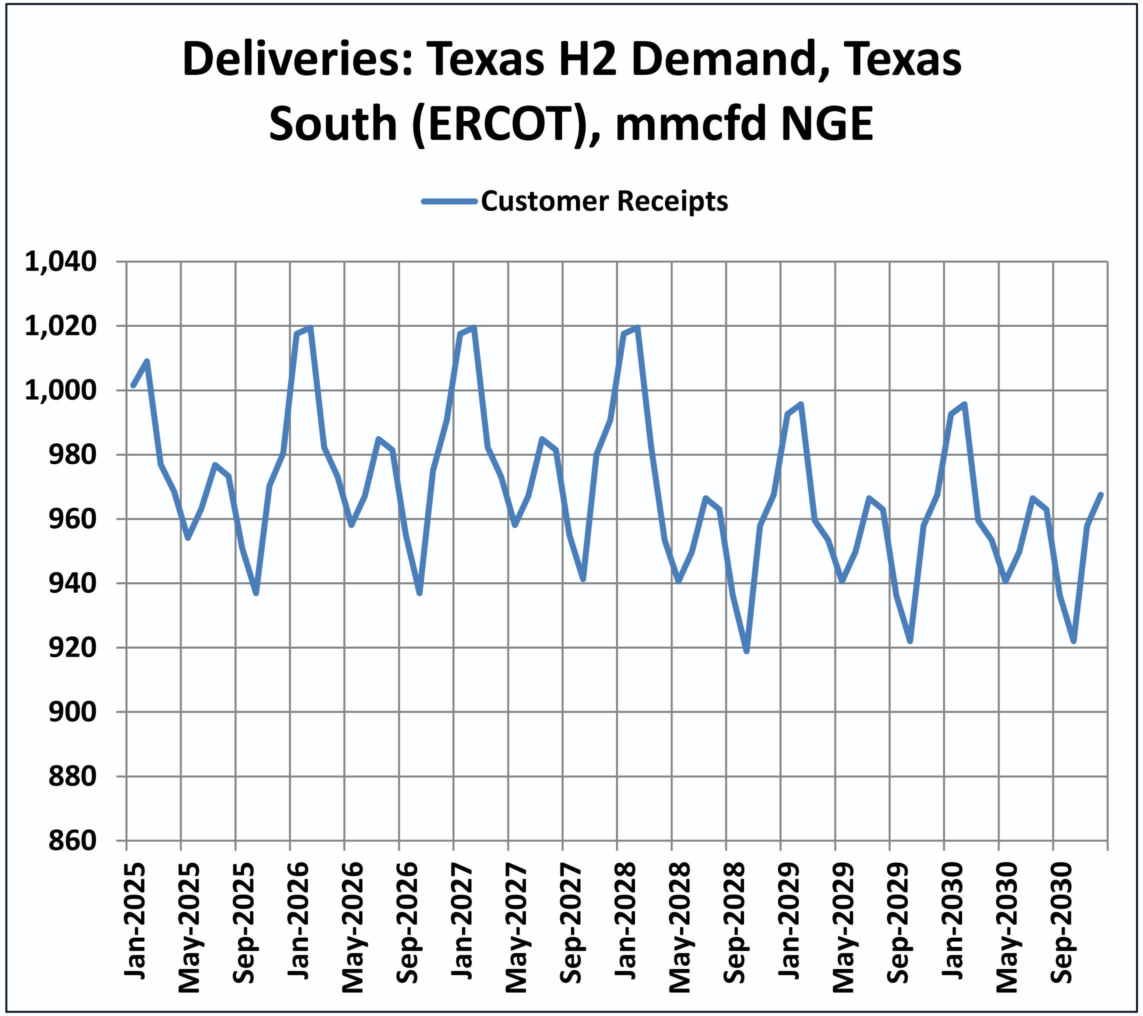
Zone	Eff_Date	Project_ID	Month	Min_Flow	Max_Flow	Loss_Frac	Min_Rate	Max_Rate	FDQ	ZDQ	FDQ%	ZDQ%	NDQ%	NDQ_Mult	Exclude
Texas H2 Supply	Jan-2025		0	0.00	3,000.00	0.00%	($5.67)	($5.67)	1,500.00	2,400.00	50.00%	80.00%	95.00%	3.00	0
Texas H2 Deliv	Jan-2025		0	0.00	2,600.00	0.00%	$0.00	$0.00	1,300.00	2,080.00	50.00%	80.00%	95.00%	3.00	0
Texas H2 Trans	Jan-2025		0	0.00	2,600.00	5.00%	$0.50	$1.00	1,300.00	2,080.00	50.00%	80.00%	95.00%	3.00	0

