

Interstate Highway 45 Zero-Emission Vehicle Corridor Sub-Group Kick-Off

August 27, 2020
10:30 am -12:00 pm

Call-In Information:
1-346-248-7799
Meeting ID: 975 4208 1182

Please mute your phone when you are not speaking

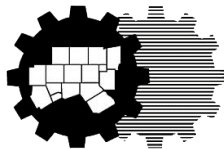
Agenda

1. Welcome/Kick-Off Survey/Housekeeping
2. Federal Overview of Alternative Fuel Corridor Deployment Plans
3. Quick Overview of I45 ZEV Corridor Plan
4. H2 Supply
5. Electricity Supply
6. Discussion and Closing Remarks

See chat box for a link
to a [Quick Kick-Off
Survey](#)



Dallas-Fort Worth
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North Central Texas
Council of Governments

BEGIN

ALTERNATIVE
FUELS
CORRIDOR



FHWA Alternative Fuel Corridors Program Overview/Update for 2020

I-45 ZEV CORRIDOR SUBGROUP KICKOFF MEETING

AUGUST 27, 2020

MIKE SCARPINO | U.S. DEPARTMENT OF TRANSPORTATION-VOLPE CENTER



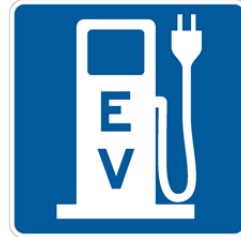
U.S. Department of Transportation
Federal Highway Administration

Agenda

- Round 4 Designation Overview
- Transportation Highway Bill Reauthorization
- FY 2020 Appropriations Bill
- Regional Alternative Fuel Corridor Convenings
- AFC Deployment Grant Awards

National Alternative Fuel Corridors

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To improve the mobility of alternative fuel vehicles, the U.S. Department of Transportation (DOT) has designated national corridors in strategic locations along major highways for:

- ▶ Plug-in electric vehicle charging
- ▶ Hydrogen fueling
- ▶ Propane (LPG) fueling
- ▶ Natural gas (CNG, LNG) fueling

Combined Results

Rounds 1-4

- ▶ Designations....
 - ✓ **100** nominations
 - ✓ Includes portions/segments of **119** Interstates, along with **100** US highways/state roads
 - ✓ Comprise **49 states plus D.C.**
 - ✓ Covers **approximately 145,000** miles of the National Highway System (all fuels combined)

Round 4 Fuel Criteria

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EV

DCFC only
(CHAdeMO +
CCS)

50 miles
between
stations

5 miles from
highway

Public stations
only (no Tesla)