Creating the CO2 Case

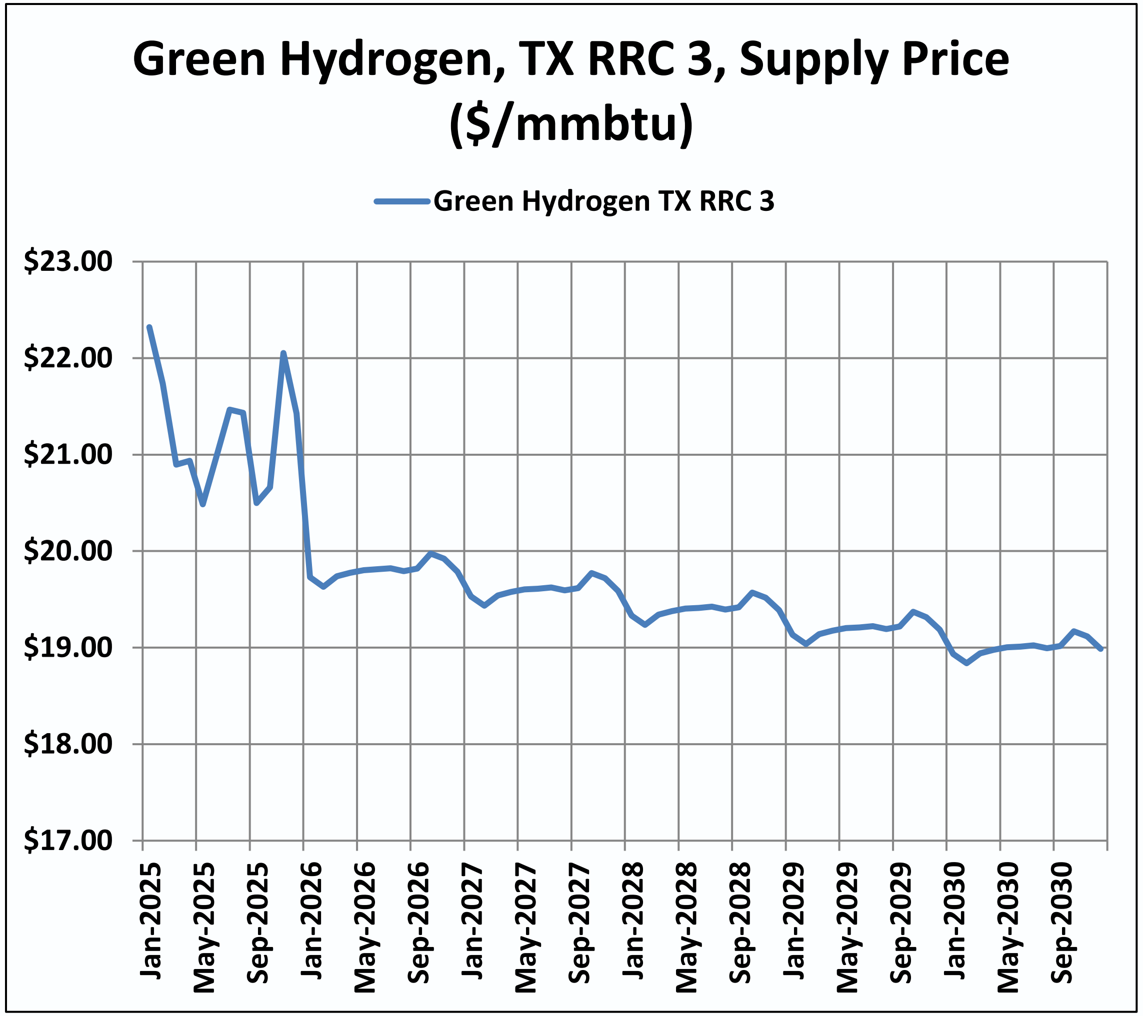
- To make these scenarios work realistically, you need to create a CO2 case and set a realistic “decarbonization” level CO2 price.
- We defined a new CO2 market called “USA”
- We only assigned Texas to this market beginning in Jan-2024, but if you are modeling more states or provinces, you need to assign them also (with dates of incorporation)
- We set this market up to have effect for IND and ELC dlvs
- We set the CO2 price at $100 per metric ton of CO2

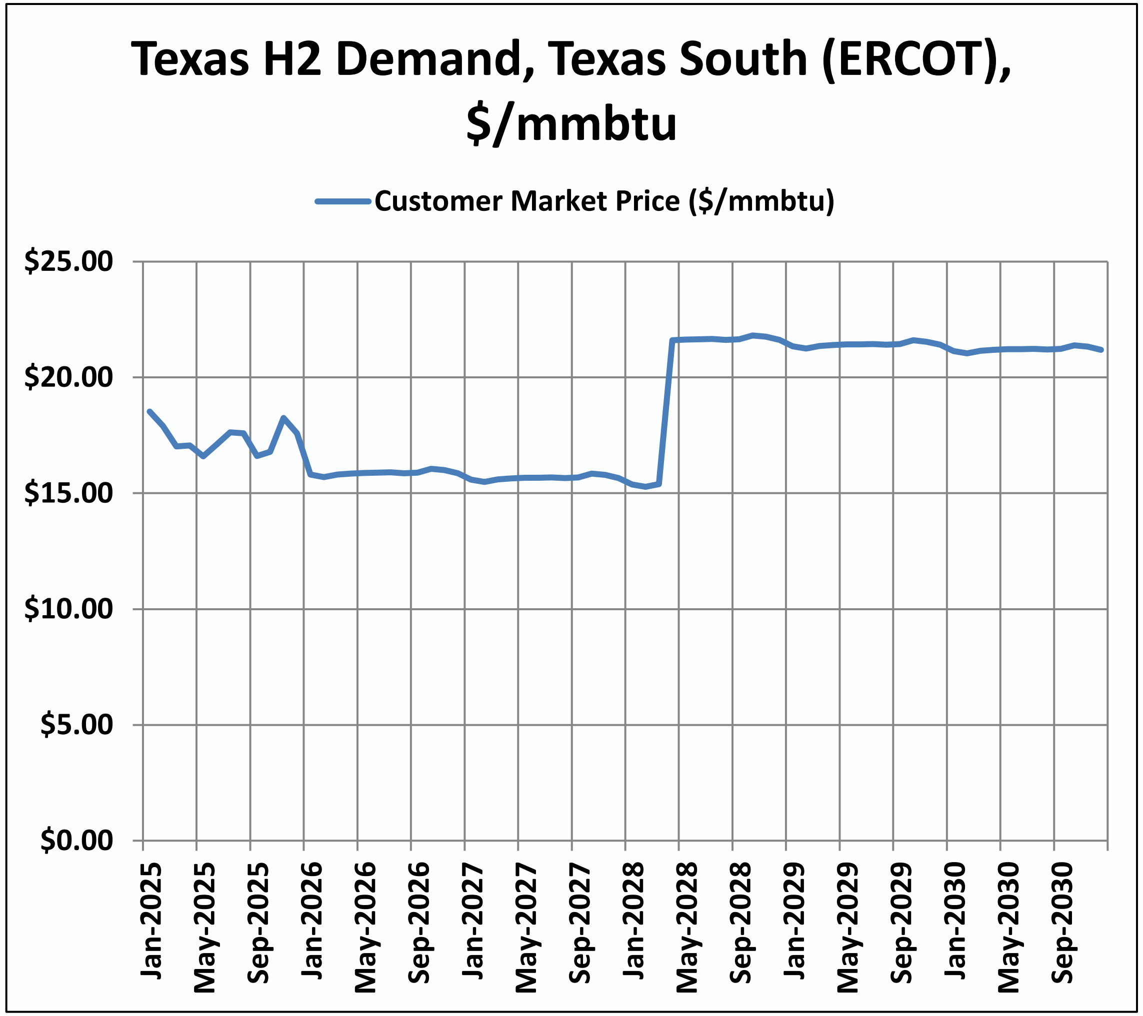
Results from the "Green Scenario": Prod / Dlvs