CNG

150 miles
between
stations

5 miles from
highway

Public
stations only

Fast fill, 3,600
psi

LNG

200 miles
between
stations

5 miles from
highway

Public
stations only

Hydrogen

100 miles
between
stations

5 miles from
highway

Public
stations only

Propane

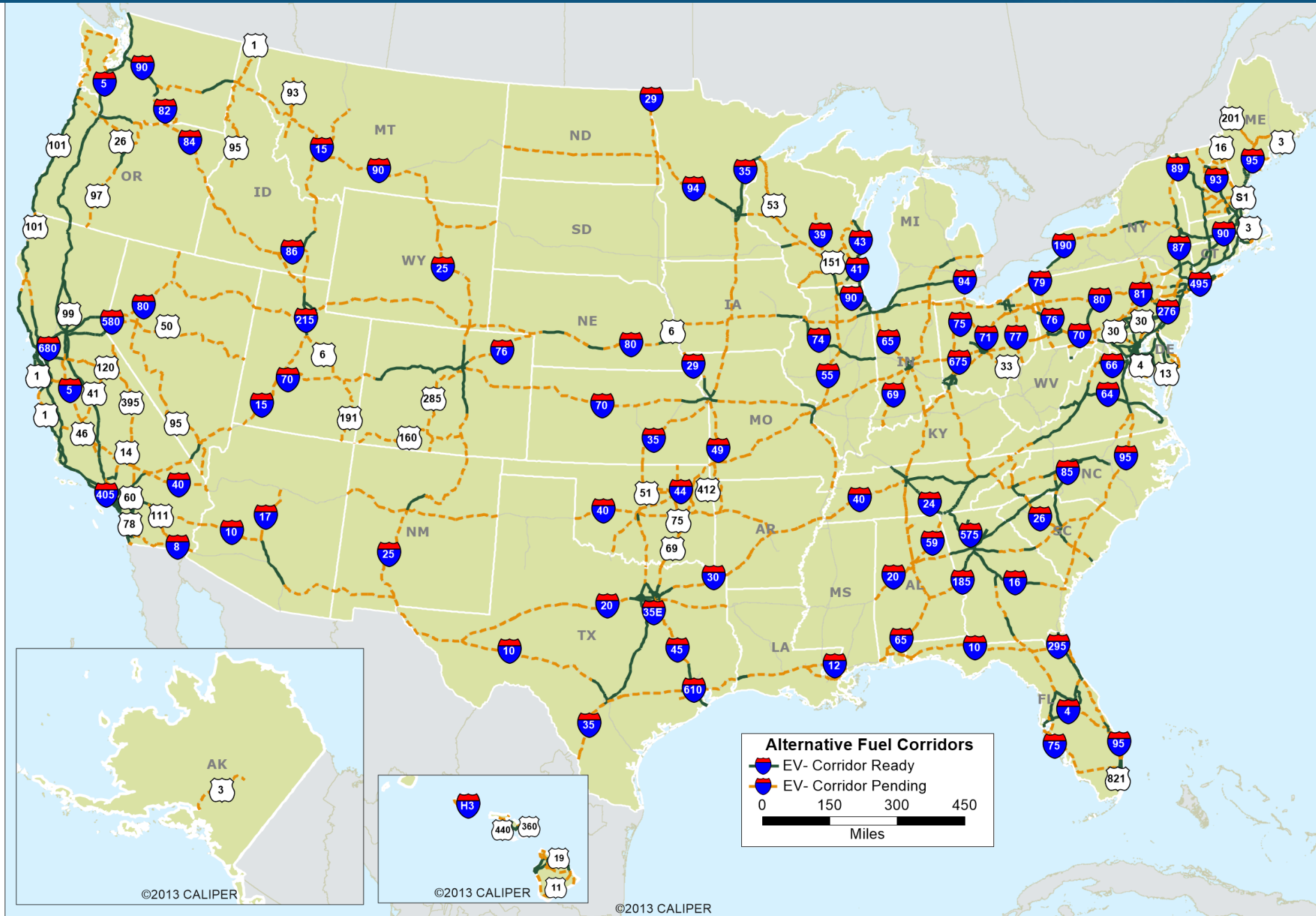
150 miles
between
stations

5 miles from
highway

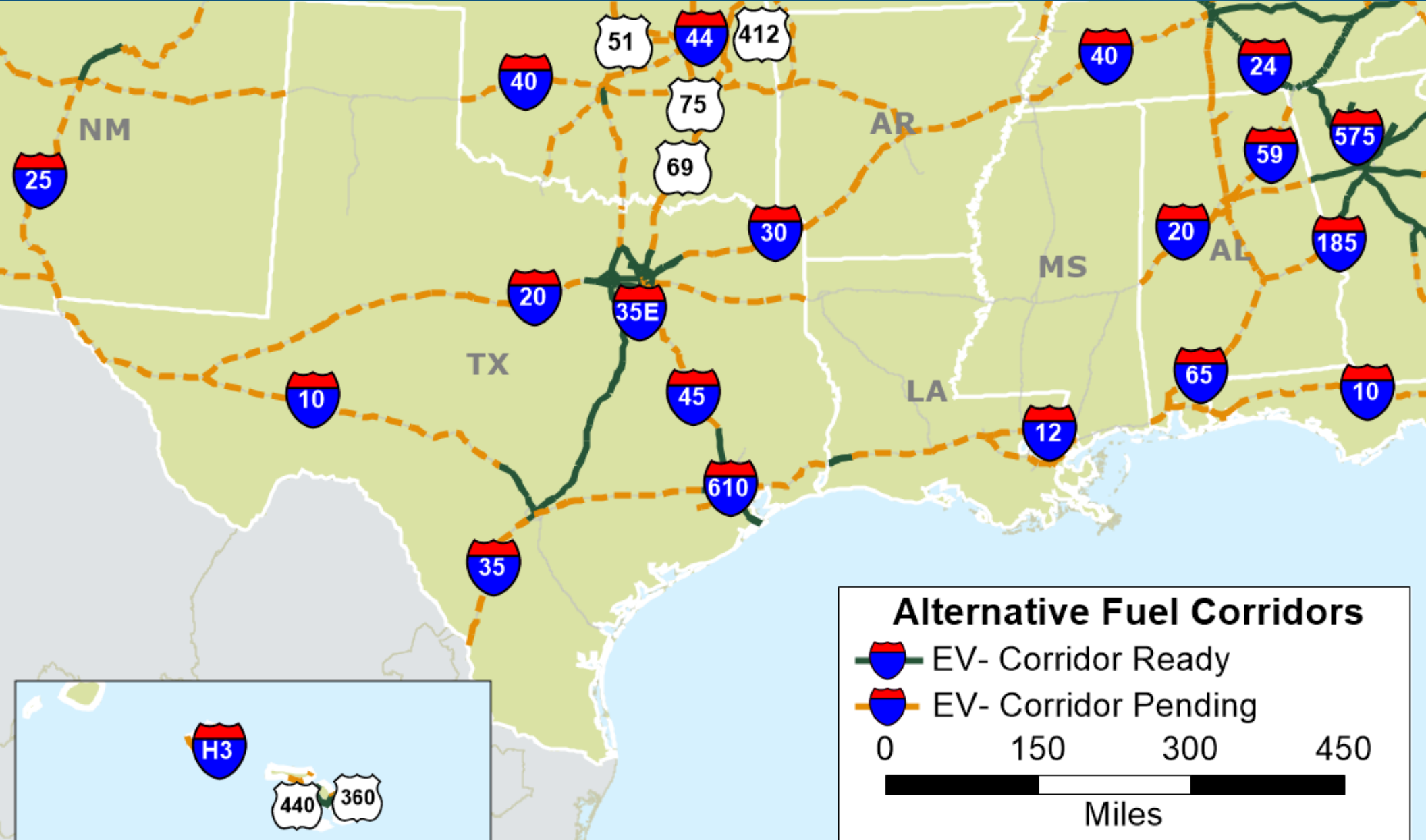
Public
stations only

Primary
stations only

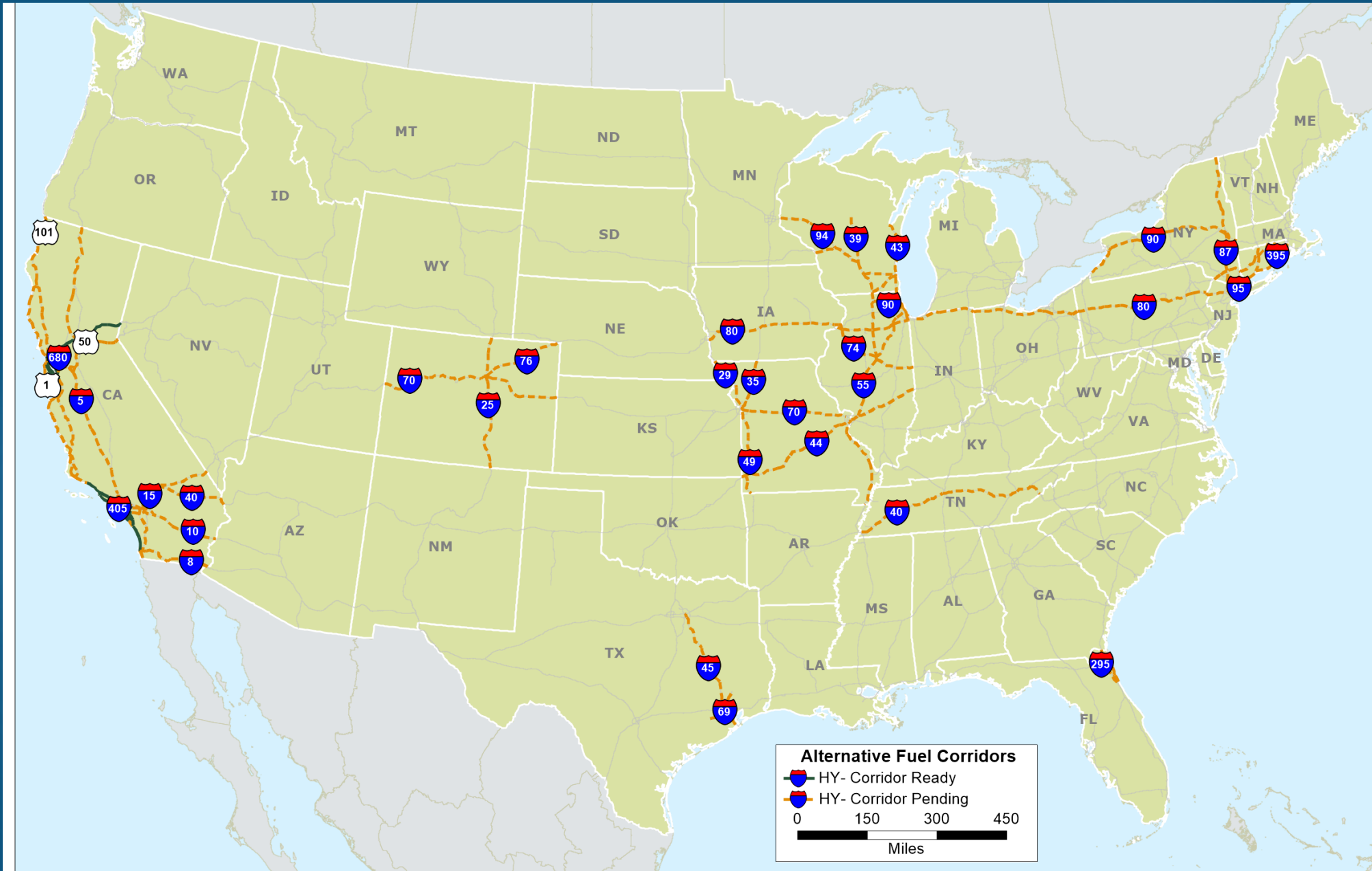
EV Corridors: Rounds 1-4



EV Corridors: Rounds 1-4

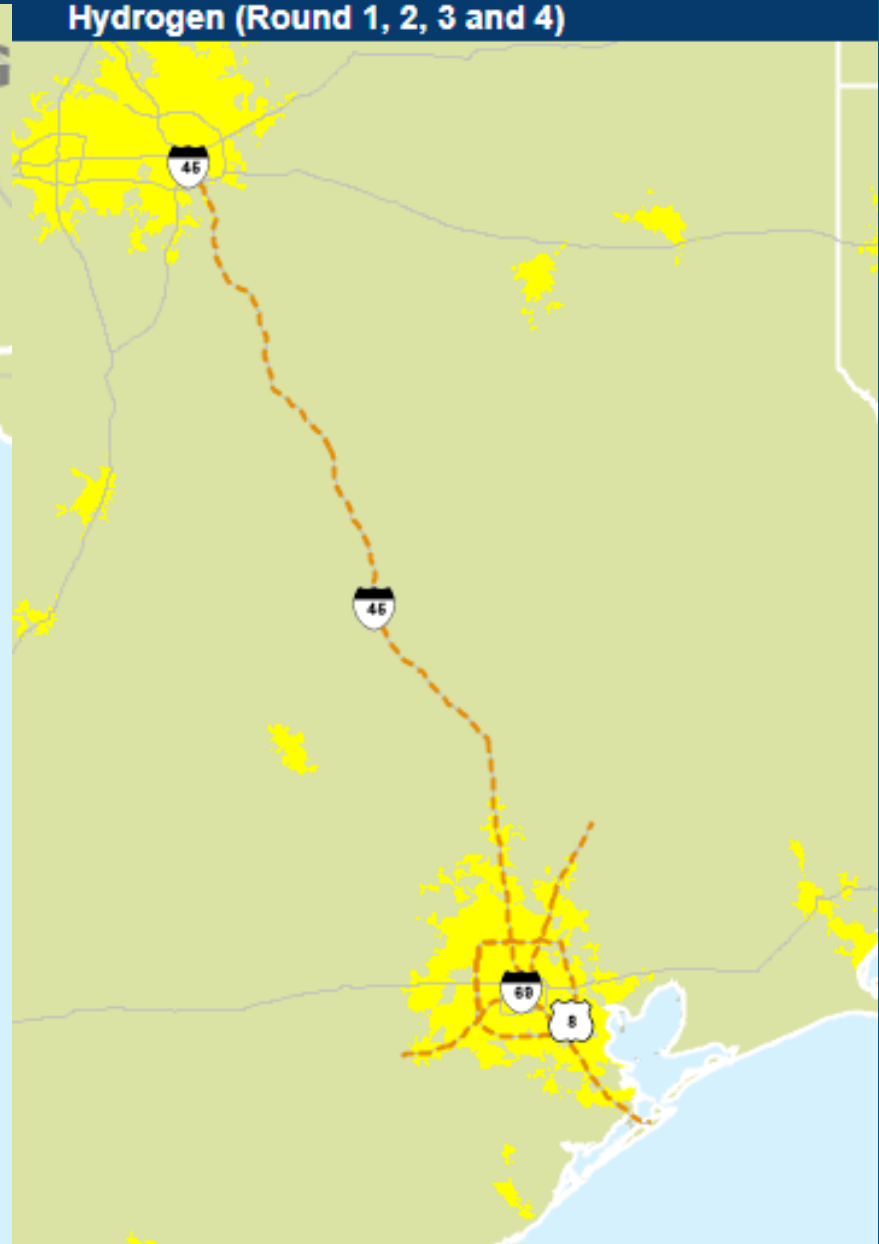
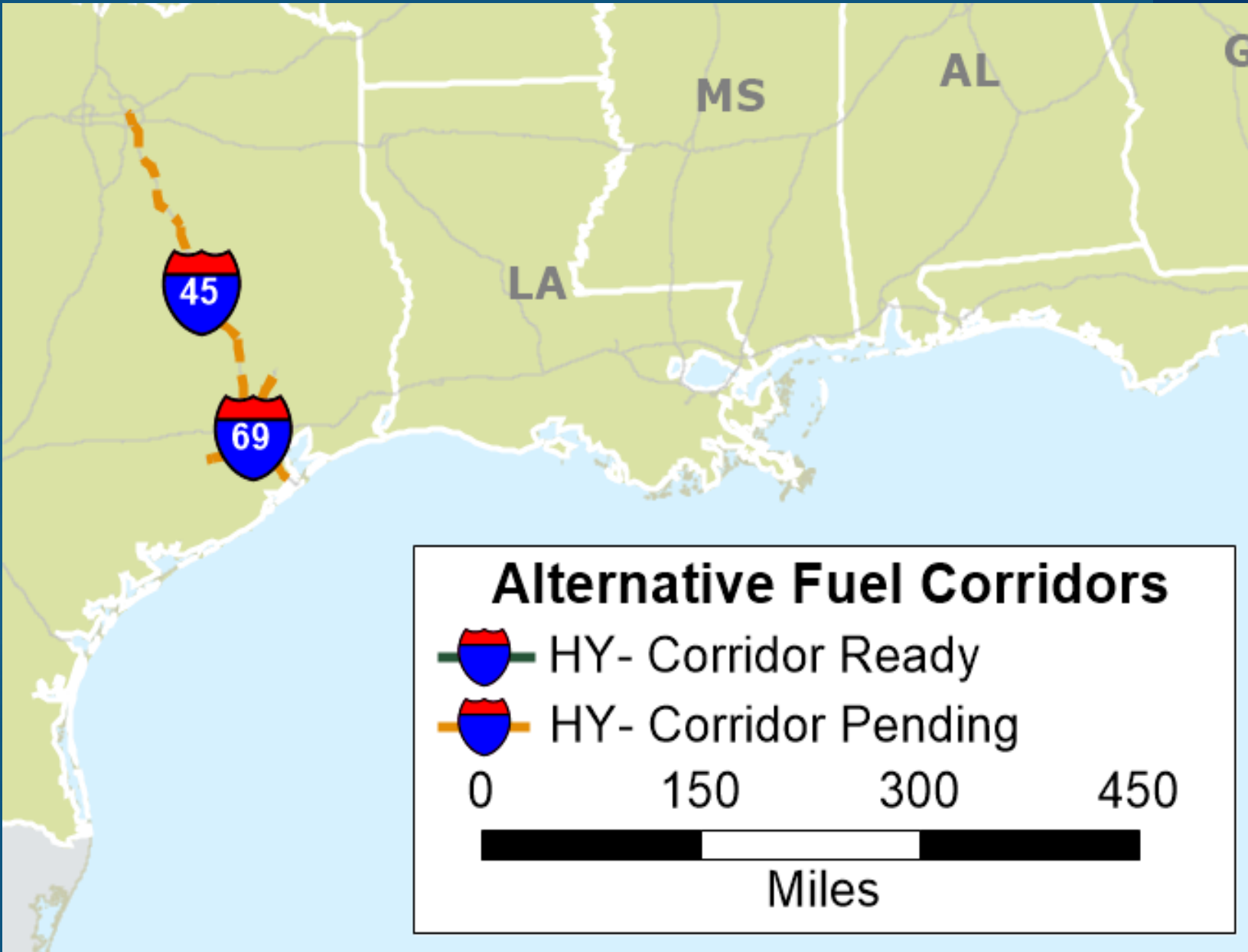


Hydrogen Corridors: Rounds 1-4



Hydrogen Corridors: Rounds 1-4

Hydrogen (Round 1, 2, 3 and 4)



Transportation Reauthorization Bills

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- **Senate Bill (S 2302) – America’s Transportation Infrastructure Act (ATIA) of 2019:**
 - Section 1401- Turns AFC Program into a discretionary/competitive grant program
 - Funds it approximately \$200M per year for five years (\$1B total)
 - Includes **EV, NG** and **Hydrogen**
- **House Bill (HR 2)- INVEST in America Act [Moving Forward Act]:**
 - Section 1303– Establishes a similar discretionary/competitive grant program.
 - Funds it approximately \$350M per year for FY22-25 (\$1.4B total)
 - Includes **EV, NG, LPG** and **Hydrogen**
 - Prioritize projects that demonstrate the highest levels of carbon pollution reductions and that are installed on designated alternative fueling corridors

FY 2020 Appropriations Bill

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- “\$781,140,392 shall be for activities eligible under sections 133(b)(1) and 133(b)(4) of title 23, United States Code, and to provide necessary **charging infrastructure** along corridor-ready or corridor pending alternative fuel corridors designated pursuant to section 151 of title 23, United States Code”
- Highway Infrastructure Program (HIP) funds from general treasury NOT Highway Trust Fund
- Creates eligibility for EV corridor infrastructure funding under HIP
- Funds are apportioned with same formula as the Surface Transportation Block Grant (STBG) Program
- Details were sent out via the List serv on Feb 20th (or see the below link)
- Funds available until September 30, 2023

<https://www.fhwa.dot.gov/legsregs/directives/notices/n4510842/>

Federal Highway Administration Regional Alternative Fuel Corridor Convenings

- Held 5 regional convenings across the U.S.
 - MN, SC, TX, RI & UT
- Strengthen coordination b/w states, public and private partners
- Evaluate regional priorities & needs, programs, and resources to expand corridors
- Identify critical infrastructure gaps
- Discuss a regional strategy to promote clean vehicle adoption and corridor growth
- Share Tools & Foster Partnerships



FHWA Regional AF Corridor Convenings

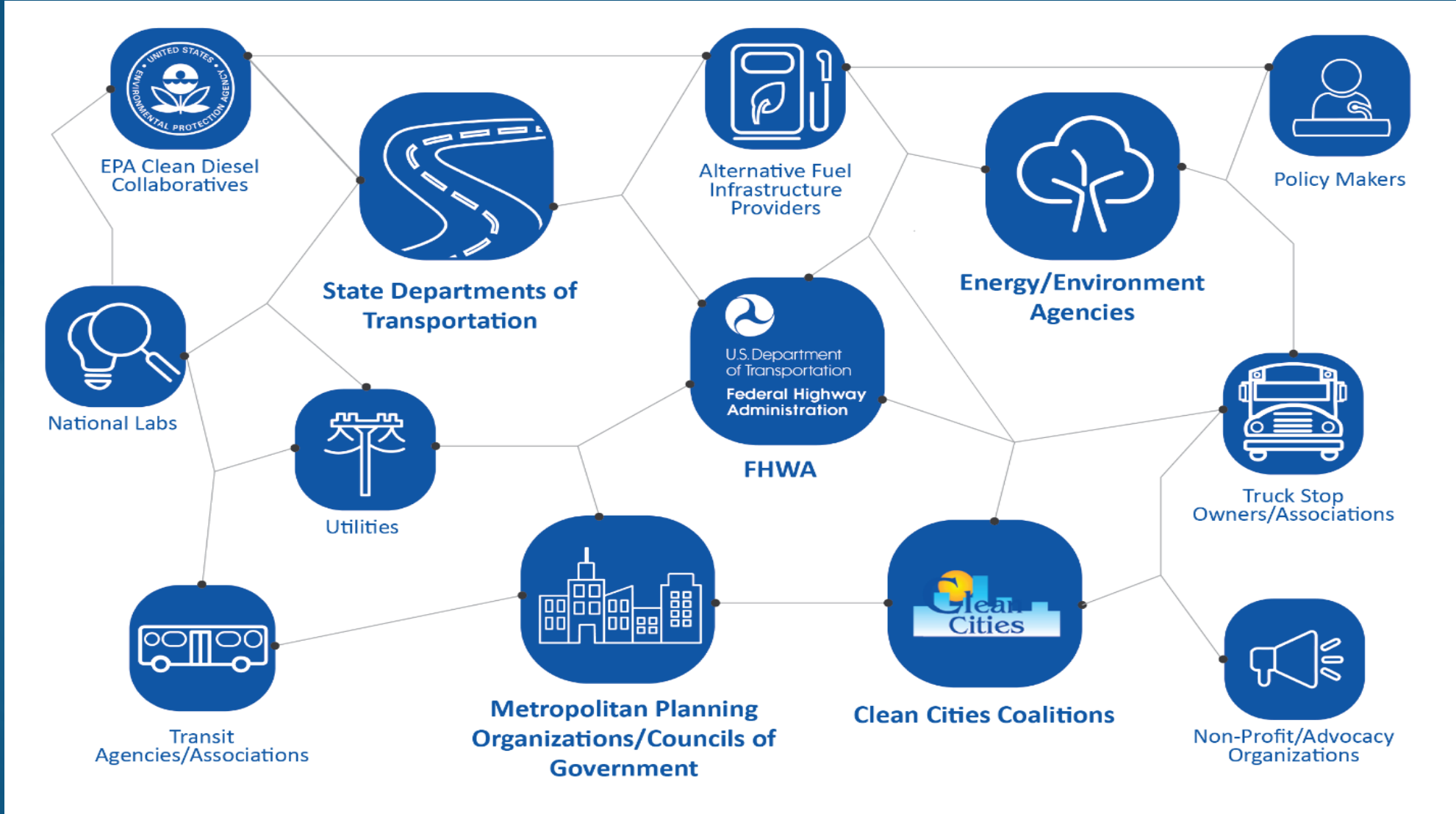
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- ▶ Five observations emerged as ways to build upon success to date and continue the expansion of AF Corridors:
 - ▶ **Corridor Funding:** Funding to support infrastructure development and upgrades, as well as signage, was identified as the number one barrier to corridor growth and vehicle adoption.
 - ▶ **Encourage Vehicle Incentives:** Incentives for AFVs will continue to encourage adoption and spur transformational growth in alternative fuel infrastructure development along corridors.
 - ▶ **Elevate Value Proposition:** Defining the value proposition of alternative fuel corridors in a way that includes the economic, environmental, and social benefits and resonates with various audiences is key for demonstrating the importance and impact of continued corridor development.