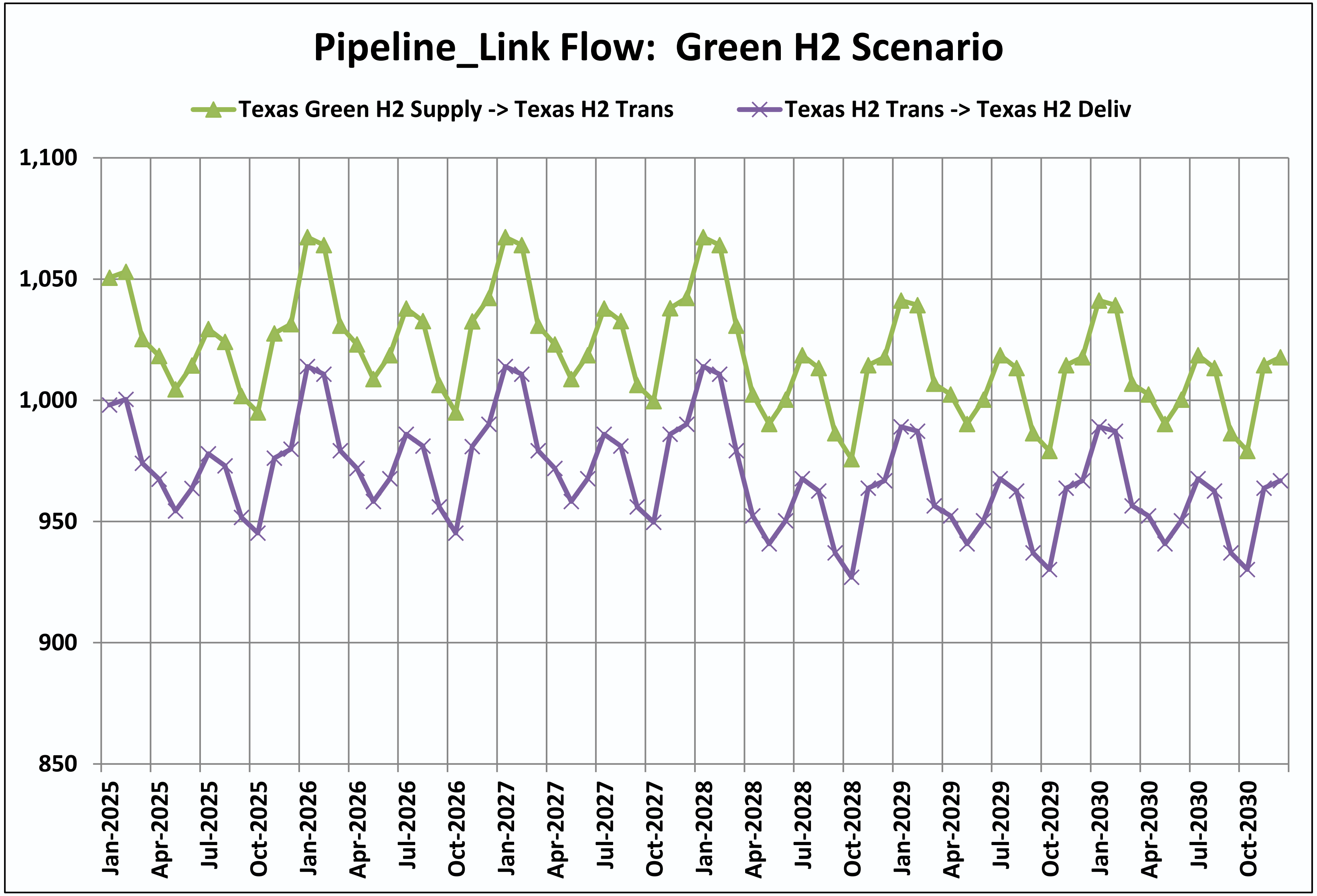
Green Hydrogen Scenario Prices





Note that supply prices are greater than delivery prices in 2025 – 2027. This is due to a production credit.

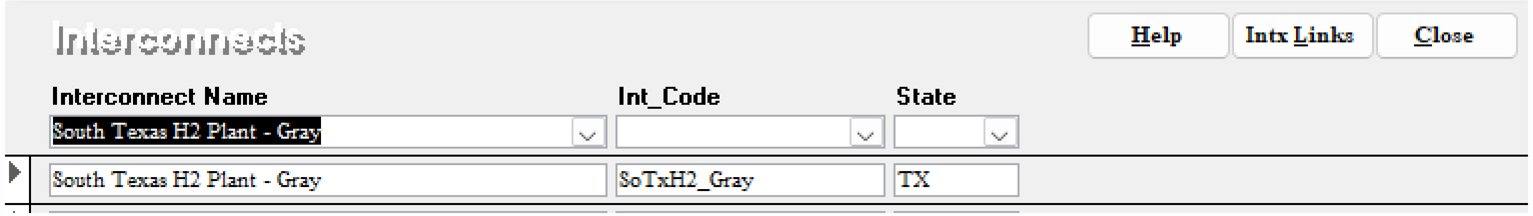
H2 Pipeline Flows (mmcf/day: NGE)



What about Gray and Green H2?

- To use GPCM to model Gray or Green H2, we must have a way to generate H2 from natural gas
- We do this using Interconnects and Interconnect Links
- We define an Interconnect for each Gray or Blue H2 plant we decide to model
- We then define inbound Interconnect Links to deliver natural gas to the H2 plant and outbound Interconnect Links to deliver H2 to pipelines carrying NGE H2
- In the following we define one such interconnect for Gray H2 and another for Blue H2

Interconnects and Interconnect Links for Gray H2 Plants

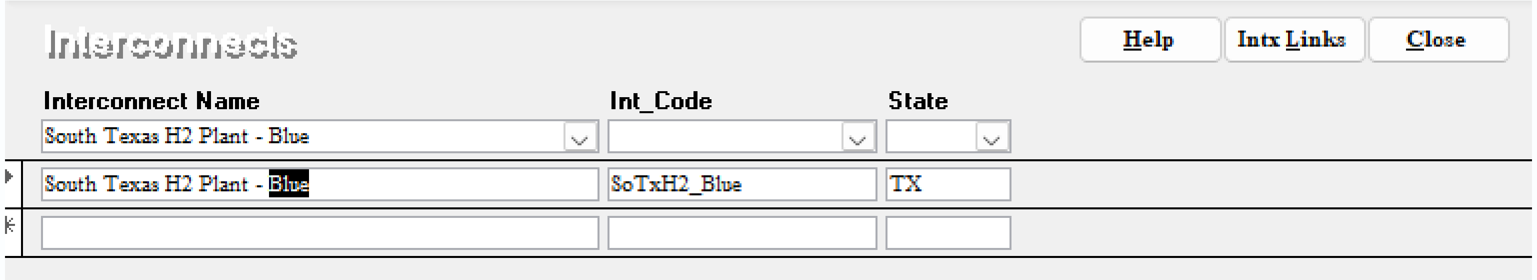


Interconnect_Link

Int_Link	Trans_Code	Trans_Loc	Int_Code	Beg_Date	Max_Input	Unit_Input_Cost	Input_Loss_Frac	Max_Output	Unit_Output_Cost	Output_Loss_Frac
UCON2024_Gray_H2	Enterprise Texas (Valero/Teco)	Enterprise TX - S TX	South Texas H2 Plant - Gray	Jan-2025	1,000.00	$0.00	0.00%	0.00	$0.00	0.00%
UCON2024_Gray_H2	Houston Pipeline Co	HPL S TX	South Texas H2 Plant - Gray	Jan-2025	1,000.00	$0.00	0.00%	0.00	$0.00	0.00%
UCON2024_Gray_H2	KM Texas Pipeline	KM Texas Katy	South Texas H2 Plant - Gray	Jan-2025	1,000.00	$0.00	0.00%	0.00	$0.00	0.00%
UCON2024_Gray_H2	Texas H2 Pipeline	Texas Gray H2 Supply	South Texas H2 Plant - Gray	Jan-2025	0.00	$0.00	0.00%	3,000.00	$2.56	5.00%

Note that the Outbound link from the Interconnect has a cost of $2.56 and a loss factor of 5%. The cost is 8 x $0.32 / kg H2 production cost. The factor of 8 converts from kg to $/mmbtu. The 5% loss is part of the heating value loss described earlier. The remainder of the loss is captured on the pipeline supply zone. Note we also provide three potential sources of feed gas to the H2 plant on pipelines operating in the area.

Interconnects and Interconnect Links for Blue H2 Plants



Interconnect_Link

Int_Link	Trans_Code	Trans_Loc	Int_Code	Beg_Date	Max_Input	Unit_Input_Cost	Input_Loss_Frac	Max_Output	Unit_Output_Cost	Output_Loss_Frac
UCON2024_Blue_H2	Texas H2 Pipeline	Texas Blue H2 Supply	South Texas H2 Plant - Blue	Jan-2025	0.00	$0.00	0.00%	3,000.00	$7.92	5.00%
UCON2024_Blue_H2	KM Texas Pipeline	KM Texas Katy	South Texas H2 Plant - Blue	Jan-2025	1,000.00	$0.00	0.00%	0.00	$0.00	0.00%
UCON2024_Blue_H2	Houston Pipeline Co	HPL S TX	South Texas H2 Plant - Blue	Jan-2025	1,000.00	$0.00	0.00%	0.00	$0.00	0.00%
UCON2024_Blue_H2	Enterprise Texas (Valero/Teco)	Enterprise TX - S TX	South Texas H2 Plant - Blue	Jan-2025	1,000.00	$0.00	0.00%	0.00	$0.00	0.00%

Note that the Outbound link from the Interconnect has a cost of $7.92 and a loss factor of 5%.
The cost is 8 x $0.99 / kg H2 production cost. The factor of 8 converts from kg to $/mmbtu. The 5% loss is Part of the heating value loss described earlier. The remainder of the loss is captured on the pipeline supply zone. Note we also provide three potential sources of feed gas to the H2 plant on pipelines operating in the area.