FHWA Regional AF Corridor Convenings

- ▶ **Address Barriers:** Numerous other barriers were suggested by participants, such as complex permitting processes, low conventional fuel cost, and the inability to charge a fee for fueling or charging services for infrastructure located in rest areas that are located on the Interstate right-of-way. Continued stakeholder collaboration is necessary to develop informed approaches for addressing these challenges.
- ▶ **Regional Coordination:** Continuing ongoing engagement and outreach with regional partnerships is critical for ensuring coordination, aligning corridor priorities, and promoting technical knowledge exchange.

FHWA Regional AF Corridor Convenings



AFC Deployment Grant Awards

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- ▶ In July 2019 FHWA released a solicitation for an applied research funding opportunity to assist transportation agencies with planning for the deployment of alternative vehicle fueling and charging facilities along Interstate corridors across the nation.
- ▶ Supports the goal of filling infrastructure gaps and designating targeted corridors as “ready”, per the criteria established under FHWA’s Alternative Fuels Corridor (AFC) Program.
- ▶ The *Alternative Fuels Corridor Deployment Plans* funding opportunity applied to both passenger and freight vehicles, and was available to State departments of transportation and metropolitan planning organizations.

AFC Deployment Grant Awards

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- ▶ The outcome of projects will be a **Corridor Deployment Plan**:
 - ▶ Provide a roadmap for the deployment of alternative fueling and charging infrastructure at strategic locations along a select national corridor.
 - ▶ Focus on current corridor-pending Interstates or segments of corridor-pending Interstates that have potential to be flipped to corridor-ready.
- ▶ Another priority of the projects is to encourage the development of public-private partnerships with truck stops, and other potential site hosts, for locating or co-locating alternative fueling and charging facilities.

AFC Deployment Grant Awards

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▶ Illinois DOT

- In coordination with **NJ, PA, IN, OH and IA**
- EV and CNG
- I-80 corridor from NJ to the IA/NE border

▶ Pima Association of Governments (PAG)

- EV and CNG
- I-10 corridor in AZ

▶ Tennessee DOT

- EV and CNG
- I-40 corridor from NC to the AR/OK border

▶ Pennsylvania DOT

- EV and CNG
- I-81/I-78 corridors from the PA/MD border to the PA/NJ border

▶ North Central Texas Council of Governments (NCTCOG)

- EV and H2
- IH-45 corridor from the seaports of Houston/Galveston to the inland ports of Dallas/Ft. Worth



For More Information

DOT Alternative Fuel Corridor Team Contact Information

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Resources

FHWA Alternative Fuel Corridor website:

http://www.fhwa.dot.gov/environment/alternative_fuel_corridors/

MUTCD Memorandum – Signing for Designated Alternative Fuel Corridors:

https://mutcd.fhwa.dot.gov/resources/policy/alt_fuel_corridors/index.htm

DOE/NREL Alternative Fueling Station Locator & Corridor Tools:

<https://afdc.energy.gov/stations/> & <https://afdc.energy.gov/corridors>

FHWA Alternative Fuel Corridors Convenings:

<http://altfueltoolkit.org/regional-convenings/>

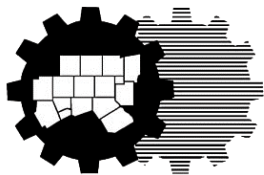
Motorweek Alternative Fuel Corridors Video Segment:

<https://www.youtube.com/watch?v=AvCqXXPcVwI>

Interstate Highway 45 Zero-Emission Vehicle Corridor Plan Overview

Sub-Group Kickoff
August 27, 2020

Bethany Hyatt
Air Quality Planner



North Central Texas
Council of Governments



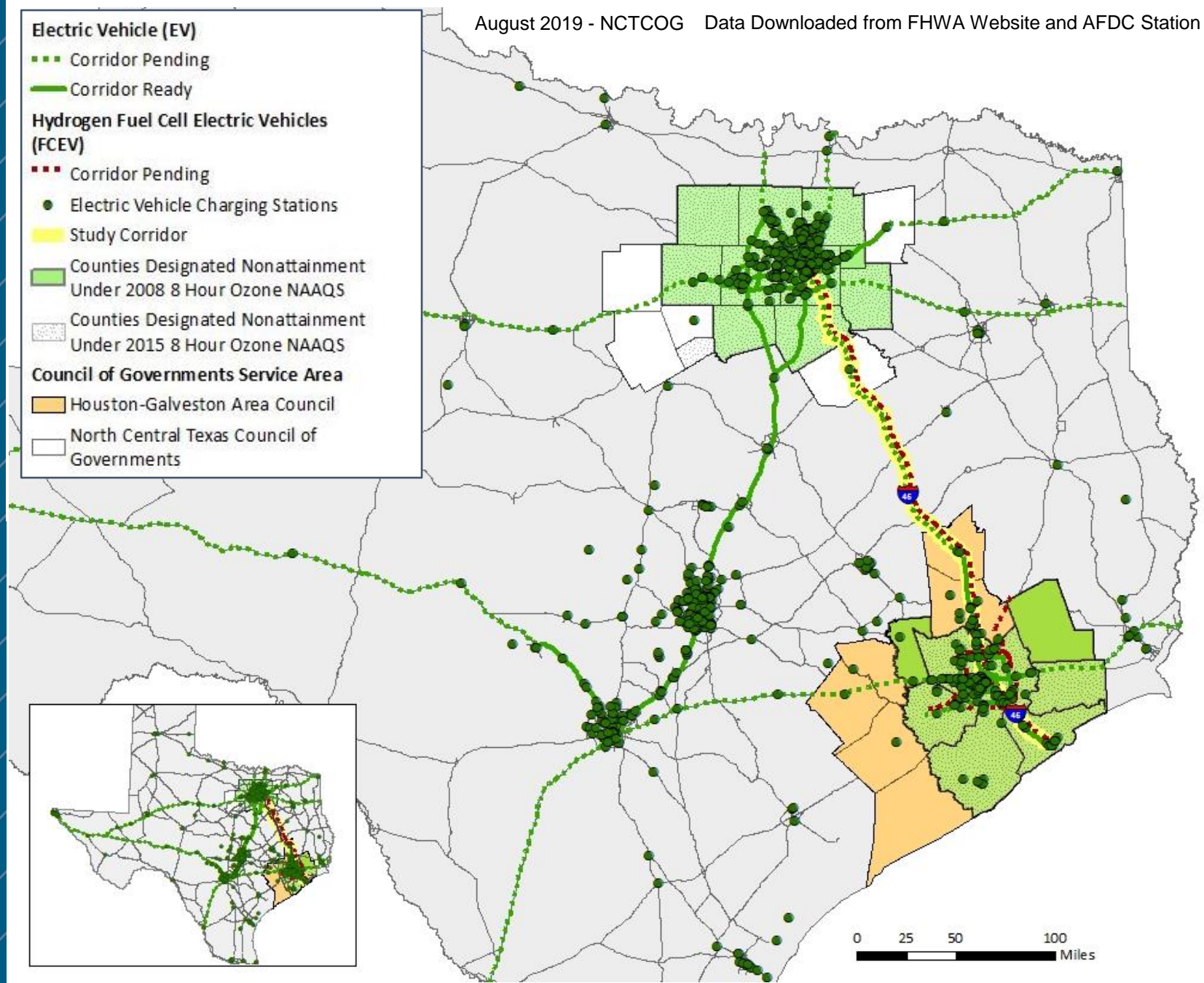
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Corridor Profile

290-Mile Corridor

Nearly half of truck freight in Texas is moved through this corridor

14% of total traffic along IH-45 is truck freight or 2.5 times the normal truck traffic for DFW



Current State of Electric Vehicle Supply Equipment (EVSE)

One Gap Remaining to Meet “Corridor-Ready” Status per FHWA Criteria: 111 Mile Gap from Ennis to Madisonville

For the corridor to be classified as ready, a station must be placed every 50 miles within 5 miles of IH-45.

<https://afdc.energy.gov/stations/#/find/nearest>

Public Stations | Advanced Filters | Corridor Measurement

Use this tool to measure the driving distance along Interstate Highways between stations that meet the criteria under the Federal Highway Administration's *Alternative Fuel Corridors Program*. Explore more [resources](#) for nominating corridors.

Texas | Electric | 50 miles between stations allowed

Starting Station: Walmart 286 - Ennis, TX
700 E Ennis Avenue
Ennis, TX 75119
0.5 miles to Interstate Highway

Ending Station: Walmart 446 - Madisonville TX
1620 East Main St null
Madisonville, TX 77864
1.2 miles from Interstate Highway

111 miles
driving distance between the stations

See Route Directions

DC Fast Chargers With Connector Types: ChAdeMO, CCS

Possible Focus Areas for Additional Sites:

1. Corsicana, Texas
2. Fairfield, Texas
3. Buffalo, Texas
4. Centerville, Texas

iPhone App for U.S. stations | Android App for U.S. stations | Developer APIs | Submit New Station | About the Data

Current State of Hydrogen Fueling Stations

There are currently no publicly available hydrogen stations currently in Texas.

For the corridor to be classified as ready, a station must be placed every 100 miles within 5 miles of IH-45.

<https://afdc.energy.gov/stations/#/find/nearest>

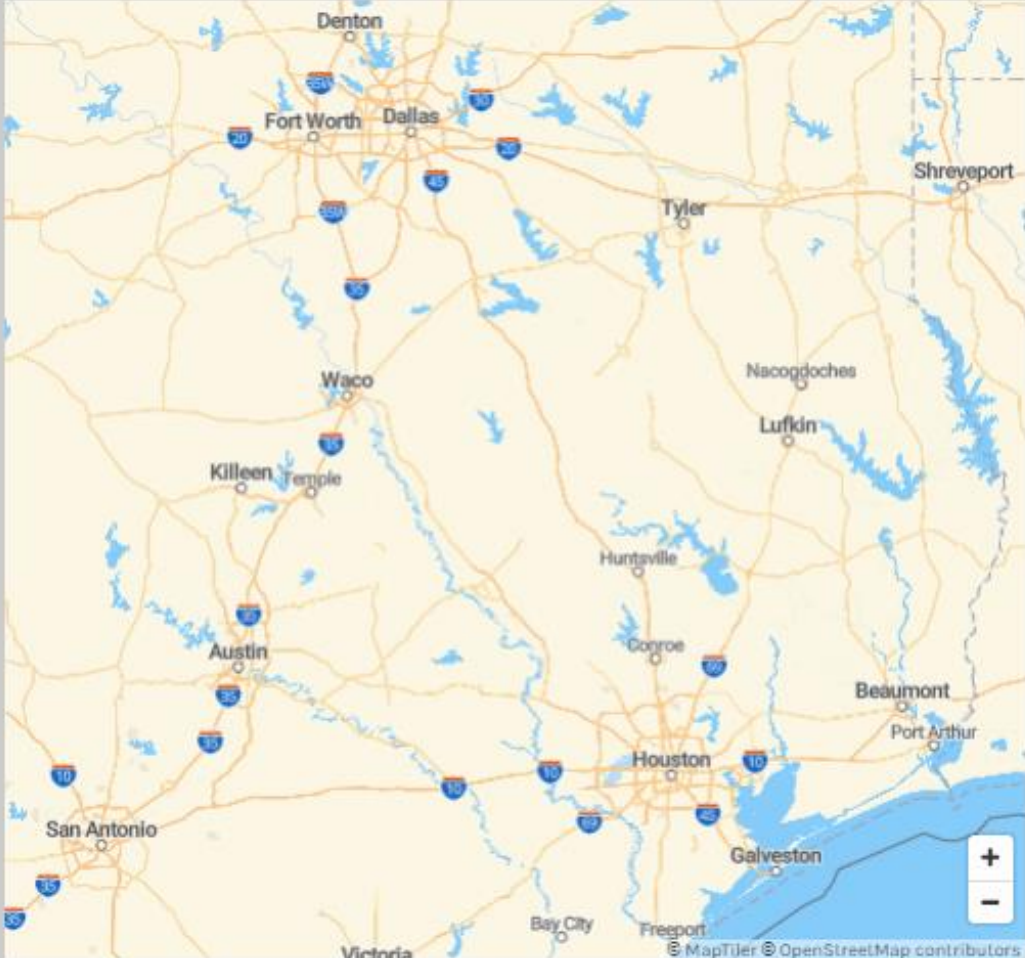
Public Stations | Advanced Filters | Corridor Measurement

Use this tool to measure the driving distance along Interstate Highways between stations that meet the criteria under the Federal Highway Administration's Alternative Fuel Corridors Program. Explore more resources for nominating corridors.