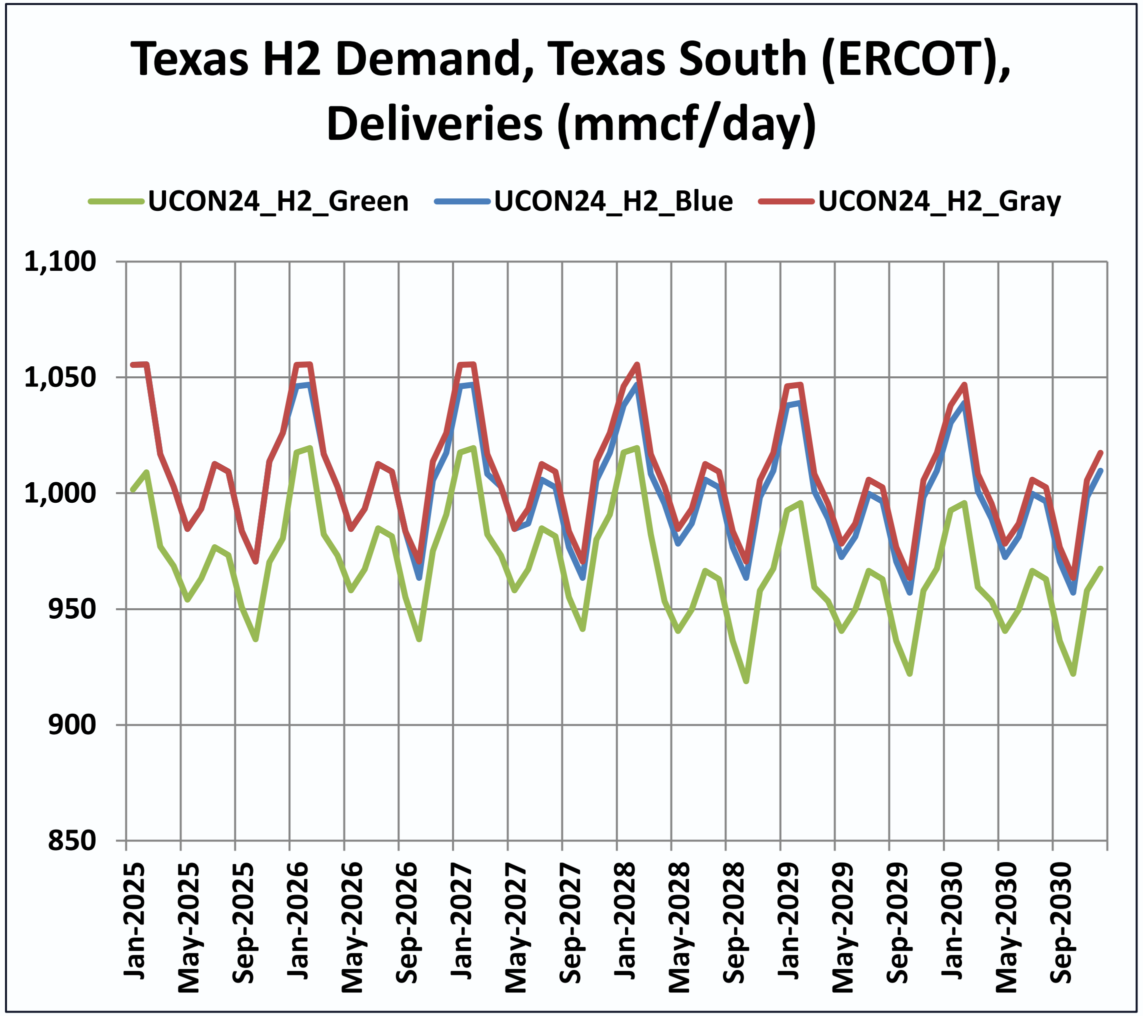
Transport Zone Data for Green, Gray and Blue

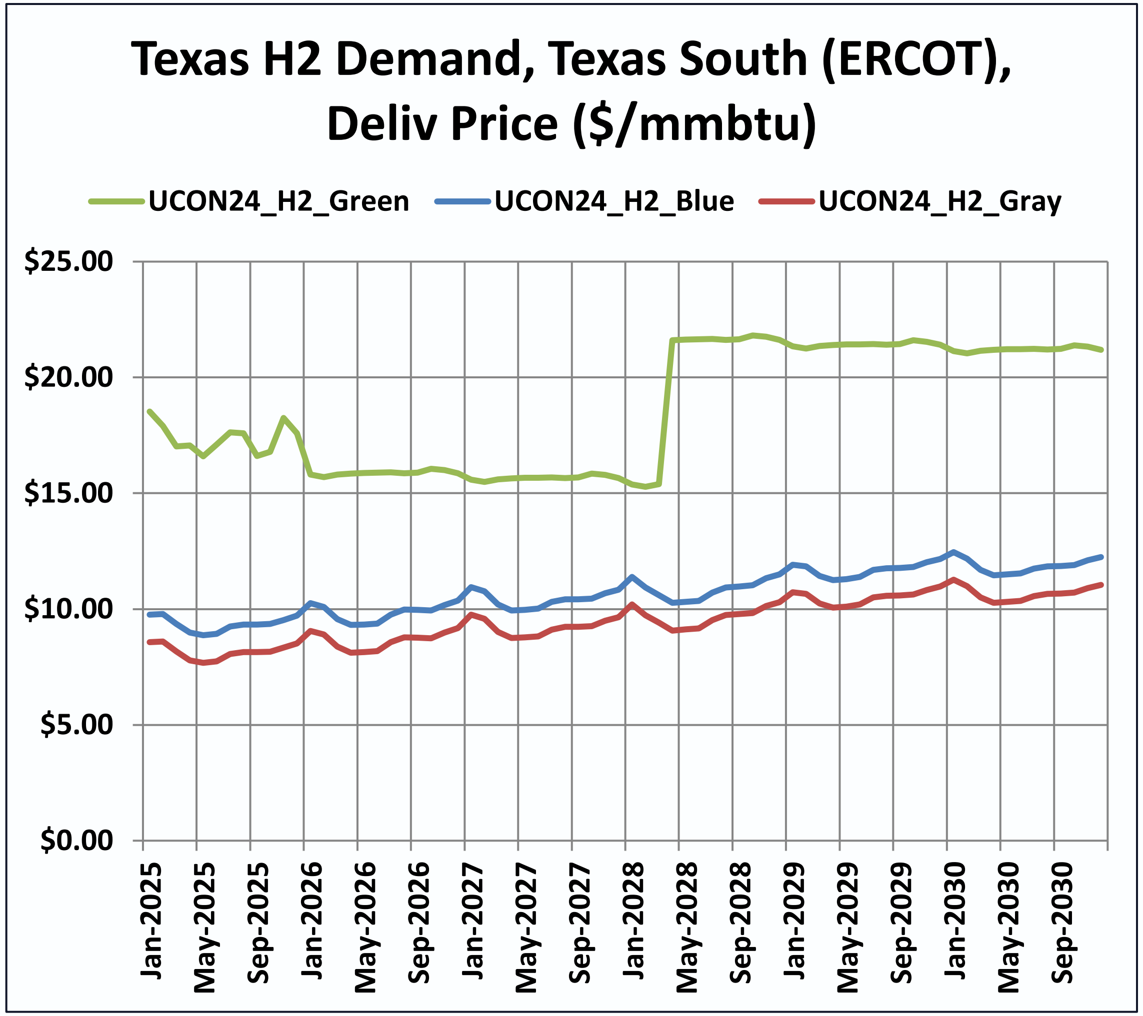
Transport_Zone

Trans_Loc	From	Max_Flow	Loss_Frac	Firm_Comm_Chg	Int_Comm_Chg
Texas Blue H2 Supply	Jan-2025	3,000.00	14.00%	($5.10)	($5.10)
Texas Gray H2 Supply	Jan-2025	3,000.00	14.00%	$0.00	$0.00
Texas Green H2 Supply	Jan-2025	3,000.00	0.00%	($5.67)	($5.67)
Texas H2 Deliv	Jan-2025	2,600.00	0.00%	$0.00	$0.00
Texas H2 Trans	Jan-2025	2,600.00	5.00%	$1.00	$1.00
Texas NG Deliv	Jan-2025	2,600.00	0.00%	$0.00	$0.00

The Transport (Pipeline) Zone Data parameters for the three different cases are shown above.
For Green H2, the supply zone has a 0% loss factor and a credit of $5.67 because it replaces natural gas when it is delivered to markets downstream. $5.67 per mmbtu is equivalent to $100 per metric ton of CO2.
For Gray H2, the supply zone has a 14% loss factor (added to the prior 5% on the interconnect link makes a total of just over 18% to account for energy loss in conversion from natural gas to hydrogen.
For Blue H2, the supply zone has the same 14% loss factor, but also has a credit of $5.10 because the process captures 90% of the CO2 produced in converting natural gas to hydrogen. $5.10 is 90% of $5.67.
In all three scenarios, the Texas H2 Trans zone costs $1.00 per mmbtu and 5% loss in transit.
In all three scenarios, the Texas H2 Deliv zone connects to downstream H2 demand (in NGE units).
The Texas NG Deliv zone connects to other downstream customers in competition with natural gas, but its High price means it is never competitive and doesn’t flow.