Texas | Hydrogen | 100 miles between stations allowed

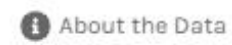
Starting Station
Select a station on the map to choose your starting point.

Ending Station
Select a station on the map to choose your ending point.



Victoria Bay City Freeport Houston Galveston Beaumont Port Arthur
Huntsville Conroe
Killeen Temple Waco Tyler Nacogdoches Lufkin
Fort Worth Dallas Denton Shreveport
Austin San Antonio

MapTiler © OpenStreetMap contributors



Deliverables



**Stakeholder
Lists**



**Stakeholder
Meetings**



**Corridor
Workshops**



Case Studies

May 2021



**Infrastructure
Deployment Plan**

May 2021

Stakeholder's Role



Infrastructure Development

- Solicit Infrastructure Needs and Criteria
- Identify and Contact Property Owners



Vehicle Availability

- Identify Best Technologies Suitable for Vocational Needs
- Evaluate Commercialization Status of Suitable Vehicles



Customer Identification

- Identify and Engage End-User Fleets
- Match User Needs to Vehicle Availability



Policy/Incentives

- Identify and Prioritize Non-Monetary Policies/Incentives
- Assess Existing and Needed Monetary Incentives

For More Information:

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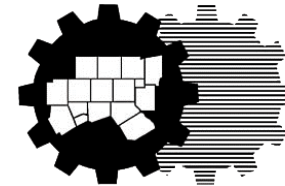
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Interstate 45 Freight Corridor Plan Highlights

What is it?

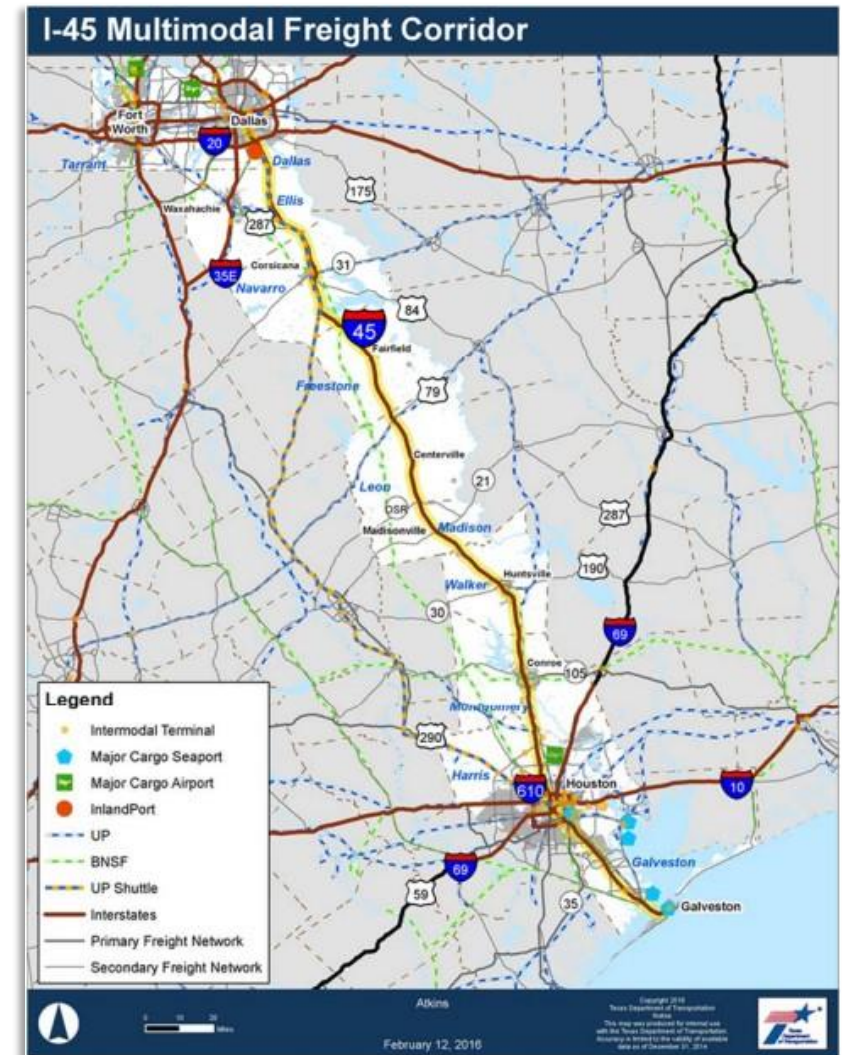
Assesses current freight network conditions and needs, as well as establishes multimodal performance measures ISO State Freight Plan

In 2010, 950 million tons of freight moved via the corridor counties, 59% of all freight moving in Texas

- Valued at over \$1.32 trillion in total
- Vital link for national economy

Key Trends:

- Large number of freight bottlenecks
- Modal shift from Truck to Rail due to LOS
- Significant increases in freight traffic in the future



Interstate 45 Freight Corridor Plan Highlights

Current Commodity Flow

- Gasoline is the highest volume single commodity now and projected through 2040
- Diverse array of commodities

Projected CF Through 2040

- Products supporting the electronics industry projected to increase 891% by 2040
- Significant increases in truck and rail freight

Table 3-12: Major Freight Commodities (I-45 Corridor Counties)

STCC2 ³	Commodity	2010		2040		Percent Change
		Tons (in 000s)	Percent of Total	Tons (in 000s)	Percent of Total	
29	Petroleum or Coal Products	158,486	17%	163,461	8%	3%
28	Chemicals or Allied Products	135,513	14%	310,887	15%	129%
50	Secondary Traffic	120,832	13%	359,070	18%	197%
14	Non-metallic Minerals	100,279	11%	209,071	10%	108%
20	Food or Kindred Products	74,989	8%	142,351	7%	90%
32	Clay, concrete, glass or Stone	68,936	7%	175,295	9%	154%
01	Farm Products	48,648	5%	99,090	5%	104%
11	Coal	43,091	5%	22,150	1%	(49%)
13	Crude Petroleum or Natural Gas	34,951	4%	65,117	3%	86%
40	Waste or Scrap Materials	23,484	2%	69,862	3%	197%
	Other	144,134	15%	426,229	21%	196%
	Total	953,343	100%	2,042,583	100%	114%

Source: TRANSEARCH® 2011

Plan Recommendations

- **New freight movement technologies**
- Conversion to “bridgeless” corridor (no bridges crossing mainlines)
- **Conversion to heavy truck corridor**
- Infrastructure Improvements (VP-HOV, bridge reconstruction, interchange improvements)
- Truck Lane Restrictions (underway)

Tapping Houston's World Class Hydrogen System Advantages

NCTCOG I-45 ZEV Corridor Subgroup Kickoff Meeting

August 27, 2020

Agenda

- Objectives and scope for Houston hydrogen project
- Houston's premier existing H2 production system
- Prioritizing and entering H2 markets
- Port of LA pilot and economics indicate H2 advantages over diesel and battery
- Regional trucking market options
- Preliminary total cost of ownership for diesel vs. H2 trucks on I-45 corridor over time
- Next steps to evaluate and progress H2 trucks in Houston area markets

Our project sought to develop a customized roadmap to enter and scale clean H2 in greater Houston

Project scope & Objectives

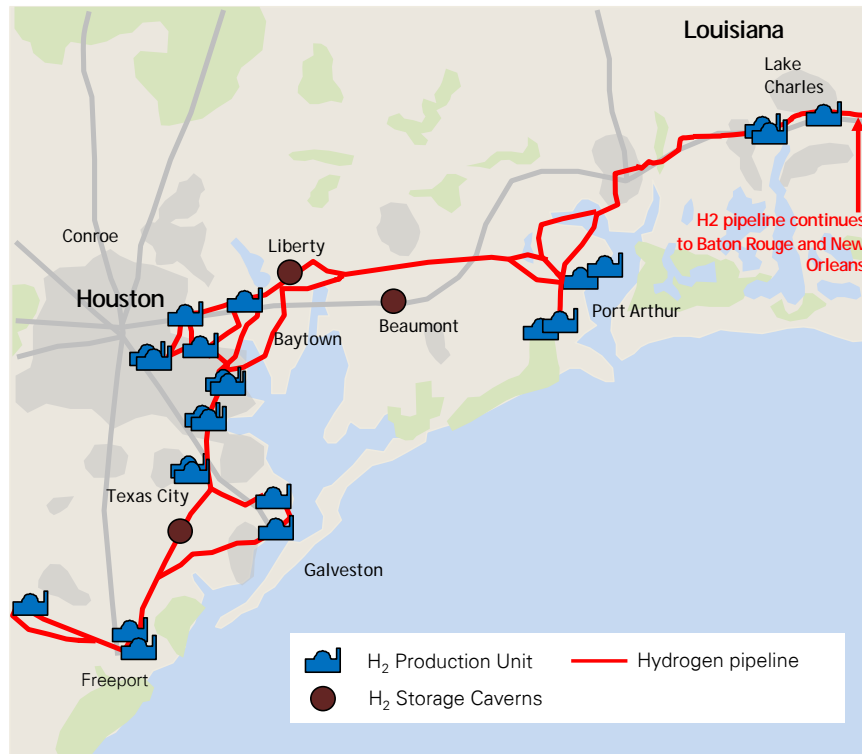
- Summarize how Houston area can leverage its current unique assets to enter clean blue and green H2 production
- Identify and prioritize the most advantaged H2 end markets to create new blue and green chains
- Develop a phased roadmap to scale the use of clean H2 and a view/vision of H2 in the Houston energy system
- Identify next steps and key collaborators to operationalize advantaged blue and green H2 chains

Key collaborators



The Houston area holds an anchor position in a world class existing H2 system

Existing hydrogen system in the Gulf Coast area



TX Gulf Coast H2 system advantages^{1,2,3}



Over 900 miles H2 pipelines (56% of US; 32% of global)



~3.4MMt of H2 produced annually (34% of US; 8.5x Rotterdam)



48 H2 production plants

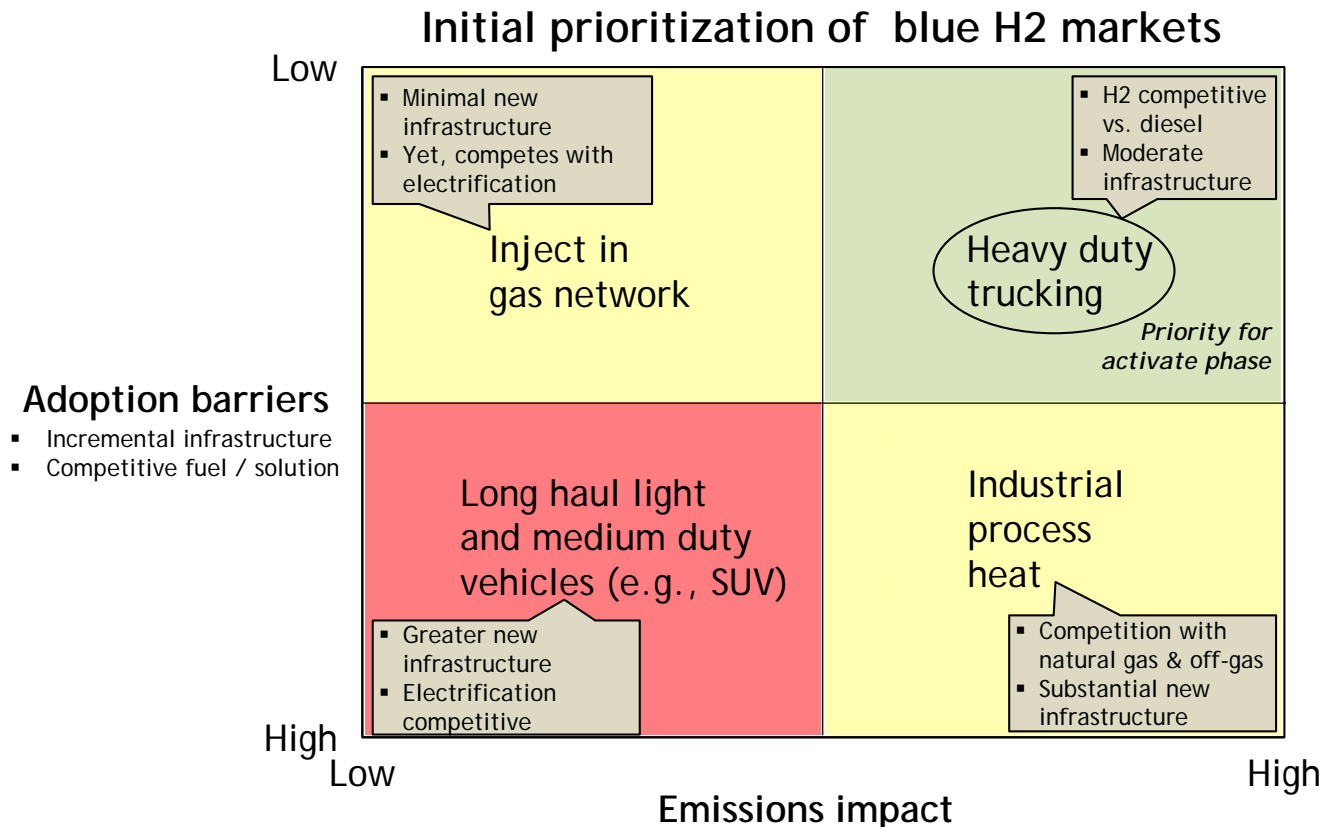


World's largest storage caverns for H2; adjacent to H2 network

Parallel work underway to develop at-scale CCUS system to convert grey to blue H2

Notes: (1) Houston MSA defined Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller counties; (2) TX Gulf Coast includes a region from Corpus Christi, TX to Lake Charles, LA; (3) Number of global H2 plants estimated by dividing global H2 production by US avg. production per H2 plant (52k tons H2 / year)
Source: H2Tools; USDOT PHMSA - National Pipeline Mapping System; Seeking Alpha; Office of US Energy Efficiency & Renewable Energy; Hydrogen Europe

New markets were prioritized based on relative adoption barriers (or advantages) and emissions impacts



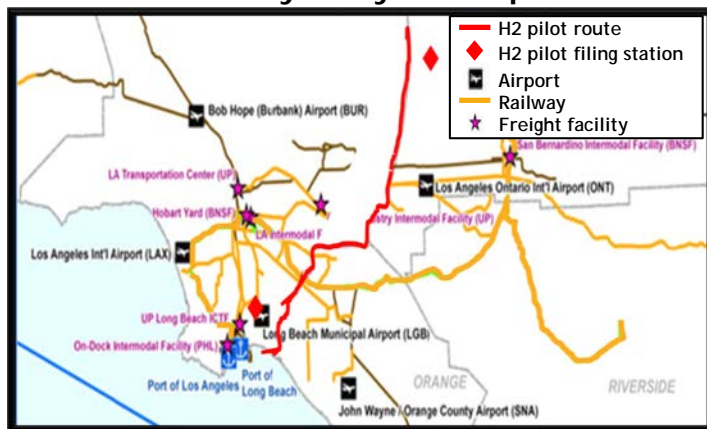
"We see heavy hauling of freight as kind of like an anchor tenant in the hydrogen shopping mall."

- Program Lead,
Canadian Energy Systems Initiative

Notes: (1) Access to CA Transportation / LCFS via addressed in Expand phase; (2) Seasonal / long duration storage addressed as part of green H2 chain
Sources: S&P Platts

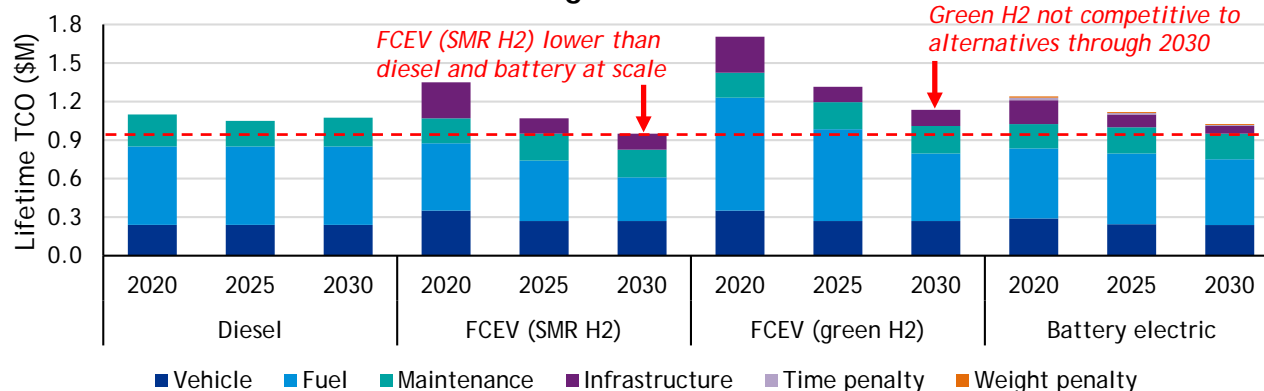
Heavy trucking studies indicating advantages vs. with diesel and electric in LA port area; pilot underway

Port of LA Heavy-Duty truck pilot



- Consortium of public and private (Port of LA, Shell, Toyota, Kenworth) stakeholders convened to test viability of using hydrogen in heavy duty trucks to reduce emissions in port drayage activities
- Pilot involves 10 HD FCEV trucks and 2 filling stations, costing \$82.5M with and funding split between state of CA and private players

TCO for diesel vs. low carbon long-haul trucks^{1,2,3,4}

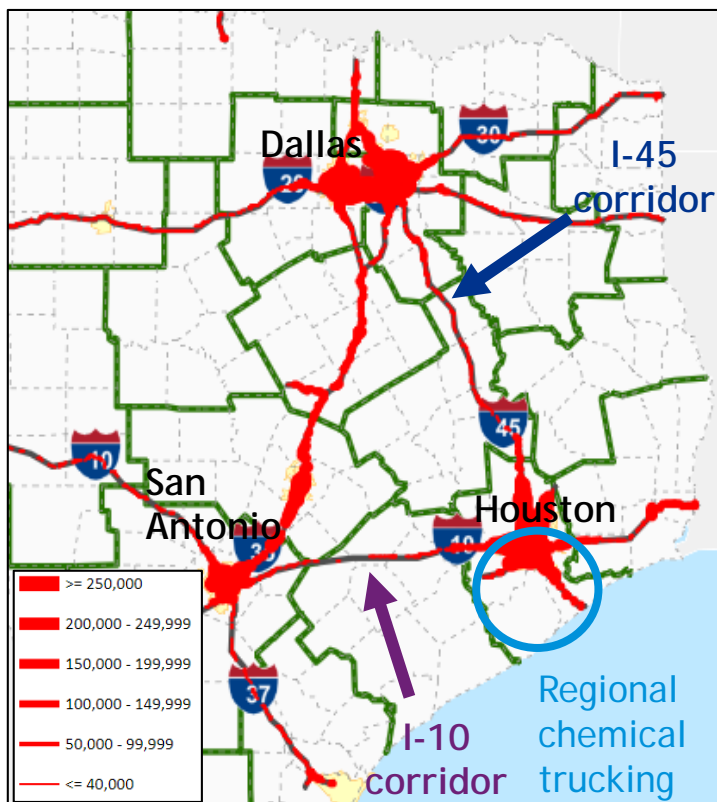


- Lower H2 (SMR) TCO driven by:
 - Low H2 (SMR) cost
 - Increasing diesel
 - High returns to scale on infrastructure

Notes: (1) ICCT study based on LA Port area with 100, 1,000, and 10,000 trucks deployed in 2020, 2025, and 2030; (3) Time and weight penalty applied to BEV trucks; (4) H2 supplied via tube trailer
Source: ICCT

There are several heavy trucking markets involving the Houston area that offer potential demonstration/entry points

Texas truck traffic, 2018



**Truck markets are focused on those involving the Houston area. Assessing viability of H2 trucks in other TX truck markets (e.g., I-35) is out of scope for this study.

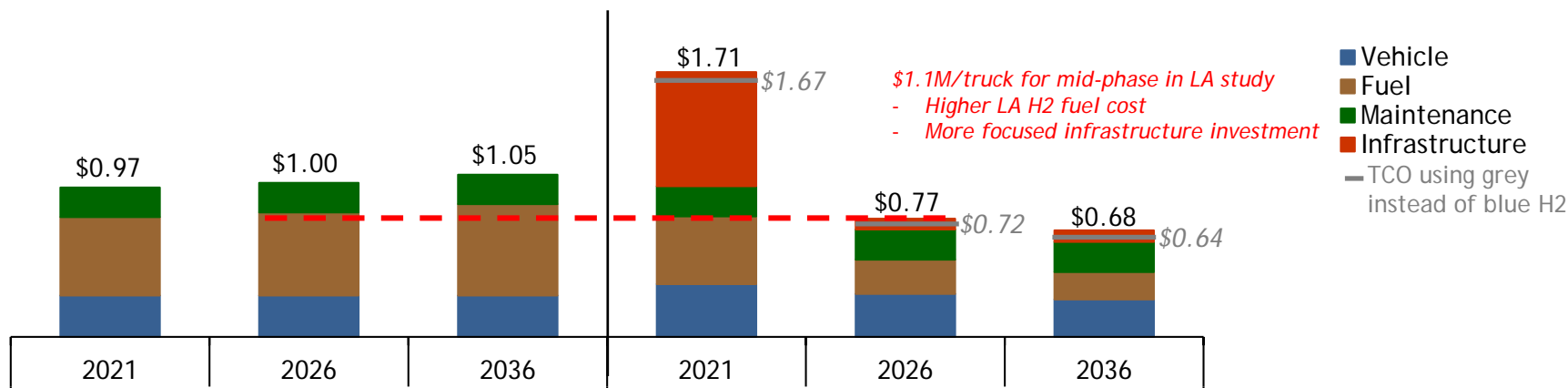
Houston truck markets: overview and pro's/con's of H2 entry

<p>I - 45 (Dallas - Houston)</p>	<p>Heavy Duty daily truck count: 4,819 Duty cycle: long-haul trucking Pro's for entering with H2</p> <ul style="list-style-type: none"> • Foundation to expand H2 along corridor via Dallas • Higher uptime and payload vs. BEV trucks <p>Con's for entering with H2</p> <ul style="list-style-type: none"> • Houston to Dallas link not sufficient stand-alone
<p>I - 10 (San Antonio - Houston)</p>	<p>Heavy Duty daily truck count: 1,557 Duty cycle: long-haul trucking Pro's for entering with H2</p> <ul style="list-style-type: none"> • Foundation to potential I-10 corridor- east and west • Synergies with P/L to tap Calif LCFS market • Potential to leverage existing H2 pipeline from Baton Rouge to Houston (and Houston to LA) <p>Con's for entering with H2</p> <ul style="list-style-type: none"> • Less traffic than Port and I-45
<p>Regional chemical trucking (Houston ship channel)</p>	<p>Heavy duty truck count: 40,000 (80% chemicals export) Duty cycle: return to base Pro's for entering with H2</p> <ul style="list-style-type: none"> • Higher payload capacity and torque vs. BEV trucks • Potential easier demonstration project <p>Con's for entering with H2</p> <ul style="list-style-type: none"> • BEV trucks may be advantaged for shorter, return to base ship channel truck trips

Notes: (1) Number of trucks determined by dividing ton-miles transported between cities by max truck payload
Source: NHTSA.gov commercial mdhd trucks; Interview with Chad Burke from Economic Alliance for Houston Port 16Jul20; Oak Ridge National Lab – FAF Tool; TxDOT

Preliminary indications are H2 is also advantaged on the I45 corridor locally. Using grey H2 can kick start the market while reducing emissions

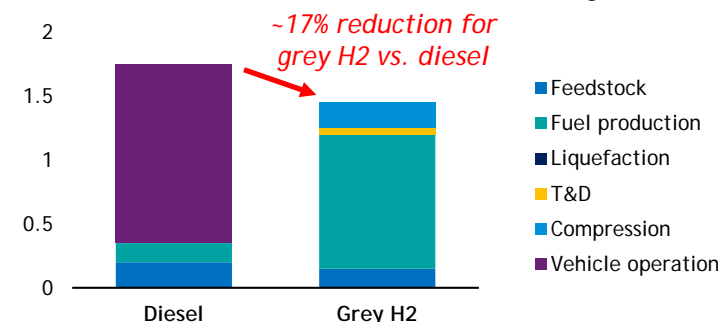
Total Cost of Ownership, diesel and H2 HDVs on I-45, \$M/truck^{1,2}



Phased Market growth for converting diesel to H2¹

Category	Pilot	Expand	Rollout
Year	2021	2026	2036
Trucks	10	121	1,205
Corridor converted (%)	n/a	2.5	25
Filling Stations	2	3	14

Well-to-wheel tractor trailer emissions, kg CO2e/mile



Notes: (1) 115,620 annual miles driven; (2) station utilization: expand: 50%, rollout: 60% (3) pilot, expand and rollout phases last 10 yrs ea.; (4) YoY H2 truck capex reduction follows three phases (4%: '20-'25, 2.1%: '25-'30, 0.6% ea. yr. afterward)
 Source: ANL: HDSRAM, EIA, KPMG analysis, ICCT: Infrastructure needs and costs for zero-emission trucks