Scenario Comparisons – H2 Deliveries (NGE)





Analysis

- In the scenarios presented here, the Gray Hydrogen solution appears to produce the lowest price for consumers, even accounting for a relatively high CO_2 price ($100 / metric ton)
- Green hydrogen has the highest delivered price
- Green hydrogen delivered prices rise by over $5 / mmbtu in 2028, pricing out demand, resulting in delivery shortfalls
  - This could be due to expiration of the zero-CO_2 credit of $5.67 in 2028, but this needs further review.

Conversion Factors

- Heat content of 1 kg H2 is approximately 125,000 btu
  - To get cost of H2 in $/mmbtu: multiply cost in $/kg by 8.0
- Heat content of 1 f3 of H2 is 323.6 btu (N/G is 1,028 btu)
  - 1 mmcf of H2 in NG Equivalent ~ 3.177 mmcf of H2
- 1 mmcf = 28,317 m3 (1,000,000 / 35.315 f3/m3)
- Density of H2 is 0.08 kg / m3 at std temp and pressure
  - 1 mmcf H2 weighs 2,265 kg (0.08 x 28,317) = 2.265 metric tons
  - To get H2 in MT: mmcf of H2 x 2.265
  - To get H2 in MT: mmcf of H2 (NGE) x 7.2 (2.265 x 3.177)
- NOTE: different sources provide different values for H2 heat content and density

QUESTIONS?

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RBAC leads the market in global and regional gas and LNG market simulation and predictive analytics in support of corporate investment and M&A strategy, ESG, risk analysis, planning, and commodity trading. Our products and expertise help companies go beyond the narratives and hype to identify the opportunities and define the risks inherent in the uncertainties of energy transition using reality and fact-based fundamentals and analysis.

We continuously enhance our market simulation systems with the latest software and computer technology while applying the best of mathematical economics to assist our clients achieve their goals. This is especially needed as we see fundamental shifts taking place in the energy industry to achieve energy transition goals and meet increasingly demanding requirements of ESG. We provide regularly scheduled updates of our simulation systems and databases to keep our clients up-to-date with the most current market information. We enhance the functionality of our systems to enable our customers to simulate the effect of new regulations or industry requirements.

Our aim is to continue to lead the market in best practices which raise the standard of market simulation, enabling rapid and flexible scenario generation, sensitivity analysis, risk-assessment and forecasting, giving clients the edge in the rapidly changing energy market.

Those using RBAC's products and services include energy industry firms and consultants, as well as government agencies involved with energy, transportation, and the environment.

RBAC's principal products include:

- **GPCM® Market Simulator for North American Gas and LNG™** focused on the North American gas & LNG markets. GPCM is the industry standard market simulator for North American gas.
- **G2M2® Market Simulator for Global Gas and LNG™** for simulating increasingly integrated gas and LNG markets worldwide.
- **Gas4Power®** for integrating gas and power market fundamentals to produce credible forecasts for both.
- **NGL-NA®** Market Simulator for North American Natural Gas Liquids

With RBAC's advanced simulation systems, licensees can create and run scenarios involving bio-methane (Renewable Natural Gas – RNG) mixed with natural gas and to assess the implications of carbon taxes and markets on supply, demand, and prices. Future enhancements will include the ability to simulate the advent of a future hydrogen market with both pure hydrogen pipelines as well as mixtures with methane. The Energy Analyst of today and the future needs these kinds of tools to conduct realistic assessments and help develop realistic strategies and plans to achieve the goals of the energy transition.

Dr. Robert Brooks founded RBAC in 1987 based on experience developing several well-respected predictive models for government and industry. He designed the first gas transportation model while getting his PhD at MIT and has led the industry ever since.

RBAC's staff includes industry-trained experts in natural gas supply and demand, transportation, storage, marketing, and trading. Our team applies its world-class expertise in mathematical modeling, statistical analysis, mathematical algorithm development, software engineering, and database design to current and future challenges, risks and opportunities in energy.