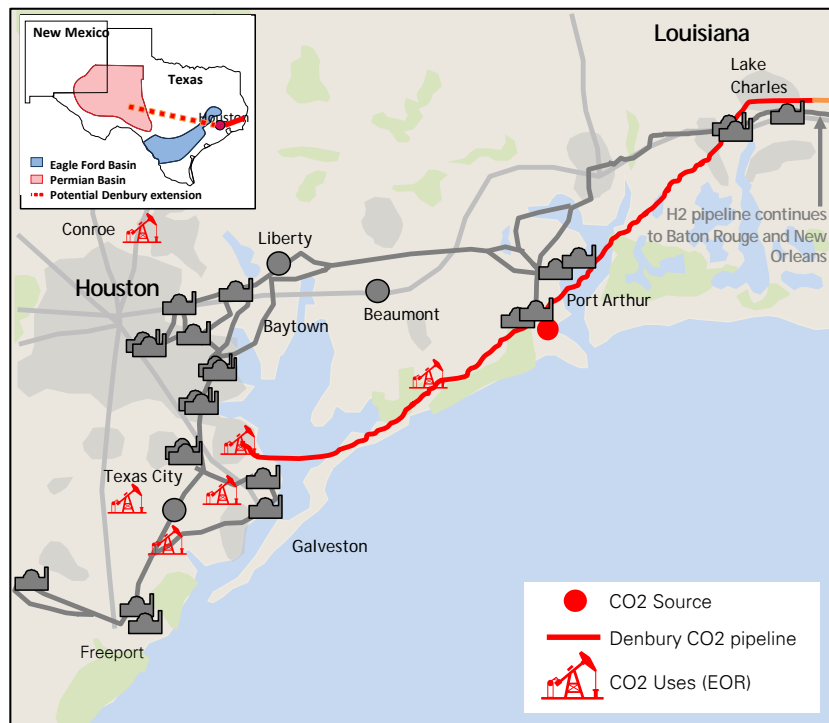
The existing coalition is well positioned to complete optimization and action planning on I45

Markets	Potential next steps
<p>I - 45 <i>(Dallas - Houston)</i></p>	<ul style="list-style-type: none"> ▪ Continue progressing NCTCOG led ZEV initiative focused on I-45 corridor plan (including Dallas - Houston) <ul style="list-style-type: none"> – Consider adding midstream players to discuss pipeline and rights of way options as part of I-45 plan (to capture cost, time to market, and volume H2 supply advantages) – Examine synergies with I70; exploiting Dallas role as central US distribution hub/crossroads
<p>I - 10 <i>(San Antonio - Houston)</i></p>	<ul style="list-style-type: none"> ▪ Assemble coalition of long haul heavy trucking stakeholders involved across the freight route from San Antonio to Houston to Baton Rouge ▪ Examine synergies with P/L (greenfield or repurpose existing) along I10 corridor to tap LCFS incentive in CA and support I10 heavy trucking corridor ▪ Develop a detailed roadmap from entry to scale; evaluate funding required and available (e.g., TERP)
<p>Regional chemical trucking <i>(Houston ship channel)</i></p>	<ul style="list-style-type: none"> ▪ Assemble coalition of regional chemical trucking stakeholders <ul style="list-style-type: none"> – Example stakeholders: chemical co's with decarbonization objectives, OEMS, industrial gas providers, CCUS providers, station operators ▪ Assess feasibility of enabling heavy trucking with H2, hybrid H2/battery, and if H2 is viable, develop a detailed roadmap from entry to scale ▪ Evaluate funding required and available (e.g., TERP)

Appendix

Potential integration of the H2 system with existing and expanded CO2 assets creates substantial blue H2 potential

Existing H2 and CCUS systems in the TX-Gulf Coast area



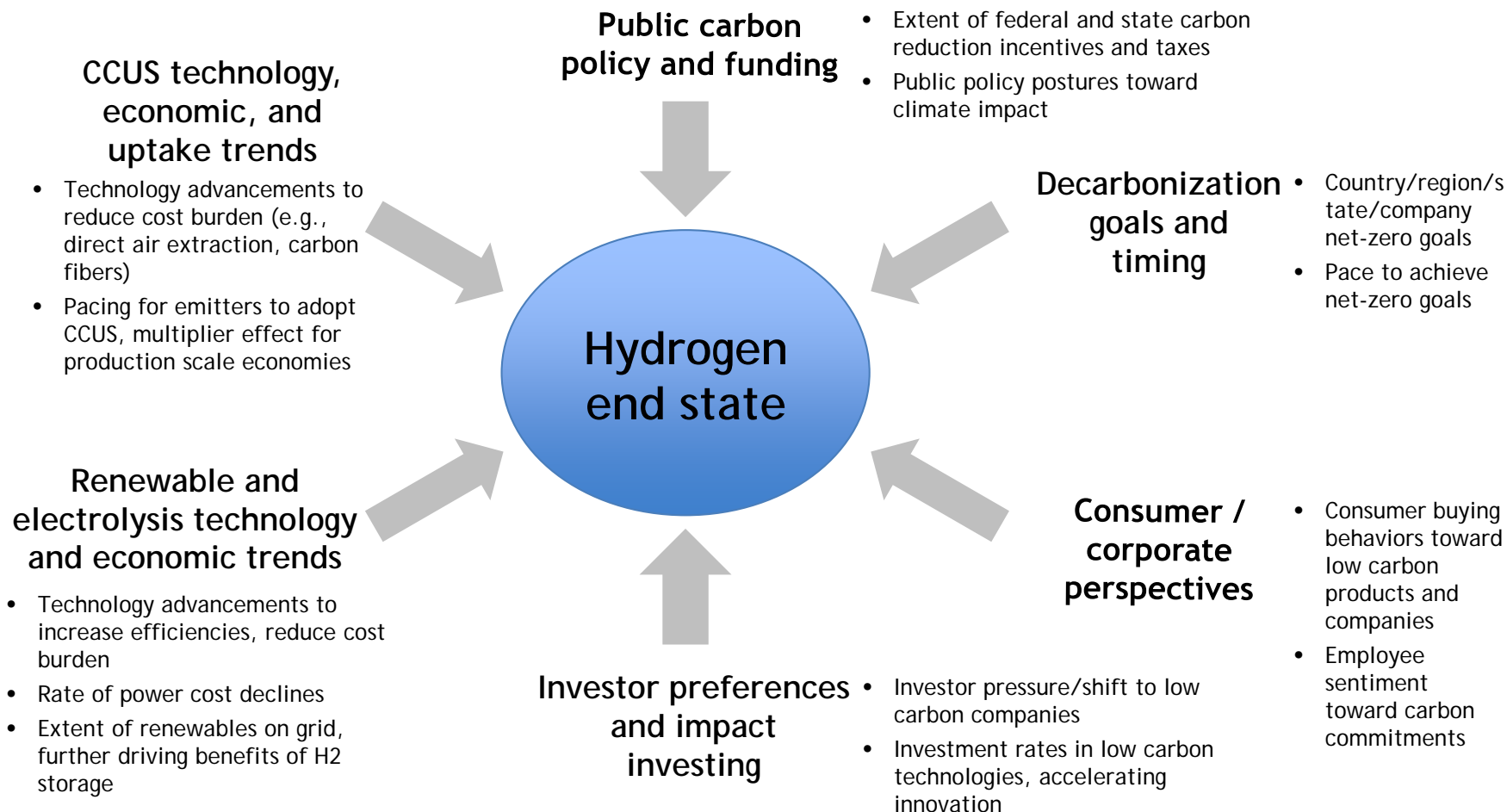
Issues to be addressed to optimize integrate and scale the existing H2 and CCUS systems:

- Which stakeholders (e.g., industrial gas provider, CCUS supplier, Denbury, O&G midstream Co, O&G Co's seeking CO2 for EOR) should be included in the coalition to integrate and scale the blue H2 system?
- To what extent is utilizing the Denbury CO2 pipeline and other assets feasible?
- Based on real estate, technology, etc., how should existing SMR plants be connected into the CCUS system?
- What new CO2 uses (e.g., EOR for Permian) and locations are optimal and how can new and existing infrastructure be leveraged to access?
- How can existing policy be utilized (e.g., 45Q) and what additional policy may be needed?

Notes: (1) Houston MSA defined Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller counties; (2) TX Gulf Coast includes a region from Corpus Christi, TX to Lake Charles, LA; (3) Number of global H2 plants estimated by dividing global H2 production by US avg. production per H2 plant (52k tons H2 / year)
 Source: H2Tools; USDOT PHMSA - National Pipeline Mapping System; Seeking Alpha; Office of US Energy Efficiency & Renewable Energy; Hydrogen Europe

Multiple forces will significantly shape demand, pace, and source of H2 (blue vs. green) in decarbonization over time

Interrelated Forces that will Shape the Future H2 Economy



Electricity Supply for Electric Vehicles in Texas



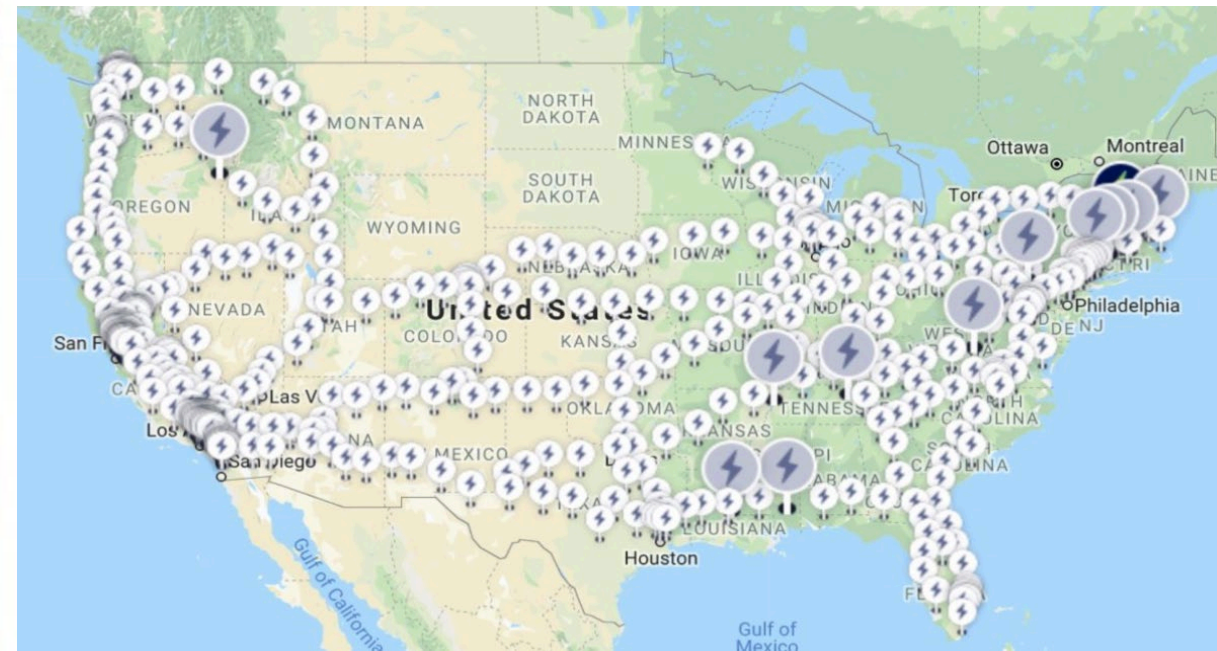
Bill Bojorquez
August, 2020

TxETRA DCFD Recommendations

- Since “range anxiety” has been identified as the #1 obstacle to purchasing an electric vehicle, we recommend a network of **Direct Current Fast Charging (DCFC) stations** to accelerate the use of zero emissions electric vehicles in order to build consumer confidence and support for long-distance inter-city travel.
- TxETRA recommended 95 new DCFC stations using the following guidance:
 - Stations no more than 50 miles apart
 - Stations on all TX interstates, high traffic highways, border crossings and evacuation routes
 - Stations in towns with Transmission-level substations
 - Minimum of four 150 kW DCFC chargers with expansion to 350 kW

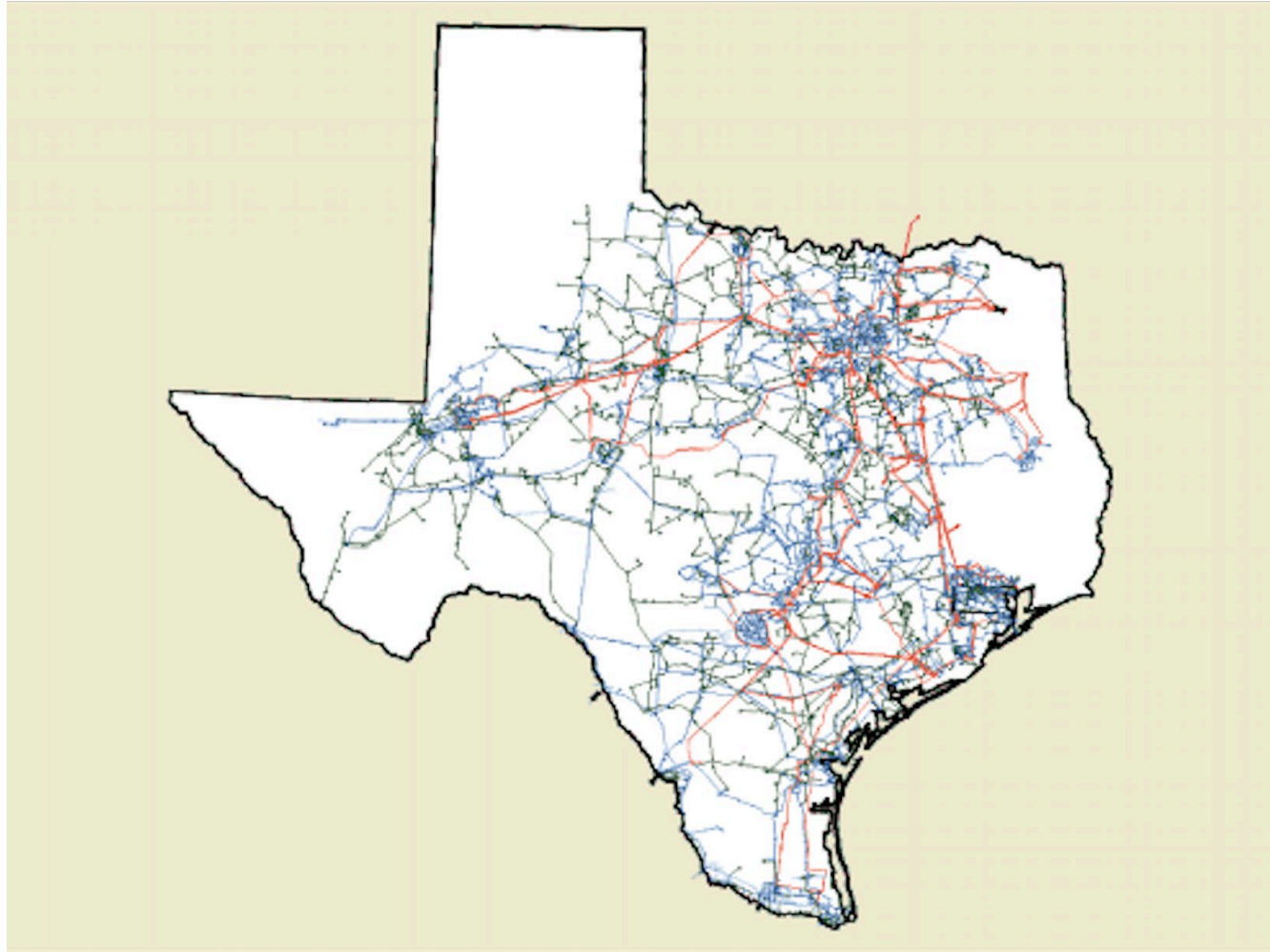
Electrify America Plan

Appendix A: Map of Designated EV Corridors

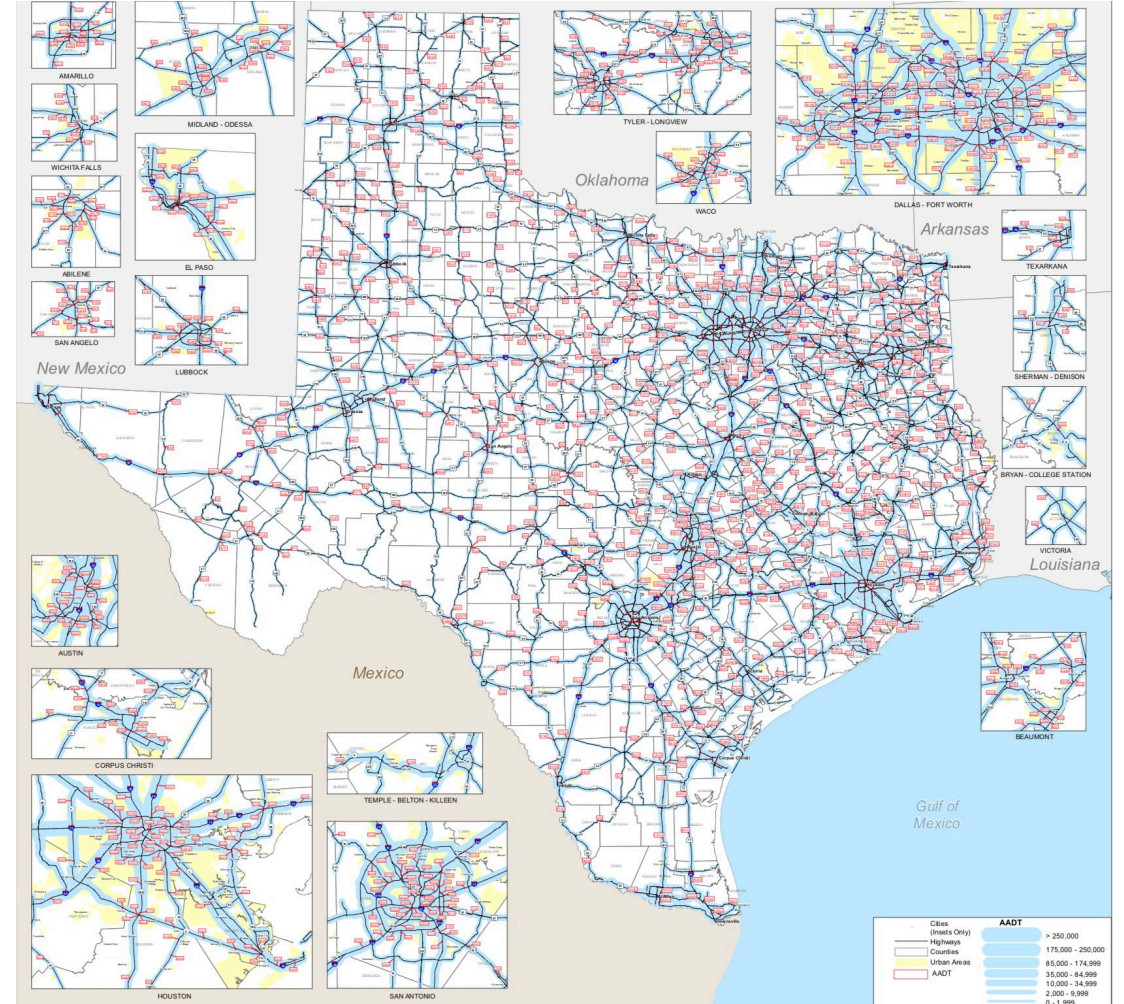


Texas Highway Maps

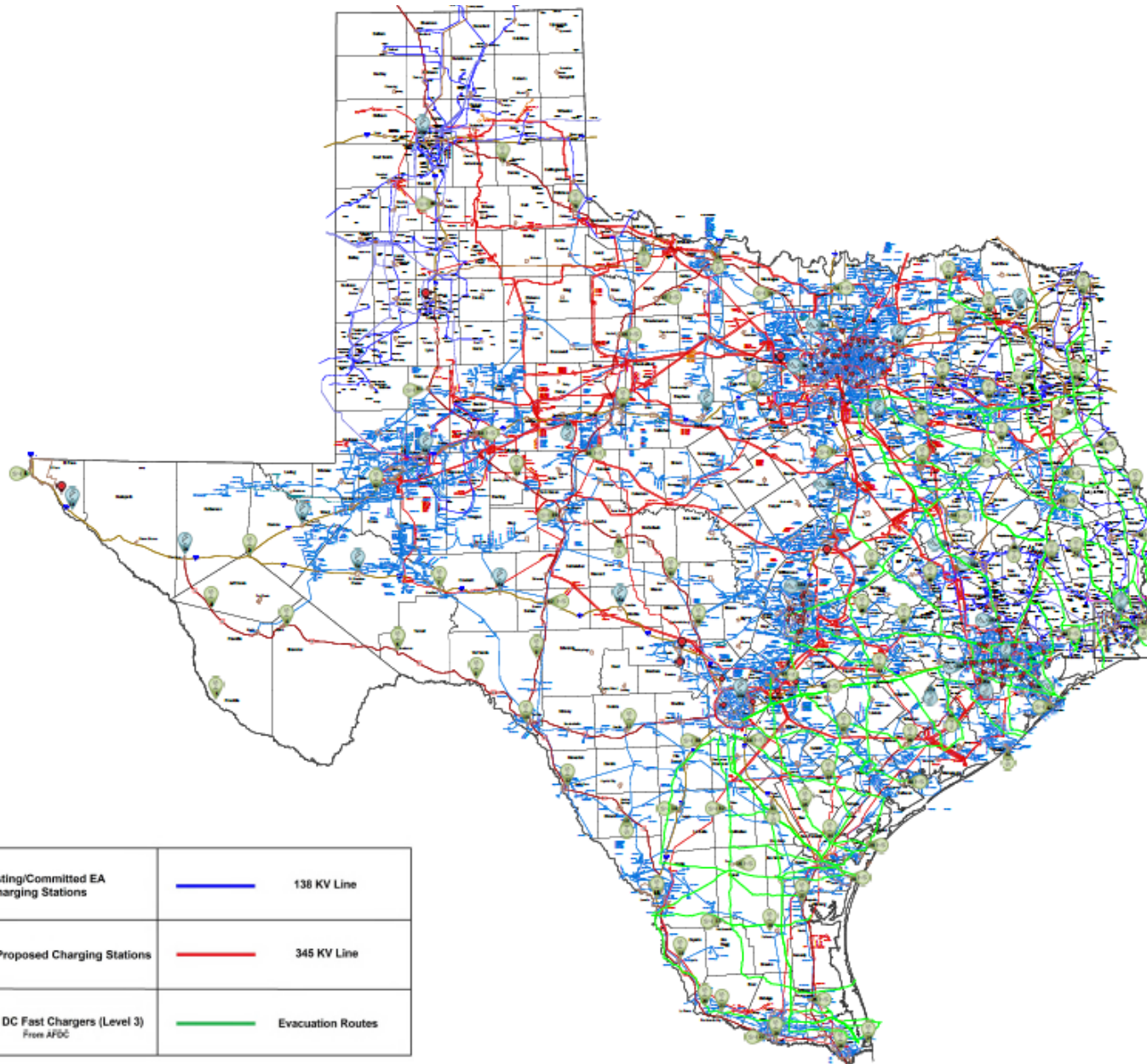
ERCOT Transmission Map



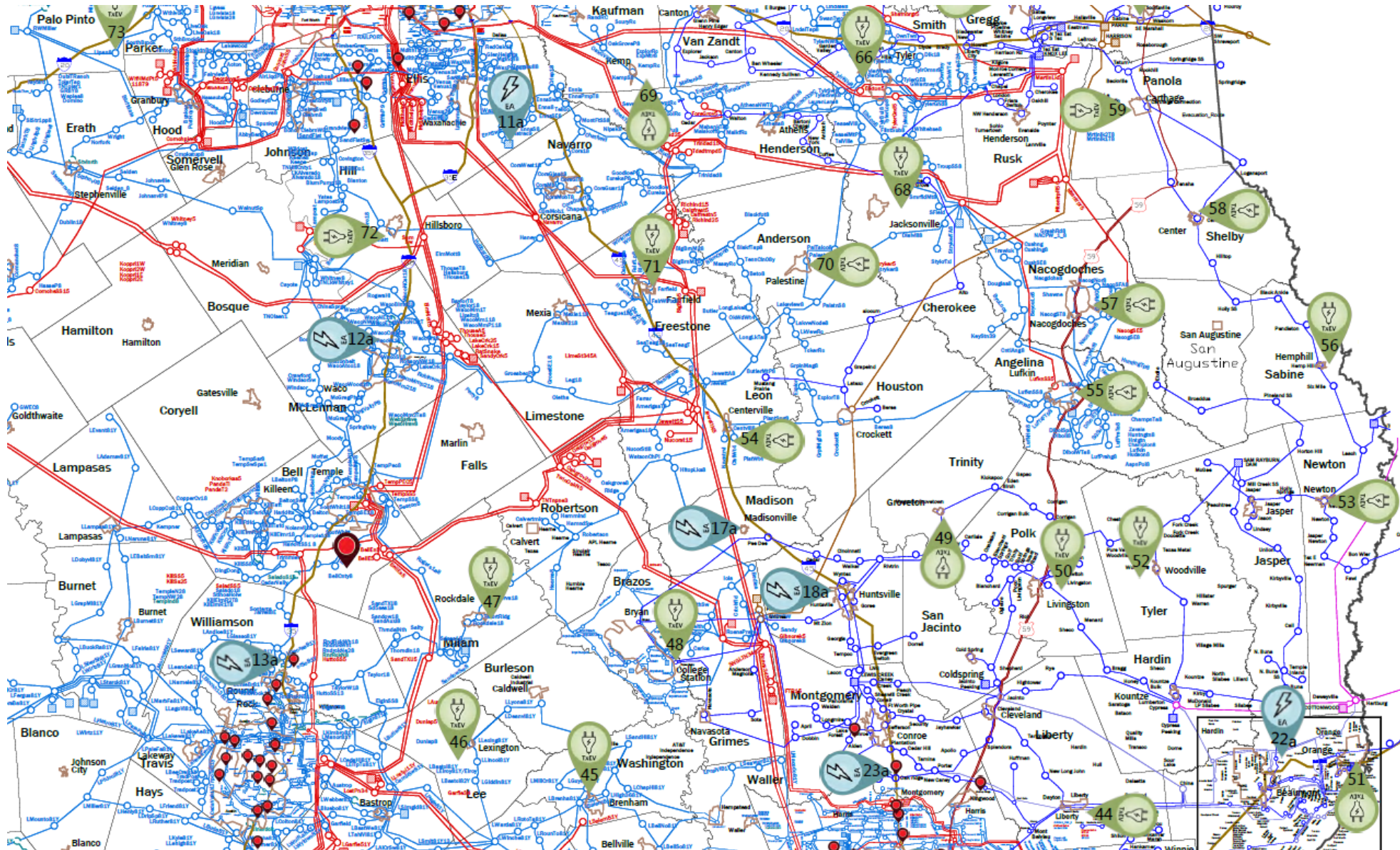
TxDot Traffic Flowband Map



TxEtra Recommended Locations

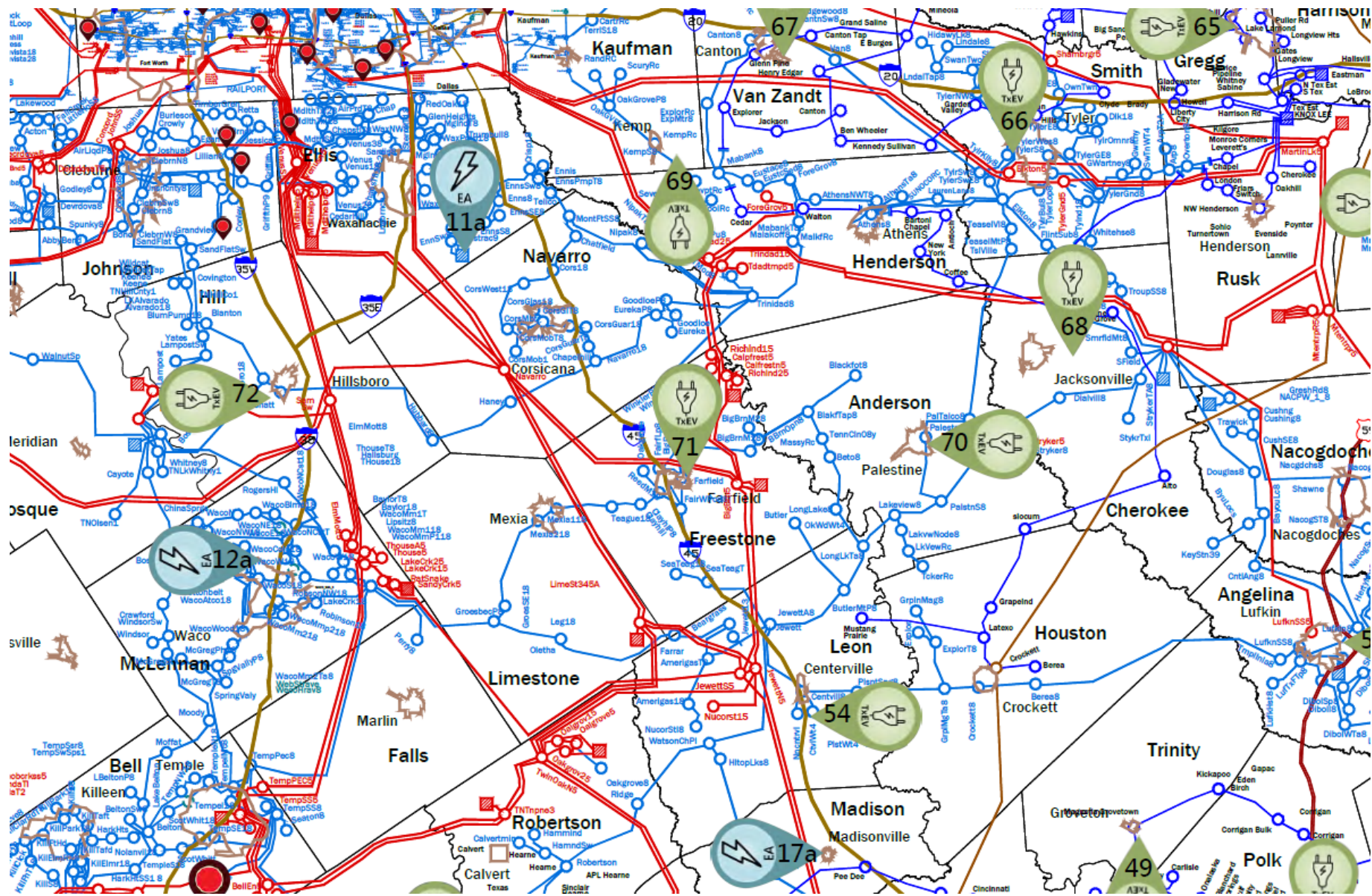


TxETRA Recommended Locations (I-45 Area)

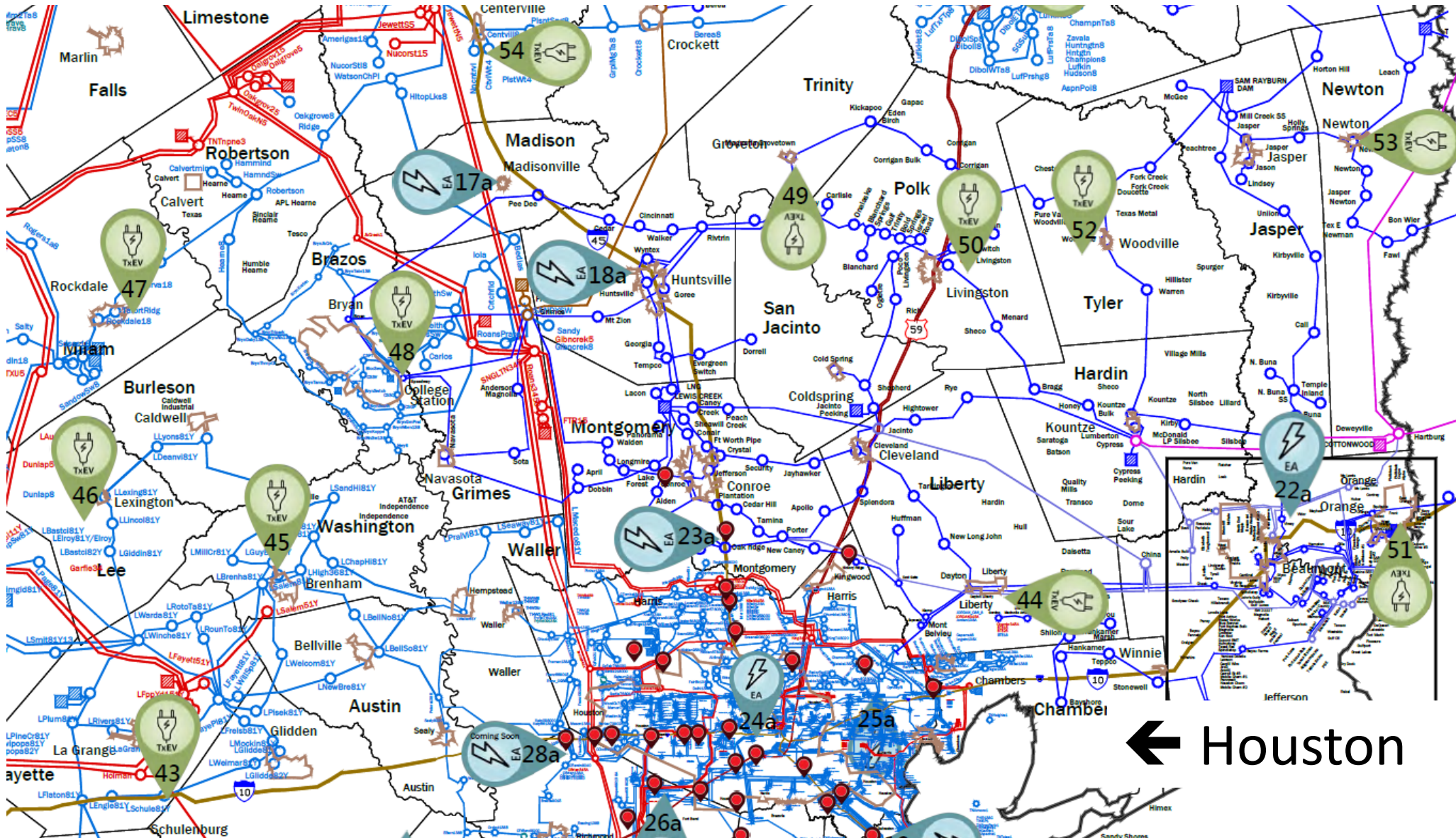


TxETRA Recommended Locations (I-45 Area)

DFW →



TxEV Recommended Locations (I-45 Area)



200 Mile Truck Fueling



Diesel

8 MPG

\$4 / Gallon \$100



CNG

6.3 MPG

\$2.24 DGE \$72



Electric

1.6 kWh/Mile

\$0.12 kWh \$23



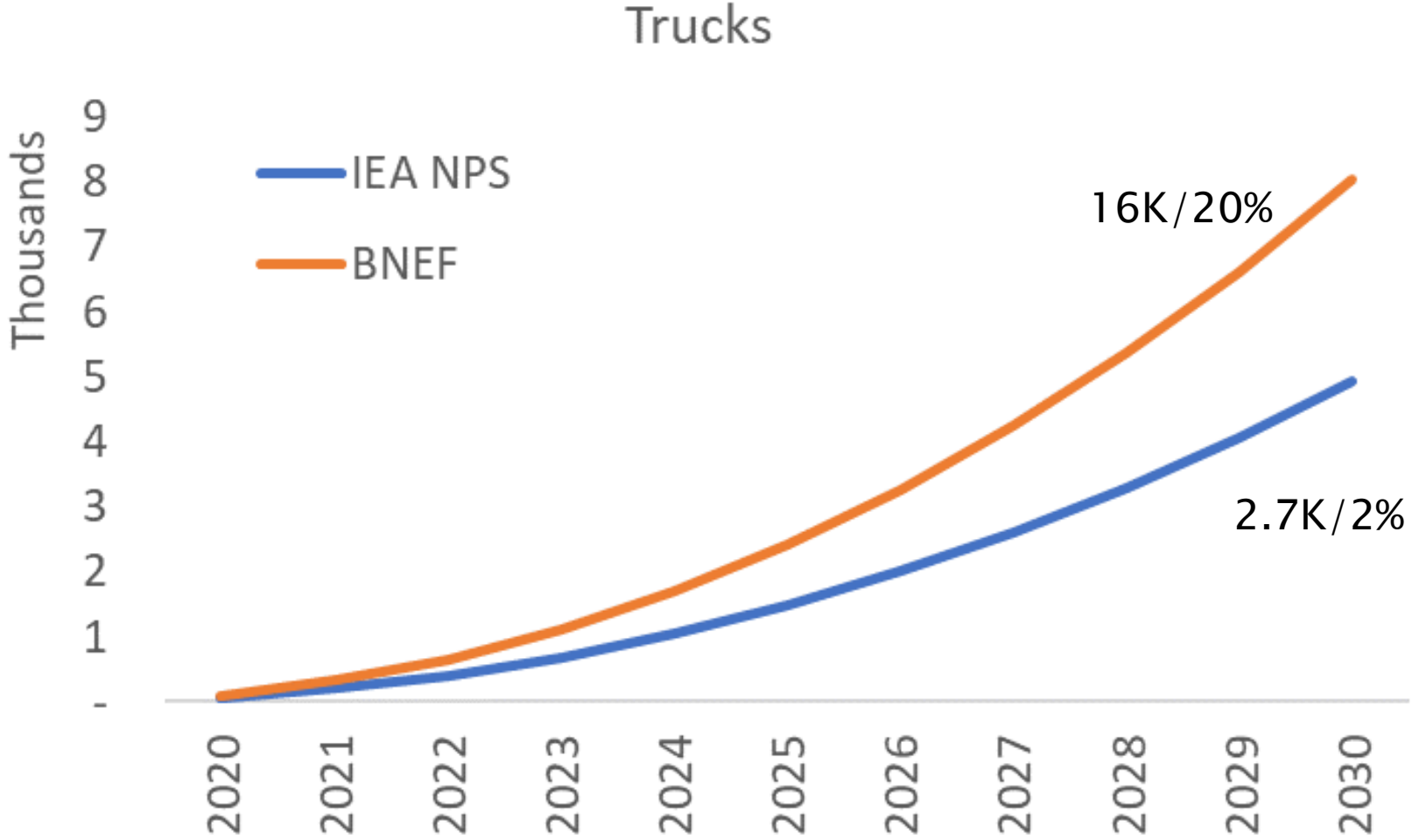
Hydrogen

10 Miles/kg

\$6 -\$16 kg \$120 - 320



EV Projections for Trucks



Four EV DCFC Station Example

- Present technology uses 150 kW HVDC
- Takes 1 hour to reach 80% charge, 1.5 hour for 95%
- Future is 350 kW charges – significant improvement in charging times



Is there Capacity for New DCFC Station Demand?

- Assume twenty 350 kW DCFC chargers in one station – total demand is 7 MW
- Assume 5 DCFCs along I-45 Corridor – total demand is **35 MW**. What is the impact on the ERCOT Grid?
- **0.05%** of the Peak ERCOT demand in 2020 (approximately 75,000 MW)
- **1.1%** of the annual peak demand growth between 2020 and 2021 (3,100 MW)
- Approximately the size of one gas compression station or one metal smelting furnace



QUESTIONS?